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Train-Ferry Landings at Port Mulgrave and Point Tupper, N.S.

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and
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Paper to be presented before the Annual General and General Professional Meeting of The Engineering Institute of Canada at Montreal, February 4th, 5th and 6th, 1931.

SUMMARY.—The train-ferry between Port Mulgrave on the mainland of Nova Scotia, and Point Tupper on Cape Breton island, has been maintained since 1901. The landings over which the trains pass from the ferry to the shore are structures which must accommodate the list of the boat, variation of draft, and a tidal range of about 7 feet.

After thirty years' service the demands of heavier and greatly increased traffic required the renewal of the original structures, and the old design was generally followed. Experience has enabled a number of improvements to be incorporated in the new landings, particularly in connection with the method of meeting the severe shocks when the ferry steamer is mooring and with a view of obtaining increased stability and flexibility. Descriptions are given of the means adopted for these purposes, and of the special methods of erection which were necessary in order to avoid any interference with the regular traffic of the Canadian National Railway. The erection programme was also limited by tidal conditions. The actual work of cutting away and removing the old structures and their replacement by the new was done in a period of four months.

All major operations had to be carried out on Sundays, and in the case of some of these it was necessary to select Sundays on which the times and heights of the tide were suitable. The replacement of one apron and its intermediate span involved the handling of more than 450 tons of steelwork, and with the renewal of 300 feet of track, had to be carried out in a period of twenty hours. The total weight of steel in the two landings is more than 1,300 tons. The paper describes in considerable detail the arrangement and operation of the structures, and the erection methods employed.

Historical

Railway traffic between the mainland of Nova Scotia and the island of Cape Breton has been maintained regularly throughout the year since 1901, when a ferry service was provided, capable of transporting an entire train with locomotive engine across the Strait of Canso, a distance of about one mile. The ferry boats are of special construction, having three parallel tracks on the deck, spaced 11 feet 6 inches centre to centre and 260 feet long. (See Fig. 1.)

The landings at Port Mulgrave on the mainland, and Point Tupper on the island, form an essential feature of this ferry service. Their geographical position and the lay-out of the yards are shown in Figs. 2, 3 and 4. These landings must accommodate the list of the boat when being loaded or unloaded, which is about one in ten; variations of light and full draft; and a range in tide of some 7 feet. The original design, which contained many interesting and unique features, was conceived by G. H. Duggan, M.E.I.C., at that time chief engineer of the Dominion Bridge Company, and was worked up under his direction, in consultation with Mr. John Forbes, of the engineering staff of the Intercolonial Railway.

The original structures had for some 30 years been subject to many adverse conditions, including the corrosive action of salt air and sea water, constant racking under heavy traffic, together with the ramming and listing of the ferry boats. Moreover, during the winter season, they had been hampered by floating ice in the slips and by heavy deposits of snow and sleet on the moving structural parts and on the machinery. But they had served their purpose during all these years, without causing serious trouble or delay. Therefore, when the demands of heavier and greatly increased traffic required their renewal, it was decided to follow the old design as closely as possible, making only such changes in detail as seemed to be warranted by past experience, together with increased sections due to heavier loadings. The new ferry landings have been built under the supervision of C. S. G. Rogers, A.M.E.I.C., Bridge Engineer, Canadian National Railways, Maritime Division. Mr. Rogers had carefully studied the condition and behaviour of the old structures; and the modifications and improvements in the new are mostly due to his suggestions. The renewals were carried out by the Dominion Bridge Company during the year 1930.

General Description

An elevation and a plan of one of the new structures are shown in Fig. 5, and transverse sections in Fig. 6. The structure consists essentially of three hinged leaves, supported at the inner or land end on a fixed abutment, and, at other points, by transverse girders, the latter being suspended from gantry frames. At the inner end there is one central track only; from which there are right and left turnouts to 10-degree reverse curves, thus providing three tracks at the outer or sea end, corresponding to those on the ferry boat. Only one of these tracks, however, can be loaded at a time. The spreading of the tracks from a point on the structure, instead of providing for three tracks

Fig. 1—The C.N.R. Car Ferry "Scotia II" approache Point Tupper.

throughout, greatly complicated construction; but this was done in the original design principally to insure that only one track could be loaded at a time. In the new design, there was no option, because the cost of revising the layout of the approach tracks would have been prohibitive.

The ferry landing, which serves as a docking and mooring structure for the vessel, is subject to severe shocks, which must be absorbed by or transmitted through the steelwork to the extreme inner end. In the original structure, the outer longitudinal girders of the apron and the main longitudinal girders of the intermediate and inner leaves were not in continuous lines, but had separate hinged bearings, side by side, on lifting girders *E* and *I*. The inner longitudinal girders of the apron and the end stringers of the intermediate leaf had separate hinged bearings on lifting girder *E*; and the end stringers of the intermediate and inner leaves had separate hinged bearings on lifting girder *I*. Moreover the impact of the vessel, which could be applied to either one of the outer longitudinal girders of the apron, or to all four of its longitudinal girders, in varying proportions, was transmitted by them to lifting girder *E*. At this point, it was taken up and transmitted by the longitudinal girders and the stringers of the intermediate leaf to lifting girder *I*. At girder *I*, a portion of the impact was received and transmitted by the trusses of the inner leaf to the buffers at the abutment; the remainder was received by the track stringers of the inner leaf, and was delivered by them to the top flange of the floorbeams to which they were attached. The latter, acting as horizontal girders, conveyed this portion of the impact to the trusses; thence it was transmitted to the buffers. Some of the shoes on lifting girders *E* and *I* were designed to accommodate girders of adjacent leaves, in which case, the thrust of one of these girders and the resistance of the other tended to twist the shoe about a vertical axis. Other shoes accommodated one member only, in which case, the thrust of the girder or stringer tended to revolve the shoe about a horizontal axis. In consequence, the connections of all the shoes on the lifting girders had become loosened and had partially failed. Furthermore, on the inner leaf, where the stringers were supported on the top flange of the floorbeams and connected thereto by only two rivets, these rivets had been loosened by the impact from the vessel, and permitted sufficient motion between the bearing surfaces to cause serious wear. In some instances, this wear, in combination with the corrosive action of salt water, had practically extended through the bottom flange of the stringers.

In the new structure, the outer longitudinal girders of the apron and the main girders of the intermediate and inner leaves are in continuous lines; for, at lifting girders *E* and *I*, they meet concentrically and are hinged by a pin common to both, thus providing definite and substantial paths for transmitting the thrust or pull of the vessel to the buffers at the abutment, and without tending to twist or to overturn the supporting shoes on the lifting girders. Owing to the comparative rigidity of these paths of resistance, any thrust on the stringers of the inner leaf should be reduced to a minimum.

Inner Leaf

The inner leaf is a pony-truss span of 100 feet, having two parallel trusses 21 feet 6 inches centre to centre, as shown in Fig. 7. It has a single track only to a point near its centre, where there is a three-way switch for the right and left turnouts. The track rails are laid on timber ties, supported by longitudinal stringers, the latter being 8 feet centres under the single track, but spread at the turnouts, where supplementary stringers are also provided. The floorbeams are 12 feet 6 inches centre to centre. The inner end of this leaf is swung by short links inside of steel box pedestals, in which are incorporated steel-spring buffers, to absorb shock from the ferry. A detail of these pedestals is shown in Fig. 8. The other end is hinged in shoes, common to this and the intermediate leaf, on lifting girder *I*. The stringers are supported on the top flange of the floorbeams, as in the original structure; but, to guard against slip from any cause, gusset plates are inserted between the stringers and the floorbeams, and securely riveted. Except for heavier sections, no other improvement of importance has been made to this leaf.

Intermediate Leaf

The intermediate leaf has two 50-foot longitudinal girders, hinged at both ends, and spread from 21 feet 6 inches at lifting girder *I*, to 28 feet 6 inches at lifting girder *E*. Its connections are shown in Figs. 9 and 10. At *I* and *E* respectively, these girders meet concentrically the trusses of the inner leaf and the outer girders of the apron, in shoes and on pins common to both. To facilitate erection, the pin bearings at both ends of these girders are constructed in the form of a hook. It was thus possible to drop the girders into place without disturbing the pins supporting the adjacent leaves. The intermediate leaf carries three tracks, and the rails are laid on timber ties, supported by stringers immediately under the rails. Additional support for the ties is provided by shelf angles on the

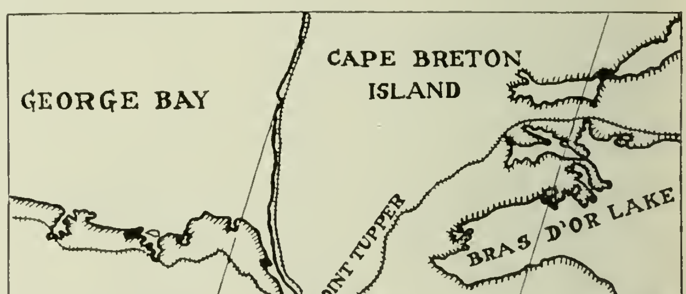

Fig. 2—Geographical Position of Port Mulgrave and Point Tupper.

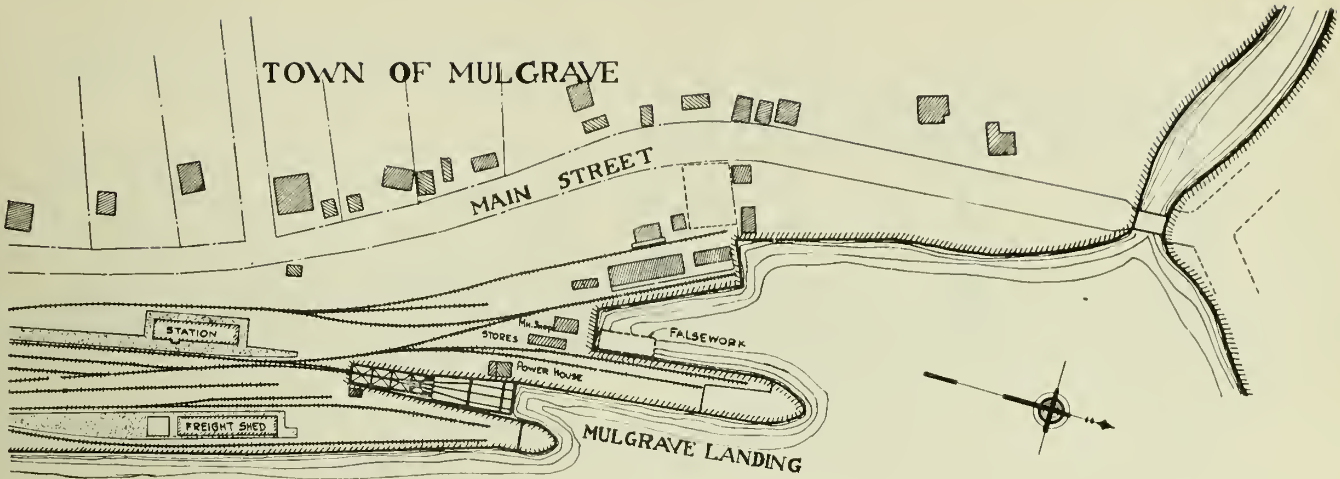

Fig. 3—Location of Yards, Port Mulgrave.

web of the main girders. The stringers on this leaf are connected to the web of the floorbeams, which latter are 12 feet 6 inches centre to centre. The main girders are unusually shallow at their ends; but adequate provision has been made for both vertical and horizontal shear by outside reinforcing plates, covering the vertical leg of the flange angles, and giving to each flange rivet the value of double shear plus bearing on the web. These outside plates were extended towards the centre of the span far enough to splice the web plate.

Apron

The outer leaf, or apron, is 50 feet long and carries three tracks. (See Fig. 11.) It has four longitudinal girders, the two inner being parallel and 11 feet 6 inches centre to centre. At gantry *E*, the two outer girders are 28 feet 6 inches centre to centre, and are hinged in shoes common to these and the main girders of the intermediate leaf; and they are spread to 32 feet 6 inches centres at the extreme outer end of the apron. As shown in Fig. 12, all of the longitudinal girders are supported by ball-and-socket bearings on a transverse lifting girder at gantry *B*, but for dead load only. The live load reactions at the outer end of the apron are taken by the vessel. The rails are laid on ½-inch plates, supported by transverse floorbeams spaced 15 inches centre to centre. In designing the floorbeams, it was assumed that the wheels might either be on the track or at any possible position between the main girders which would produce the maximum shear or moment. All floorbeams, except those at both extreme ends of the apron, were proportioned to carry the maximum wheel concentrations, with impact, uniformly distributed over a length of three feet; but those at both extreme ends were proportioned for the full effect of the wheel loads, with impact.

The excessive listing of the ferry during loading or unloading, to which reference has already been made, affects chiefly the apron; for, while the end supported by the lifting girder at gantry *E* will always be horizontal, the outer end must conform to the deck of the vessel, as indicated in Fig. 13. It was thus necessary to provide a large degree of flexibility in the apron, and without overstraining its main materials or connections. These conditions prohibited the usual and cheaper beam-and-girder construction, with stiff or semi-rigid connections.

To effect the desired flexibility, the end connections of all intermediate floorbeams are provided with universal bearings, as shown in Fig. 14. These consist essentially of steel-trunnion castings, riveted to the ends of the floorbeams. On the trunnions are spherically turned enlargements, which bear on the heavily reinforced web of the longitudinal girders in cylindrical holes. The same general type of bearings was used in the old structure, and provided the necessary flexibility. It was realized, however, that there had been considerable wear on the bearing parts, although the extent of this wear was difficult to determine while the old structure was in service. Accordingly, the diameter of the trunnions and the thickness of web reinforcement were substantially increased in the new structure. On dismantling the old apron, it was found that the wear on these parts had been considerable, as expected; also that it was principally in the holes, rather than on trunnions. With this type of universal bearing, which permits of transverse movement as well as angular, it is necessary to provide some means for spacing the main girders. In the old structure, the spacers consisted of round rods, threaded through wrought iron pipes, and provided with rounded

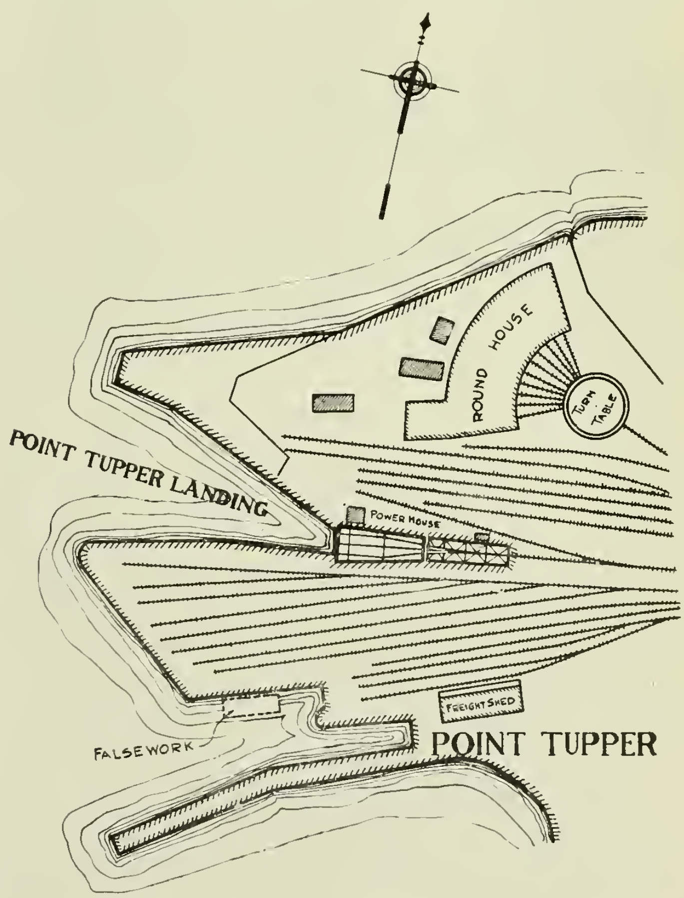

Fig. 4—Location of Yards, Point Tupper.

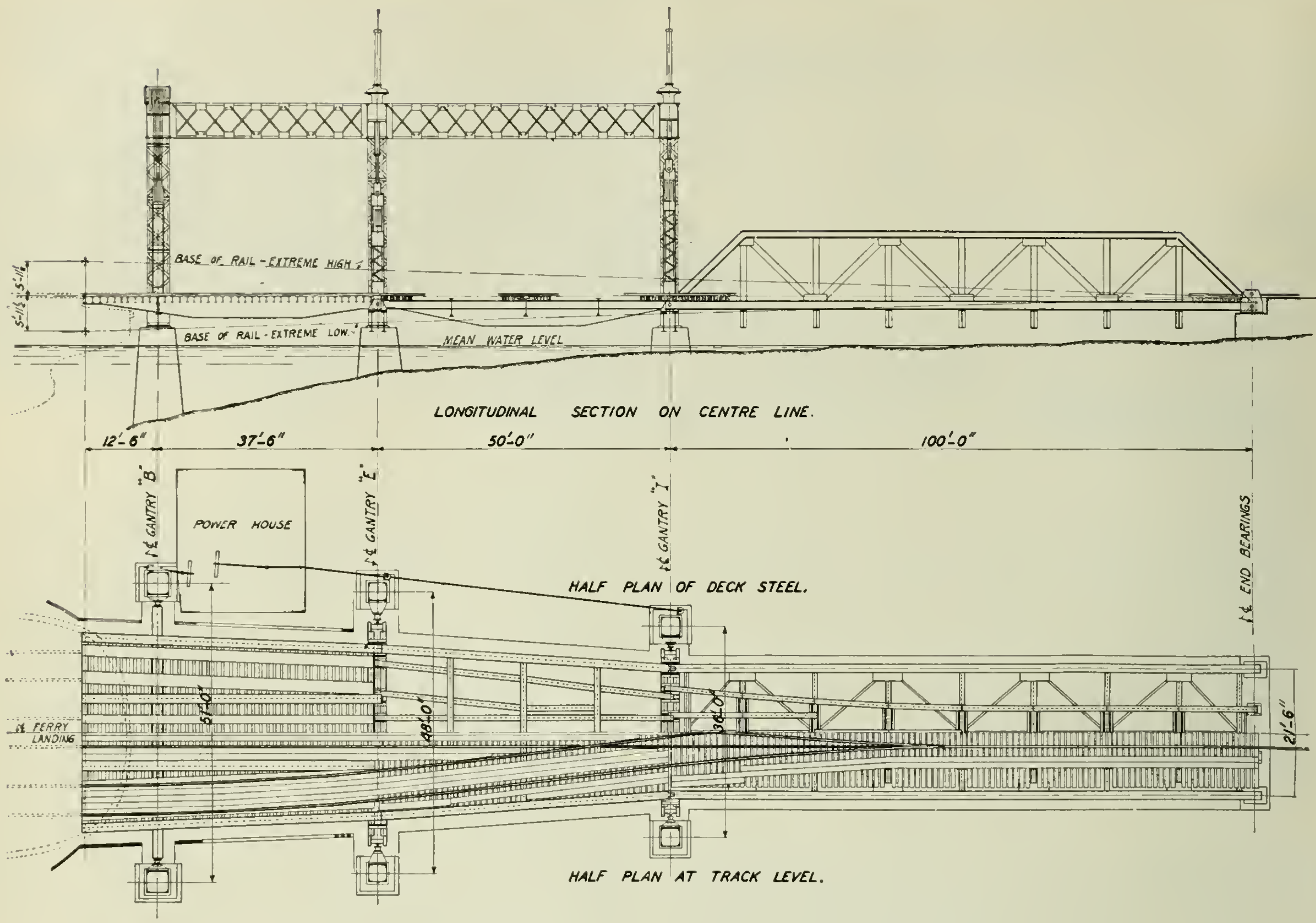

Fig. 5—Plan and Longitudinal Section through Ferry Landing.

castings at the ends, to bear against the web of the girders. They were located between the floorbeams, and spaced 3 feet apart. This construction was unsatisfactory; for many of the spacers had failed and had been renewed from time to time.

To serve as spacers in the new structure, the floorbeams at both extreme ends of the apron are connected by pins to exceptionally heavy stiffener angles, riveted to the web of the main girders. Additional spacers are provided at the middle and quarter points, consisting of substantial I-beam sections, hinged to the main girders immediately below the deck plates.

Further to increase the flexibility of the apron, the track rails are not connected rigidly to the floorbeams, but are bolted to the ½-inch deck plates only. The latter are maintained loosely in position by cleats, riveted to the top flange of the floorbeams, small vertical and horizontal clearances being provided, between the cleats and the deck plates, sufficient to permit of the slight movement between the deck plates and the floorbeams, incident to warping. In the old apron this feature of the design was similar; and the working of the floor plates had caused them to cut into the top flange of the floorbeams as much as ¼ inch. To prevent this wear, it would be necessary to connect the floor plates rigidly to the floorbeams, which was considered inadvisable because it would restrict the warping.

Stability, strength and rigidity are the main governing factors in the design of most engineering structures; but, in an apron of this type, flexibility is an additional requirement, of great importance, and the problem has been to provide a due measure of each of these qualities without sacrificing the others.

In the original structure, the main or longitudinal girders of the apron were found to be lacking in lateral stability. At the outer end, these girders were provided with spherical shoes, bearing on flat bed plates on the deck of the vessel. At the inner end, they had pin bearings in their single web, and were supported in shoes on lifter girder *E*. Owing to lack of definite transverse support, they early developed a tendency to tilt, and anxiety was felt lest they should capsize. To prevent this the railway added, near the hinged end of the girders, deep transverse struts, which were effective in preventing the girders from overturning, but were sufficiently narrow to twist and to permit of the necessary warping of the apron. Even with these struts, the main girders had developed a permanent wind, with their outer end twisted out of the vertical about one in twelve.

In the new structure, some definite measure of stability has been given to the longitudinal girders of the apron by means of double bearings at their hinged end, as shown in Fig. 10. It will be noted that the outer girders are here converted into a box section; and double bearings on the shoe pin, about 20 inches apart, are thus obtained. To serve a similar purpose at the hinged end of the inner girders, where a box section could not be used owing to the interference of the stringers of the intermediate leaf, double bearings on the pin have been obtained by the use of substantial flanged castings, riveted to the heavily reinforced web of the girders. As a result of these improvements, there is thus far no perceptible cant or twist in the main apron girders of the new structure.

The outer end of the apron is exceedingly shallow, to conform to the construction of the ferry; but it has been possible to provide sufficient resistance to vertical and horizontal shear in the main girders by outside reinforcing plates, covering the vertical leg of the flange angles, as explained in connection with the intermediate leaf.

Gantry *B*

The lifting girder at gantry *B* supports only its own weight and the dead load reactions of the apron. It is constructed with a single web, and it is made exceptionally shallow, to keep it as far from the water as possible. In accordance with the requirements of the engineer, allowance has been made for corrosion by substantially increasing its section over that required for present strength. It is entirely suspended from sheaves, carried by the gantry girder above, and is counterweighted for its dead load reactions plus or minus about 25 per cent.

As will be seen from Fig. 13, there are two counterweights for each end of this lifting girder, main and auxiliary. The auxiliary counterweights are above the main counterweights, and are suspended by cables from an operating drum at the centre of the gantry girder, by which they may be raised or lowered, or maintained at any desired height. The function of the axuiliary counterweights is to operate the apron, as follows:—When the outer end of the apron is unsupported by the ferry, the auxiliary counterweights are in contact and acting in conjunction with the main counterweights; and, the lifting capacity of the combined counterweights being greater than the dead load reactions of the lifting girder, the latter will rise when the auxiliary counterweights are lowered, and will fall when they are raised. When the vessel has been brought into position, the apron is lowered to meet the deck of the ferry; and, after the ferry has been secured to the apron, the auxiliary counterweights are raised, thereby causing a positive reaction on the ferry, equal to that produced by the dead load of the apron when supported at both ends only, less a negative reaction due to the upward force at *B* which is exerted by the main counterweights. The resulting positive reaction is sufficient to maintain the longitudinal girders of the apron in contact with the deck of the vessel at all times. The auxiliary counterweights are then raised high enough so as not to interfere with the free working of the main counterweights, which will rise and fall on one or both sides, to accommodate the angular and vertical movements of the ferry while being loaded or unloaded. On departure of the ferry, the end locks are released, and the auxiliary counterweights are lowered as far as necessary to raise the end of the apron well above the deck of the vessel.

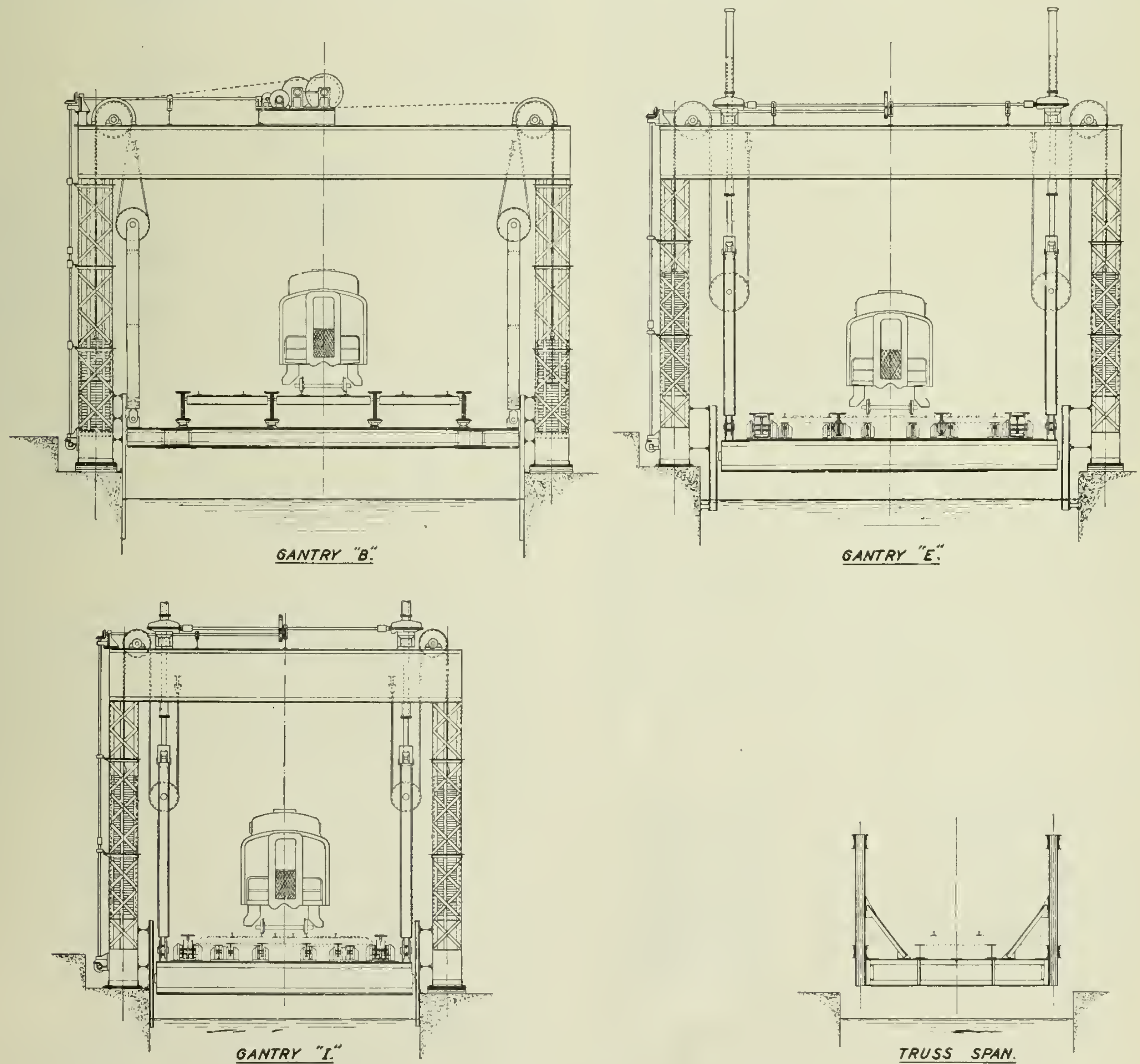

Fig. 6—Transverse Sections of Ferry Landing.

Fig. 7—View of Landing from Shore End—
Inner Leaf in Foreground.

The posts for gantry B are 45 inches square, and are composed of four corner angles with tie plates and latticing on all sides; they serve the double purpose of supporting the gantry girder with its loads and as a guide for the counterweights. The latter are composed of cast-iron slabs, measuring approximately 44 × 44 × 3 inches. The weight of each main counterweight is about 31,000 pounds and that of each auxiliary counterweight about 20,000 pounds. Provision was made for increasing or decreasing both main and auxiliary counterweights. Each main counterweight is suspended by four 1¼-inch diameter wire ropes, which pass through holes in the auxiliary counterweight; and each auxiliary counterweight by two 1¼-inch diameter ropes. The diameter of the sheaves is 48 inches. Fig. 13 is a section at gantry B, showing the inclination of the lifting girder and the deck of the apron at this point, also the relative position of the several counterweights, when the outer end of the apron is supported on the deck of the ferry and the latter is heavily loaded on one side, causing it to list. Furthermore, this view shows the main or longitudinal girders of the apron, in section, with the webs vertical, to which reference has previously been made; and one set of the hinged spacing struts.

Gantries E and I

Gantries E and I, and the lifting girders at these points, are similar to one another. In the original structure, the lifting girders at E and I were of single web design, 42 inches deep, and the flanges of the longer girder E were very heavily plated to resist the large bending moment. In order to provide for the much greater dead and live loads supported by the new structure, and to avoid using a greater depth of web plates, it was decided to use two girders at each of these locations, spaced 24 inches centre to centre, and having flanges 13 inches wide. The girders are connected at the ends by lifting diaphragms, and the top flanges are connected at points of loading. This arrangement permitted of a much better distribution of metal in the flanges, and provides ample space between the girders for inspection and painting. The sections of these girders also were substantially increased to allow for corrosion.

The lifting girders at gantries E and I are suspended by screw shafts and by counterweight cables from the gantry girders above, the counterweights being so proportioned that there will always be a positive dead-load reaction of 10,000 pounds on each screw shaft, thus preventing the possibility of an upward thrust thereon. In addition to this amount of dead-load, the screw shafts support the entire live load reactions of the lifting girders. They are raised or lowered by revolving nuts and bevel gears, but are operated only under dead-load conditions, or a load of 10,000 pounds each, plus friction.

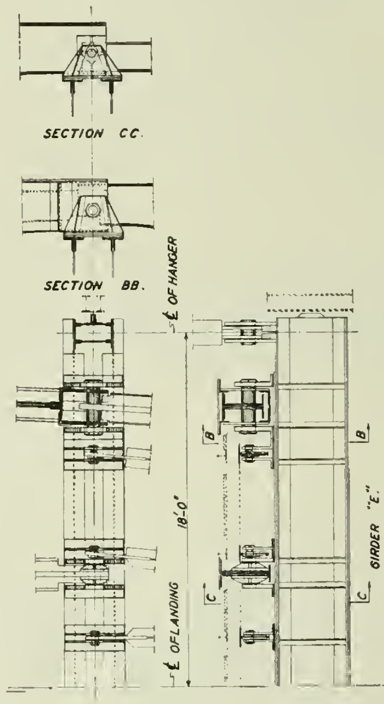

Fig. 9

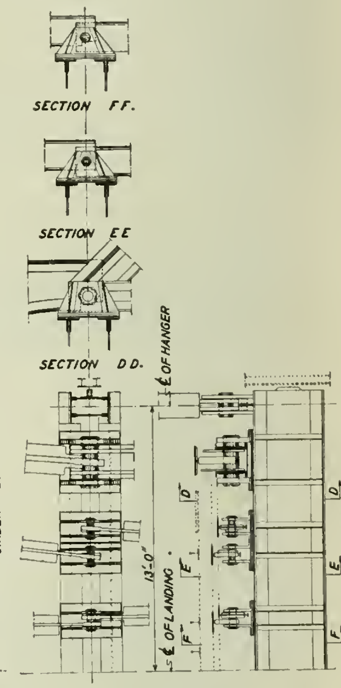

Fig. 10

Connections for Intermediate Leaf, Longitudinal Lifting Girders E and I.

The posts for gantries E and I were made 37 inches square, the same as those of the original structure, in order to use the old counterweight slabs as far as possible. They are composed of four corner angles with tie plates and latticing on all sides. The weight of each counterweight at gantry E is about 45,000 pounds; at gantry I, about 55,000 pounds, and provision was made for increasing or decreasing these weights. Each counterweight is suspended by four 1¼-inch wire ropes. The diameter of the sheaves at gantry E is 48 inches; but, at gantry I, it was impossible to use sheaves of greater diameter than 36 inches, the same as in the original structure. However, the vertical movement of the lifting girder at gantry I is infrequent and small, probably not exceeding 3 feet.

Guide rollers are provided at the ends of all lifting girders; and structural steel guides are attached to all gantry posts and supporting piers.

Mechanical Features

The ferry landing is operated by a steam-power plant, provided for the old structure and located at one side of

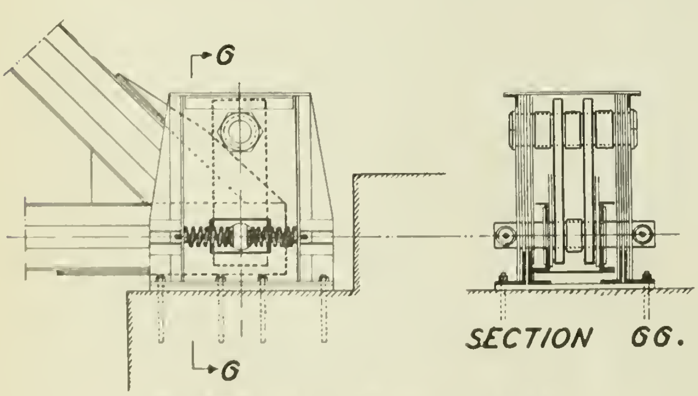

Fig. 8—Truss Span—Shoe and Buffer.

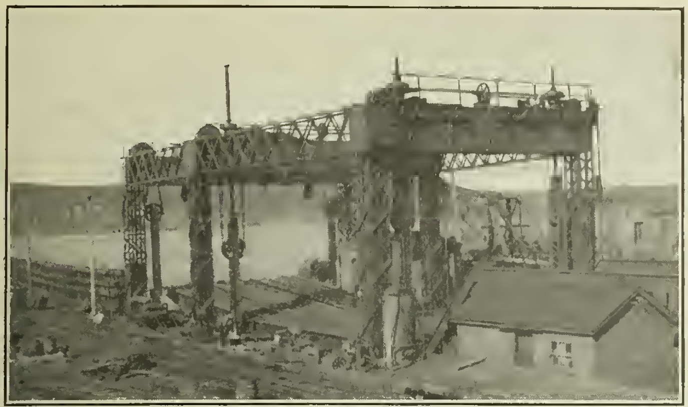

Fig. 11—Point Tupper Landing—Showing Apron and Intermediate Span.

the slip. Power is transmitted by shafting and gears attached to the steel superstructure. The apron, which requires to be raised and lowered much more frequently than the other leaves, is operated independently. On the other hand, adjustments in height at gantries *E* and *I* may be made either simultaneously or independently.

The general principles underlying the mechanical operations are the same as for the original landing, although some details have been considerably improved, due to suggestions made by the Canadian National Railways engineers as a result of their many years experience in the operation of the old structure.

The major mechanical troubles in the old structure were the wearing of the operating nuts on the screw shafts, and the breaking of counterweight ropes.

When in their lowest position, the old screw shafts were exposed to the weather practically throughout their entire length, and were consequently subject to the very bad sleet conditions during the winter, and to a great amount of dirt and grit from passing locomotives, at all times. They were made from vanadium steel, and buttress threads were used in order to avoid the bursting effects incident to the use of V-threads. For the new structure a steel was adopted which would not be so difficult to machine to a smooth surface as vanadium steel; and, because it is a better manufacturing proposition to cut a V rather than a buttress thread, it was decided to use the former. The screws are completely enclosed in an oil-tight pipe case, shown in Fig. 15, which protects them from the weather and all foreign matter. This device was rendered possible

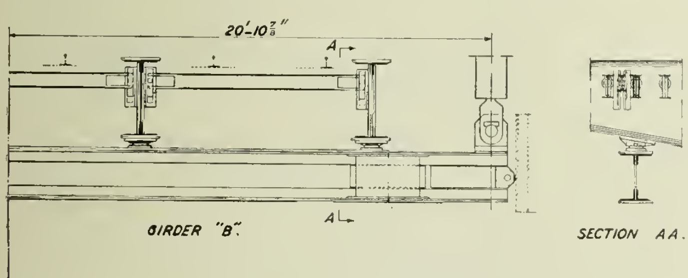

Fig. 12—Details at Apron Girder ***B.***

by shortening the connecting links between the screws and the lifting girders and by lengthening the screws a similar amount.

The new screw shafts were manufactured from a chrome alloy steel, having an ultimate strength of 100,000 pounds per square inch, which, while being reasonably capable of withstanding wear, can be readily machined to a perfectly smooth surface for contact with the bronze nut. The thread is of a modified Acme type, cut rather deeper than the standard Acme thread in order to give as much bearing area as possible on the surface of the thread. Moreover, the thread in the steel screws was made thinner than that in the bronze nuts, in order to make the strengths of these two parts more nearly equal.

The bronze nuts are supported on special bronze and hardened steel thrust washers. Ball bearings were at one time considered for this location, but it was decided that they were unnecessary, because the load under which they would be operated (10,000 pounds) is so small compared with the maximum load of 440,000 pounds which they would be called upon to sustain. Moreover, owing to the high efficiency of the ball bearings, they might revolve automatically under this great load and its vibratory effect, and thus lower the suspended structure inadvertently.

Bronzes were made in accordance with the Canadian Engineering Standards Association Standard Specification for Movable Bridges, as follows:—

Bushings.................	Grade C
Thrust Washers...........	Grade B
Operating Nuts...........	Grade D

The trouble with the breaking of counterweight ropes has been overcome by increasing the size of the sheaves as much

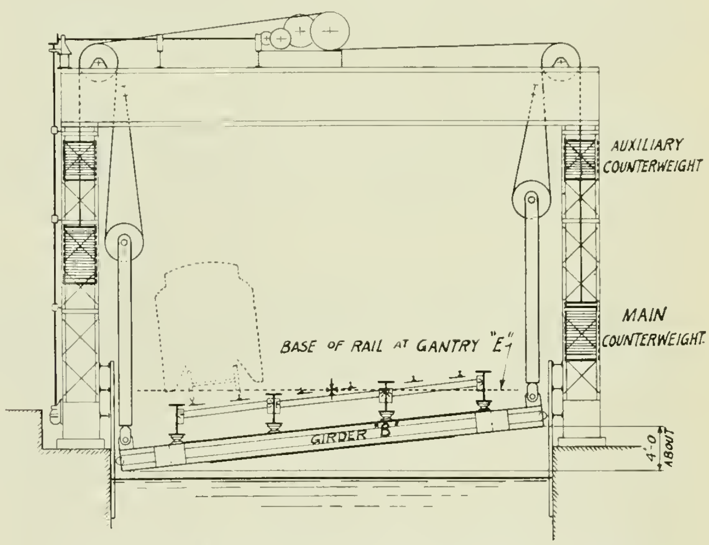

Fig. 13—Diagram showing Warping of Apron when Outside Track of Ferry is Loaded.

as possible, also by increasing the number of parts of rope to each counterweight.

General

The original ferry landings were, to a great extent, pioneers in this type of structure; and, notwithstanding some minor defects in design, they may be said to have given satisfactory service during their long life of 30 years.

The new structures are in principle and general dimensions practically the same as their predecessors; but have been modified and developed in detail where experience has shown this to be desirable.

These structures may be considered essentially as machines, rather than bridges; and, as such, wear and tear must be expected. Moreover, owing to the extremely severe conditions at the sites, corrosion must also be expected, no matter how much care may be exercised in maintenance.

Erection

The ferry service between Mulgrave and Point Tupper constitutes the sole link connecting the railways of Cape Breton island and the mainland; consequently the volume of traffic handled at this point is considerable.

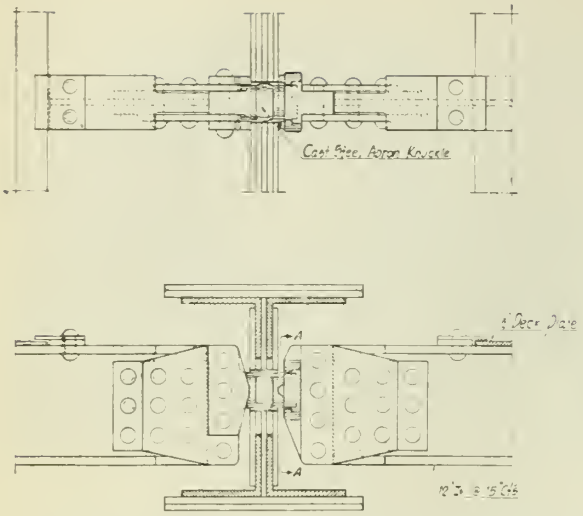

Fig. 14—Connection of Deck Beams to Apron Girders.

The flow of traffic is steady and continuous at all times throughout the week, except on Sundays, when freight movements are restricted to a minimum and no passenger trains are handled between the hours of 3.30 o'clock a.m. and 11.30 o'clock p.m.

It being entirely out of the question to interrupt traffic for any considerable period on week days, all operations which involved the replacement of the deck and floor system of the landings had to be carried out on Sundays. All other work was so planned and carried out that the loading and unloading of the ferry was not interfered with in any way.

The field operations covered a period of four months, work being commenced at Mulgrave on May 14th and the Point Tupper landing being completed by September 17th. The length of time required for doing the work was considerably increased by the requirement that traffic be maintained at all times and by the limited working periods available between trains, which necessitated all major changes being made on Sundays. In the case of the apron replacements, the choice of time was further restricted by having to select Sundays on which the times and heights of the tides were suited to the floating scheme used.

To ensure that the new spans could be speedily erected, one intermediate span was completely shop assembled, together with the apron girders, the adjoining truss chords and the transverse girders *E* and *I*. At that time slight alterations were made to provide increased clearance between some of the members where, it was considered, erection would be thereby facilitated.

Fig. 16 shows the general arrangement of the equipment, falsework and temporary operating devices used in the erection of the Point Tupper landing. As the erection procedure was practically identical for both landings, the following description of the operations at Point Tupper applies to those at Mulgrave as well.

For descriptive purposes the work may be conveniently divided into three stages: first, the replacement of the shore span; second, the replacement of gantries *B*, *E* and *I*, and third, the replacement of the apron and the intermediate span.

Replacement of Shore Span

Advantage was taken of the fact that, with girder *I* fixed in its mean vertical position, the available adjustments of the landing at gantries *B* and *E* were still sufficient to provide for all ordinary tidal ranges and for the loaded and unloaded conditions of the ferry.

Timber blocking was first placed and tightly shimmed under all floorbeams of the shore span, under the stringers adjacent to girder *I* and under the ends of girder *I* itself, as shown in Fig. 17. The operating machinery of gantry *I* was then disconnected, the counterweights were securely blocked, and their load transferred to the blocking by burning through the counterweight ropes.

The dismantling of the trusses was next undertaken, the top chords and web members being burned apart and removed as traffic conditions permitted. In preparation for the replacement of the floor system the rivets in all floorbeam and stringer connections were cut out and replaced by bolts. The bottom chords were partially burned through but sufficient metal was left to ensure lateral and longitudinal stability of the structure under operating conditions.

The actual replacement of the floor steel, bottom chords and laterals was made on a Sunday, work being commenced at 3.30 o'clock a.m., immediately after the departure of the last passenger train. With a locomotive

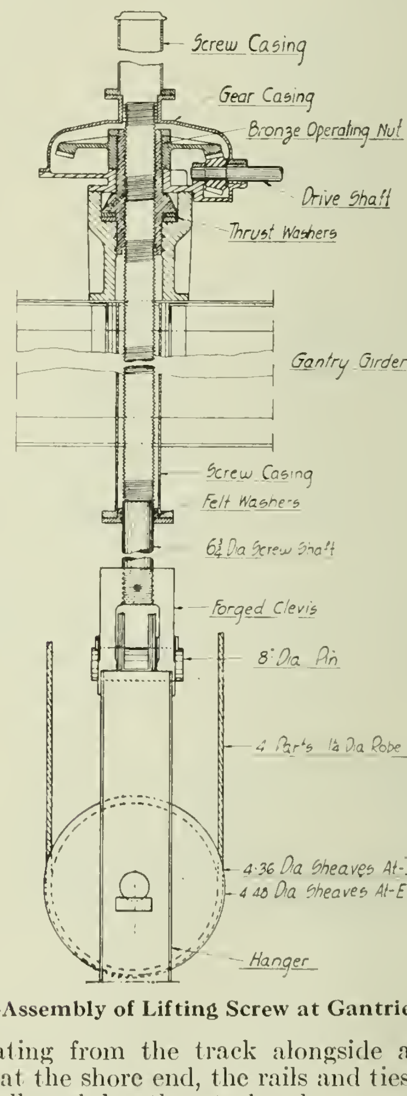

Fig. 15—Assembly of Lifting Screw at Gantries *E* and *I*.

crane operating from the track alongside and a derrick car located at the shore end, the rails and ties were quickly removed, followed by the steelwork, as rapidly as connections could be unbolted or burned apart. No attempt was made to remove the connecting pins at girder *I*, it being found easier to free the members by burning.

The old steelwork having been removed, the height of the timber blocking was altered to suit the new floor steel, which was then erected, followed by the assembly of the new bottom chords and laterals. All stringer connections were fully pinned and bolted, and the ties placed, after which the rails were relaid and connected by the Railway Company's track crew.

At Mulgrave the complete replacement of the floor system and truss chords was made in fifteen hours and at Point Tupper in three hours less, as a result of the experience gained at the former point.

The outer end of the new shore span was at this stage supported entirely on the timber blocking, its only connection to the intermediate leaf being through the track rails, therefore extra precautions had to be taken when mooring the ferry to prevent any excessive shock being transmitted to the landing.

The erection of the shore span was completed by the assembly and riveting of the truss web members and top chords and the riveting of the floor steel, which was done as traffic conditions permitted.

Replacement of Gantries *B*, *E* and *I*

The order of replacing the three gantries was predetermined by the manner in which the existing counterweights were to be utilized in the new and heavier structure.

For the new landing, entirely new counterweights, somewhat different in design from the old, were provided at gantry B, and the old blocks from this point were used to make up the additional weights required at gantries *E* and *I*. As the superstructures of the gantries could not be assembled until the counterweights were in place, it was necessary to dismantle the old gantry *B* to obtain its counterweights, before the new gantries *E* and *I* could be completed.

Gantry *I*, being entirely disconnected from the landing, was first dismantled, and new gantry posts erected and securely guyed in position. The old counterweights were then placed and blocked at a predetermined elevation to provide for the future connection of the gantry hangers to the new girder *I*, which had to be placed under the end shoes of the shore span.

Before gantries *B* and *E* were removed, it was necessary to provide temporary devices for raising and lowering the landing at these points.

As shown in Fig. 18, pile bents were first driven on either side of girder *B* close to its ends. Owing to the limited railway clearance inside the gantry it was necessary to locate these piles close to the gantry posts and in line with the hangers, which prevented the piles being capped until the hangers had been removed. To permit of this being done, the ferry was moored in position and the outer end of the apron lowered on to it. The counterweights were then blocked, and the hanger rods burned through, thereby transferring the weight of the apron to the ferry.

The hangers were then removed and the piles capped, after which heavy tackles (consisting of 5-sheave steel blocks with 9 parts of ⅞-inch diameter wire rope) were suspended therefrom, their lead lines being carried through a series of snatch blocks to a hoisting engine, located alongside the slip.

These tackles were connected by heavy lashings to the apron, which was then raised and the ferry released. During the period necessary for the replacement of gantry *B*, the apron was operated by means of these tackles.

The existing gantries *B* and *E* having been securely shored and guyed for stability, their connecting struts were removed and gantry *B* was completely dismantled. The

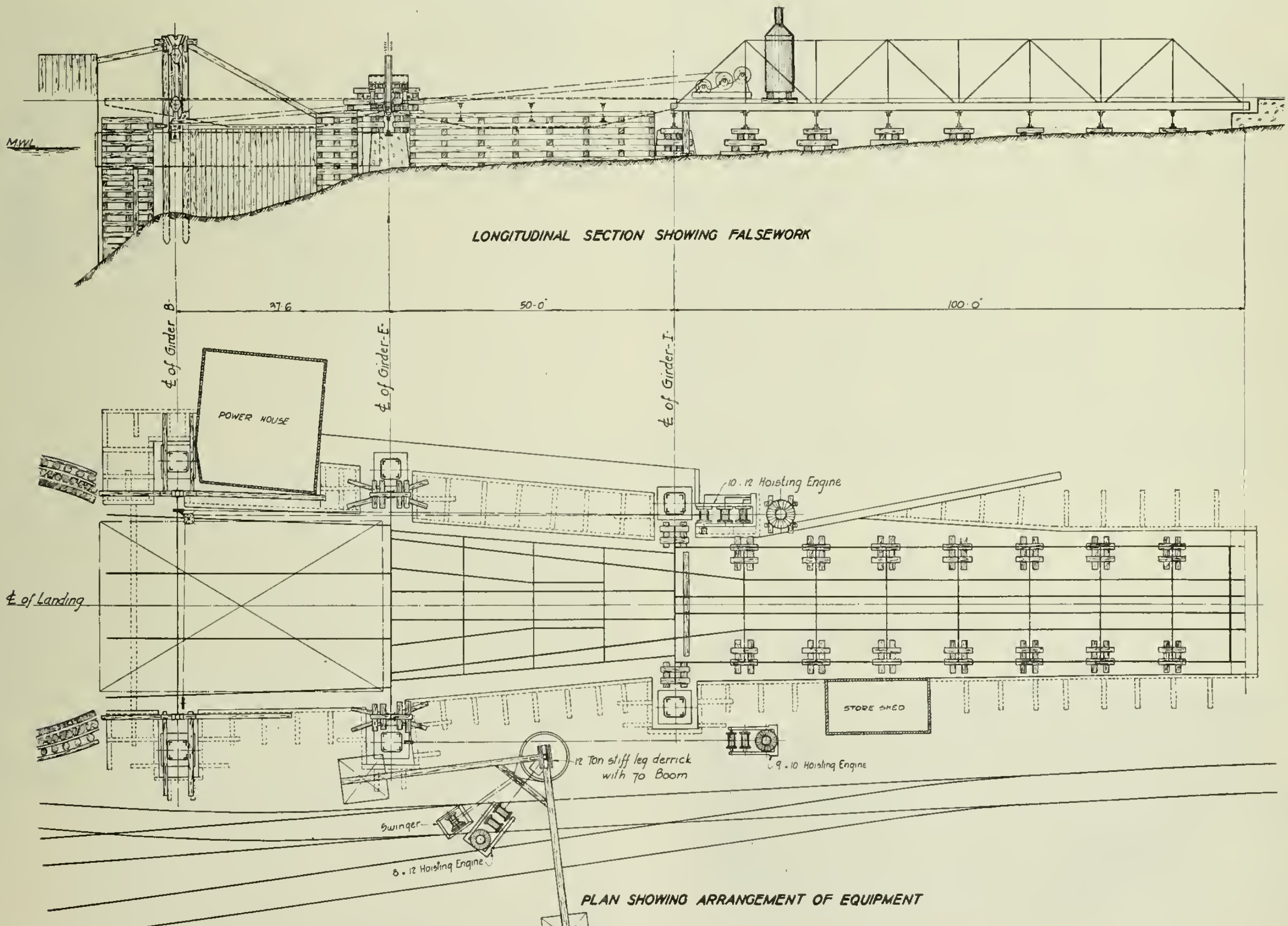

Fig. 16—Plan showing Arrangement of Erection Equipment and Falsework.

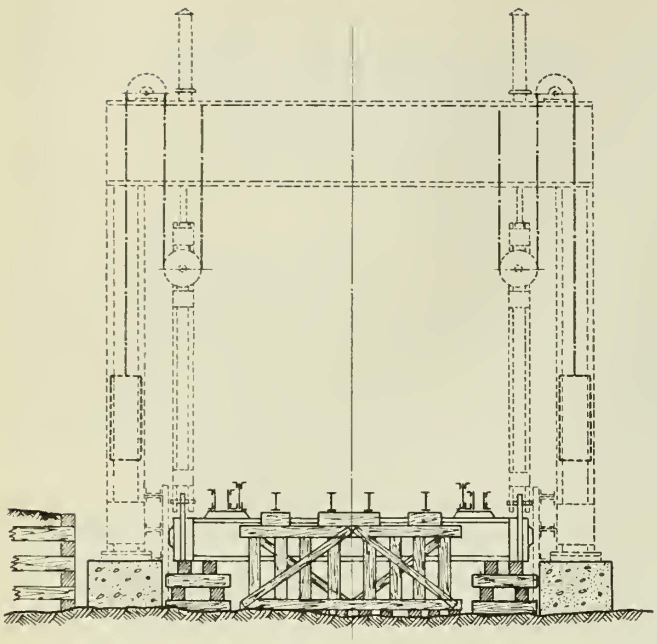

Fig. 17—Temporary Blocking under Girder *I* and Stringers of Truss Spans.

new gantry was then erected, complete with its machinery, hangers and counterweights. The temporary operating tackles were removed and the new hangers connected by means of special links to the old apron, the ferry being again utilized to support the apron during this operation. As the new counterweights were heavier than required to balance the old apron, additional steel was placed on the outer end of the apron to make up the difference, and the apron was operated thereafter through the new machinery.

The old counterweight blocks from gantry *B* being now available, the necessary number were added at gantry *I*, after which its superstructure and machinery were completely erected.

To provide for the raising and lowering of girder *E*, after the gantry at this point had been disconnected, two 50-ton capacity jacks were installed at each end of the girder. This arrangement is shown in Fig. 19. The jacks were set on timber cribbing and operated against temporary jacking girders, which were inserted through the hangers and bolted to them. At these points, timber blocking was also provided to carry both the live and dead

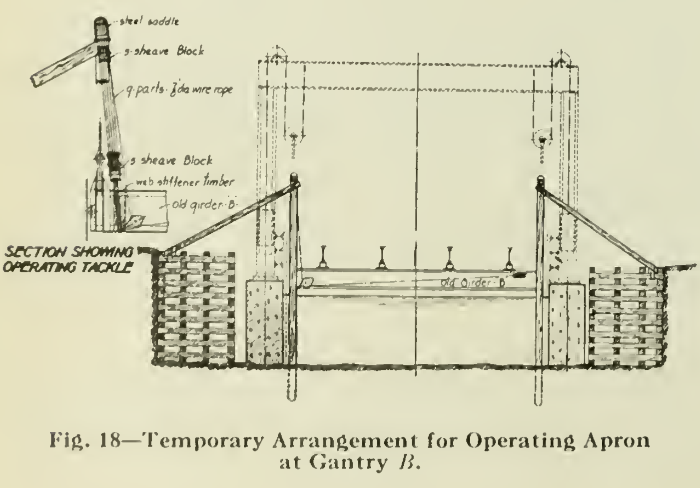

Fig. 18—Temporary Arrangement for Operating Apron at Gantry *B*.

load of the landing when jacking was not actually in progress.

To transfer the load to the jacks, the counterweights were blocked in their posts, girder *E* was jacked up an amount sufficient to release the load on the ropes and the hangers were then burned through immediately above the jacking girder connections.

During the replacement of gantry *E* it was necessary to maintain a jacking gang practically twenty-four hours a day to regulate the elevation of girder *E*, as required. Therefore the old gantry, with its operating machinery and counterweights, was removed and the new one erected as speedily as possible. After the machinery had been placed and tested, the new hangers were connected to the old girder, by means of the special yokes shown in Fig. 20 and the operation of this girder was thenceforth done through the machinery.

Replacement of Apron and Intermediate Span

The replacement of the apron and the intermediate span involved the removal of approximately 200 tons of old steel and the erection of 250 tons of new steel in one day. At first glance, it had appeared advisable to divide this work into two distinct operations to be undertaken on separate days. However, further investigation showed that

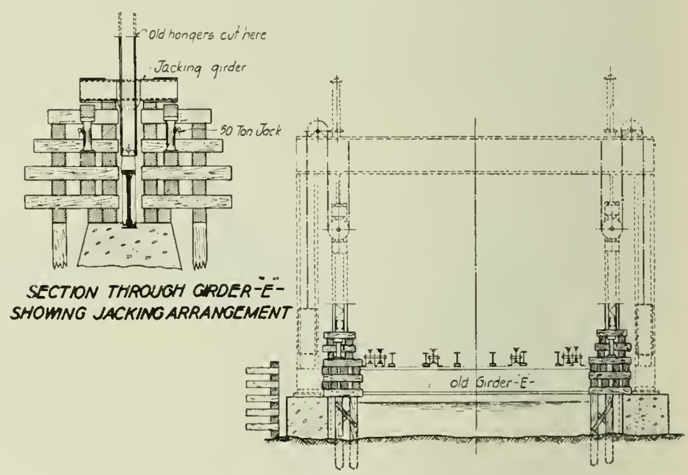

Fig. 19—Temporary Arrangement for Operating Landing Gantry *E*.

the interlocking features of the two spans provided many complications in such a scheme and it was decided to replace the two spans in the one operation.

The apron consists of an intricate structure, made up of a large number of separate pieces whose assembly in place would have proven extremely difficult, if not impossible, in the limited time available. It was therefore decided to assemble it in advance and float it into position as a unit. On this basis, falsework was erected in a nearby slip, alongside of which a railway track was conveniently located. Here the apron, together with girder *B*, was completely assembled and riveted, the deck plates were added and the new track rails placed and bolted in their final positions. To facilitate the connection of the apron to girder *E*, the supporting shoes from the latter were assembled with their pins to the apron girders.

As the replacement of the apron and intermediate spans had, of necessity, to be made on a Sunday, when the heights and times of the tides would be suitable for the floating operations, the actual date was chosen well in advance and all preliminary work was carefully scheduled to ensure its completion before that date. Early in the field operations, tide gauges were installed at the site and regular readings were taken and compared with the available tidal data for that locality. In this way, sufficient information was gathered to indicate clearly in advance what conditions would prevail during the floating operation.

Prior to the date of the actual replacement, all preliminary work was completed. The rivets in all connections of the intermediate span were cut out and replaced by bolts, jacks were installed under the counterweights in gantries *E* and *I* and heavy auxiliary tackles were hung from gantries *B* and *E*, their leads being carried to two steam hoisting engines located nearby. All new steelwork was sorted and carefully checked, the new deck ties were framed and the track spikes of the intermediate span were removed in so far as this could be safely done.

Two days in advance of the replacement, at low tide a scow was floated into position under the new apron, blocking was adjusted and by means of the rising tide the apron was lifted from its falsework. The scow was then moored in the slip and additional weight was added to obtain the desired trim.

Fortunately on the days chosen for the operations, both at Mulgrave and Point Tupper, the weather and tidal

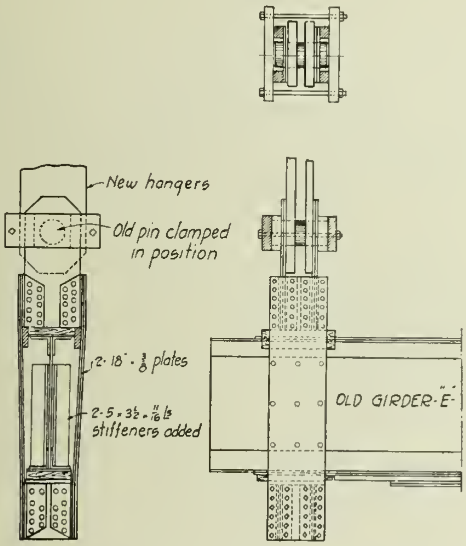

Fig. 20—Temporary Connection between old Girder *E* and new Hangers.

conditions proved to be ideal and the work was commenced at 3.30 o'clock a.m. when the landing was cleared of traffic.

The first operation consisted of bringing the new girder *E* out onto the landing and suspending it by tackles from gantry *E* (as shown in Fig. 21) in such a position that, after the removal of the old steel, it could be lowered and connected directly to its hangers. This procedure was necessitated by the fact that the girder, which weighed 26 tons, was too heavy to be placed by the locomotive crane from any position other than standing on the tracks of the landing itself.

The intermediate span was then quickly stripped of its deck and the existing steelwork, including girders *E* and *I*, removed as rapidly as the connections could be unbolted. Both the locomotive crane and stiffleg derrick were used in this work.

Meanwhile the removal of the old apron had also been commenced. On the rising tide a scow was floated underneath the apron, and blocking was adjusted on the scow.

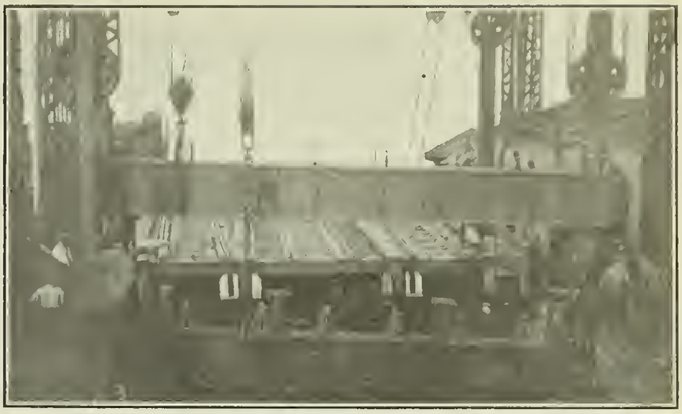

Fig. 21—Removing old Girder *E*. New 26-ton Girder suspended from Overhead Gantry.

The apron was disconnected from girder *E* by burning through the longitudinal girders close to their ends and the transverse girder *B* was disconnected and shortened by burning 5 feet from each end, to permit it to clear the sides of the ferry slip as the apron was being floated out. (See Fig. 22.)

A tug, which had been chartered for the occasion, then took the old apron in tow, removed it from the ferry slip, and shortly afterwards returned with the new apron which was moored in readiness to be connected. The old apron was later transferred to the falsework on which the new one had been assembled and there burned apart for disposal.

The design of the landing is such that it was necessary to connect the apron to girder *E* before the outside girders of the intermediate span could be placed. By the time the old intermediate span had been all removed and the new girder *E* had been lowered and connected to its hangers, the apron was floating in position ready to be connected. So well did the operations coincide with the tide at this stage, that the shoes on the apron girders were within one inch of their correct elevation with respect to girder *E* and it was a simple matter to connect them. (See Fig. 23.)

The length of girder *B* being considerably greater than the width of the ferry slip, field splices had been provided, 5 feet from each end, to permit it to be floated in with the assembled apron. Immediately the apron was floated into position, the end sections of the girder were assembled and the splices fully pinned and bolted.

By the time this work was completed the tide had fallen sufficiently to permit the release of the scow which was done by raising the outer end of the apron on the tackles at gantry *B* and by knocking out the blocking under the shore end.

Fig. 22—Old Apron with Girder *B* being floated out.

Fig. 23—Apron connected to Girder *E*. Note Shoes for connection of Intermediate Span Girders and Springers.

After the removal of the scow, the apron was again lowered, the pins which connect the hangers to girder *B* were driven and the temporary tackles removed from gantry *B*. By means of the operating mechanism, the apron was lowered to release the counterweight blocking which was then removed.

Meanwhile, the old intermediate span having been completely dismantled, the new girder *I* was lowered under the end of the shore span and connected to its hangers, which, as previously indicated, had been set slightly low with respect to the truss span. Girder *I* was then raised by means of the jacks set under its counterweights (at the same time the adjusting screws were slacked off to prevent them from taking any load) until the truss shoes were in contact with the girder. Most of the adjoining members of the shore span were immediately connected to the girder, but as some of the connecting pins also engage stringers of the intermediate span, these were driven later as the adjoining stringers were erected.

As shown in Figs. 9 and 10, the girders of the intermediate span are carried at either end on pins which also carry the outside girders of the apron and the trusses of the shore span respectively. The pin holes of the intermediate span girders are slotted and the details to which they connect are especially designed to permit of the girders being lowered onto their pins after the adjoining members have been permanently connected. After these girders were placed, the remaining steelwork was erected, the floorbeam and stringer connections being fully pinned and bolted. Girder *I* was then jacked up an amount sufficient to release the blocking under the shore span, and then jacked down to transfer the load to the counterweight ropes, after which the jacks were removed. The deck ties were quickly placed and the Railway Company's track crew proceeded to relay and connect the rails.

The replacement of one apron and intermediate span, involving the handling of over 450 tons of steelwork and the replacement of 300 feet of track in a period of twenty hours between trains, was a considerable undertaking but the work was so organized and carried out that the operations were completed well within the time limit.

At Mulgrave, the steel was completely erected in sixteen hours and the tracks were reconnected two and a half hours later. At Point Tupper the steel was erected in twelve hours and the tracks were reconnected five hours before the first train was due.

This operation practically completed the erection, apart from the riveting, painting and other incidental work of a minor character.

Fig. 24 illustrates the progress of the work in this final stage and demonstrates the manner in which the tide was utilized for the various floating operations.

The total weight of steel in the two landings amounts to 1,305 tons, made up of 865 tons of structural steel, 130 tons of machinery, wire rope, etc., and 310 tons of counterweights. Approximately 19,000 ⅞-inch diameter rivets were driven in the field connections.

Erection Equipment

The landings were erected chiefly by means of a 30-ton capacity locomotive crane assisted by a 12-ton capacity stiffleg derrick with 75-foot boom, set up alongside the landing. A 50-foot self-propelling derrick car with two 10-ton capacity booms was used to handle material in the yard and to assist generally in the erection.

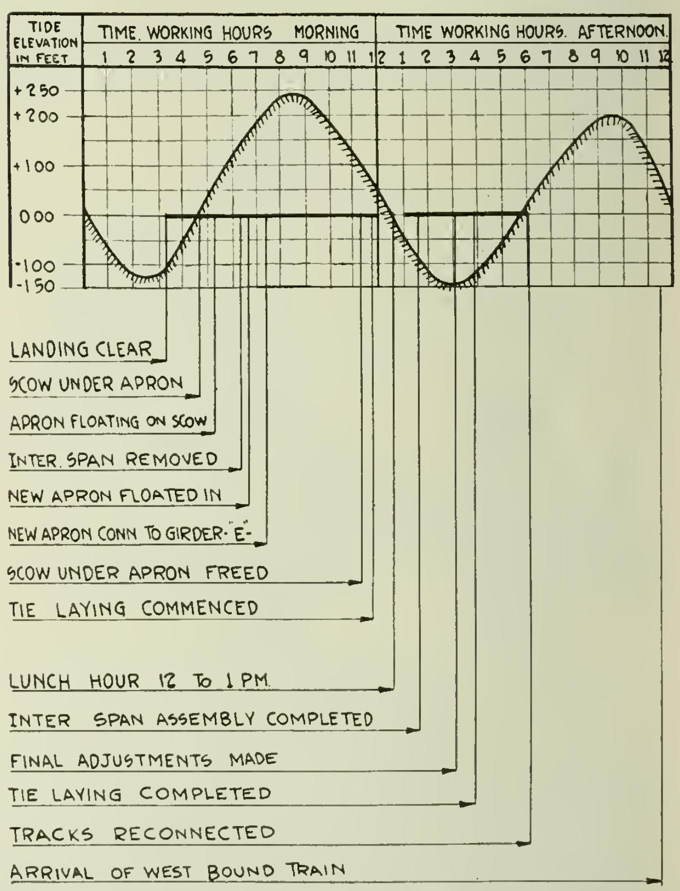

Fig. 24—Diagram showing Progress of Work in Final Stages.

To operate the derrick and the various tackles used, three independent steam hoisting engines of various capacities were provided. The two specially built wooden scows used in the floating operations were each 50 feet long, 30 feet wide and 6 feet deep.

Structure and Oil Prospects of the Eastern Foothills Area, Alberta, between the Highwood and Bow Rivers[1]

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Geological Survey, Department of Mines, Ottawa, Ont.

Paper to be presented at the Annual General and General Professional Meeting of The Engineering Institute of Canada, Montreal, Que., February 4th, 5th and 6th, 1931.

SUMMARY—The Foothills are considered to be an overthrust mass thrust eastward onto the relatively flat-lying sediments of the plains. Low angle faults are known to underlie such structures as Turner valley, Jumpingpound and Wildcat hills and another low angle fault probably underlies the Highwood structure and its extension to the northwest through Waite valley, Fisher creek and the Two Pine area. The Highwood anticline is believed to be too wide and to consist of too many high structural blocks to yield large oil fields although the prospects are by no means exhausted. Fisher creek and the Two Pine structure each containing one high structural area in the central part of the anticline would be expected to cause a much better concentration of gas and oil than a wide structure and are hence thought to be favourable locations for test wells. The whole Foothills belt is considered to be structurally similar to the foothills of the Polish Carpathians where large oil fields have been developed.

The foothills of Alberta occupy a belt of country 12 to 25 miles wide, extending from the international boundary to north of the Peace river. For the most part they consist of parallel ridges trending in a northwest and southeast direction, with elevations increasing from east to west from 3,500 feet to more than 5,000 feet, and with individual ridges rising as much as 1,000 feet above the intervening valleys. The valleys are generally narrow, but fairly flat areas a mile or so in width are not uncommon. The boundary with the mountains to the west is sharp, but the eastern edge is much less clearly defined, and the foothills gradually merge into the gently undulating plains. The main lines of drainage cut across the foothills from the mountains to the plains and in all cases occupy well-defined valleys in which the rivers flow in deeply incised channels, offering many opportunities for the development of water power plants such as have now been constructed on the Bow river at Kananaskis and Ghost rivers.

In order to appreciate fully the geology of the foothills intermediate between the mountains and the plains, it is necessary to understand something of the character of the geological formations and the nature of the geologic processes to which they have been subjected. The following description however, will apply only to that area between the Bow and Highwood rivers (Fig. 1), where in the last few years the writer has been engaged in geological investigations for the Geological Survey of Canada. Briefly the succession of geologic formations in descending order is as follows:

Eras	*Periods*	*Formations*
Tertiary	Eocene	Paskapoo
Mesozoic	Cretaceous	Edmonton
		Bearpaw (not always present)
		Belly River
		Upper Alberta shale (Upper "Benton")
		Cardium
		Lower Alberta shale (Lower "Benton")
		Blairmore
		Kootenay
	Jurassic	Fernie
Palaeozoic		Limestones, dolomites, shales, etc.

All formations here indicated are sedimentary, and no igneous or volcanic rocks occur, although in the southern foothills the latter occur in the Crow's Nest pass area. These sediments were originally deposited in a big basin or geosyncline extending from Manitoba westward and including the Rocky mountains. For long intervals this basin was occupied by an arm of the sea which in certain periods extended from the Gulf of Mexico to the Arctic ocean. The sediments deposited in this sea trough were mainly limestones and shales, and evidences of marine life are found throughout a thick series of limestones and shales in the Palaeozoic, as well as in shales in the Fernie, Alberta shale and Bearpaw formations. At other times the basin was above sea-level and detrital materials consisting of pebbles and boulders (conglomerates) and sand with small amounts of mud (shales) were washed into it by fresh water. These sediments now constitute the formations which we call Paskapoo, Edmonton, Belly river, Blairmore and Kootenay. Undoubtedly during part of this time the basin was occupied by brackish water, and in the swampy shallow lagoons plants grew in great profusion, forming the beds which were later metamorphosed into the coal seams that occur in the Edmonton, Belly river, Blairmore and Kootenay formations and are now extensively mined in Alberta and eastern British Columbia.

The sediments represented in this great deposition are many thousands of feet thick and must have formed a great weight on the earth's crust, eventually weakening it to the point where it was no longer able to withstand the earth's stresses. In the readjustment the pressure was

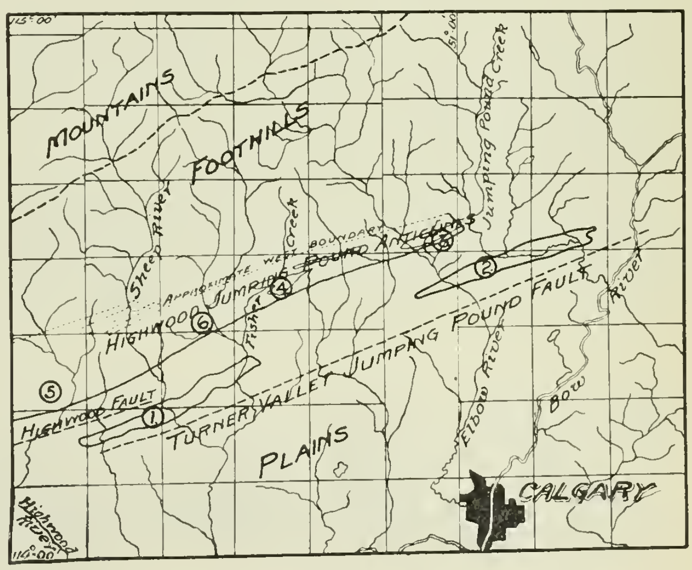
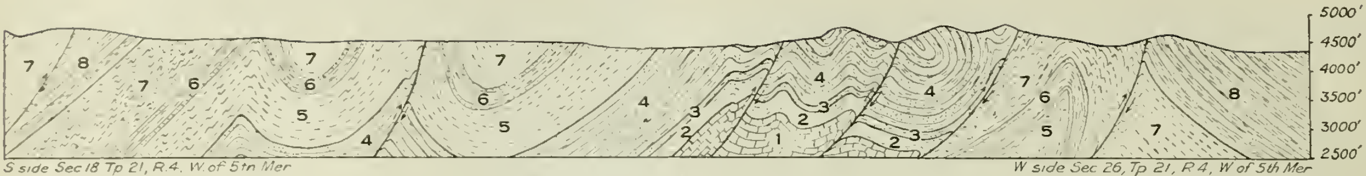


Fig. 1
Map of the Highwood Bow River Area.
1 Turner Valley Anticline.
2 Jumpingpound Anticline.
3 Two Pine Anticline.
4 Fisher Creek Structure.
5 Highwood Anticline.
6 Waite Valley Anticline.

(1) Published with the permission of the Director, Geological Survey of Canada, Ottawa.

Fig. 2



Fisher Creek structure

Scale of Miles
(Vertical and Horizontal)

0 1 2

applied from the west to the east, the western part being uplifted into mountain ranges, and the sediments being broken into large blocks which were thrust over the sediments lying to the east. These in turn were crumpled and broken and forced still farther eastwards. The lines of fracture along which blocks of these sediments moved eastward are known to us as thrust faults, and in many cases the displacement is measured in miles. The Bannock overthrust in southeastern Idaho and Utah for example, has been traced by Mansfield of the United States Geological Survey for a length of 270 miles and has a displacement of 12 to 35 miles. The present mountain front is the result of erosion on a large overthrust of this type and consists of limestones of Palaeozoic age that have overridden younger rocks to the east. East of this mountain front is a crumpled and broken zone which we call the foothills, and it was not until recently that it was realized that the whole foothills area is underlain by a low angle major thrust plane along which the sediments have been pushed onto the relatively flat-lying sediments of the plains. In this movement the strata composing the foothills were highly contorted and were broken into many fault blocks. (Fig. 3.) These fault blocks have in general a westward dip and each succeeding fault block to the west is pushed over the adjoining one to the east. The faults that separate the individual fault blocks are considered to be subsidiary to, and join the major low angle thrust at depth. It is probable, however, that in the foothills there are several major low angle thrusts, between each of which are fault plates of highly folded and faulted strata. This is the type of structure best known in the Alps, but occurring in the Carpathians, in the Highlands of Scotland and in America in the southern Appalachians and Ouachita mountains. The low angle faults are commonly called sole faults in Scotland, and the block between two such faults is known in the Alps as a "decke" or "nappe."

The recognition that a low angle thrust fault underlies the whole foothills belt came from a study of well logs in Turner valley, which is on the eastern edge of the foothills. The Turner valley field is an anticline in which a central valley exposing Alberta shale ("Benton") is bounded by ridges of Belly river strata which on the west and east sides have westerly and easterly dips respectively. This anticlinal structure, however, is in reality a drag fold developed above the low angle thrust plane and was caused by the resistance to eastward movement along the fault plane. The strata of the eastern edge, as the block was shoved easterly along the fault plane, have been buckled under, and the fault plane emerges at the surface at a fairly steep angle (probably 65 to 75 degrees from the horizontal) although the fault plane to the west may have a dip of not more than 20 degrees. (Fig. 3.) The strata west of the line of emergence of this fault are steeply tilted, whereas east of it fairly gentle dips are prevalent. This fault, therefore, may be considered to be the boundary between the foothills and the plains. Several wells in Turner valley have drilled through this fault, two wells after penetrating Palaeozoic limestone for a considerable thickness passed into Cretaceous beds which are much higher stratigraphically. Another low angle fault occurs in the New Black Diamond area a few miles west of Turner valley, and this fault at depth is known from drilling to have a westward dip of about 20 degrees. The area between the low angle fault under Turner valley and the low angle fault under the New Black Diamond area might for convenience be called the Turner valley fault plate or nappe. This nappe is itself folded and faulted and within the width of Turner valley there may be no less than four thrust faults which join the low angle fault at depth.

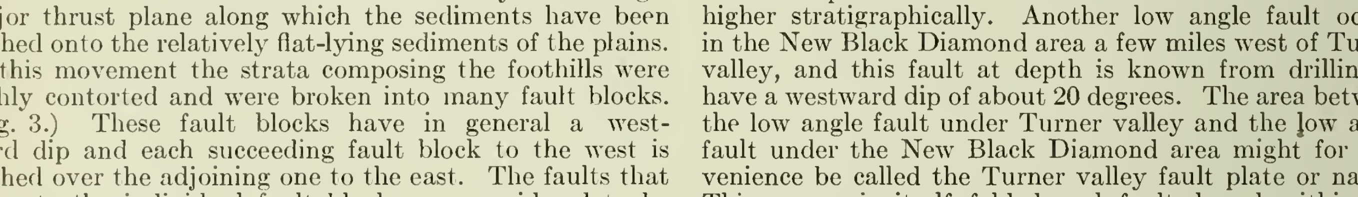
Key to Formations on Figs. 2 and 3

10 Paskapoo.
9 Edmonton.
8 Belly River.
7 Upper Alberta Shale (Upper Benton).
6 Cardium.
5 Lower Alberta Shale (Lower Benton).
4 Blairmore.
3 Kootenay.
2 Fernie.
1 Palaeozoic Limestone.

Explanation of Fig. 3

The section through Turner valley is generalized and is intended to show the type of structure rather than the actual structural conditions on the line of section.

Fig. 3



Section in vicinity of Sheep Creek through Turner Valley structure

Scale of Miles
(Vertical and Horizontal)

0 1 2 3 4

No discussion can be made here of the relation of gas and oil in Turner valley to this complicated structure, as the object of this paper is to discuss the prospects for gas and oil in the eastern foothills adjoining Turner valley. It is sufficient for this purpose to know that Turner valley is producing large quantities of gas and oil and the question arises: are structural conditions duplicated elsewhere.

The major low angle fault under Turner valley has been traced northwestwards from Turner valley to Bow river where it ends. (Fig. 1.) Another fault to the east of it starts south of Bow river and has been traced northwestward for some miles. To the south of Turner valley another fault west of the Turner valley fault becomes the low angle thrust under the Highwood area. Thus although we are not always dealing with the same fault we are dealing with the same faulted conditions, and the evidence points to the whole foothills belt in this general area being underlain by such a low angle fault. In the area between Highwood and Bow rivers the Turner valley fault passes to the east of the Jumpingpound anticline just south of Bow river and this structure like that of Turner valley is a drag fold developed above the fault plane. Two wells have been drilled on the Jumpingpound structure, starting in strata of the same age as occur in Turner valley. It has been found, however, that whereas the low angle fault in Turner valley cuts below the top of the Palaeozoic limestone productive of gas and oil, the fault in the Jumpingpound wells cuts much nearer the surface, and the wells passed through it without reaching the productive limestone horizon. As this low angle fault is believed to cut lower stratigraphical beds as it passes westwards, there is a possibility that the limestone might be reached above the low angle fault on the west side of Jumpingpound structure. Wells to test this would be very deep and hence may not be justified under present conditions. Of the two wells drilled on the Jumpingpound anticline, one was drilled on the eastern flank and the other about the centre of the structure. Thus although the Jumpingpound anticline is believed to be the same type of structure as Turner valley, it differs in detail sufficiently to cause the eastern and central part to be of no value from the standpoint of gas and oil prospects.

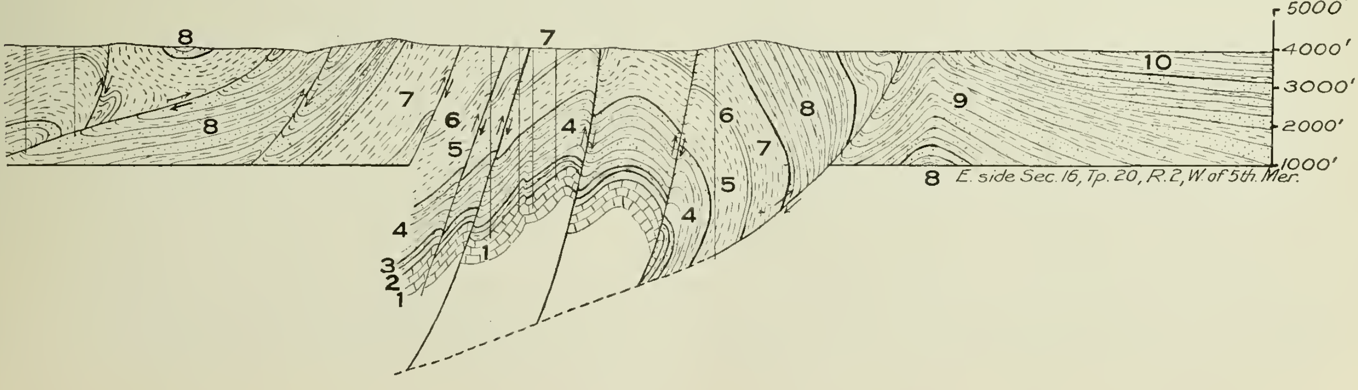
The Wildcat hills anticline to the north of Bow river is outside the area under discussion but here again is a structure similar to Jumpingpound and Turner valley. In this case, however, the fault cuts under the structure even higher than at Jumpingpound and hence prospects are negative.

To the south and west of Turner valley is the Highwood anticline area. A low angle fault cuts under the Highwood area and hence structurally the Turner valley conditions are again duplicated. Erosion over a great deal of the Highwood area has been much deeper than in Turner valley with the result that Blairmore and lower Alberta shales are exposed over wide areas. Four wells have been drilled in the Highwood area and all have penetrated the Palaeozoic limestone, two reaching this horizon at less than 2,500 feet. Three of these wells gave shows of oil but in all three salt water was encountered. Under normal conditions salt water is found in all oil fields underlying the oil and gas on the flanks of the structure. The presence of salt water when studied in reference to the structure in the Highwood area indicates that if commercial oil pools exist here they will be confined to rather limited areas.

In view of all this adverse evidence one may well ask if this area between the Highwood and Bow rivers offers any favourable oil prospects. The answer, in the writer's opinion, is still decidedly in the affirmative and is based on the following considerations.

The Highwood anticline is a very broad structure. Between the flanking Belly river ridges which are considered to be the boundaries in the Turner valley structure the Highwood anticline on Highwood river is 6 miles wide. Within this, faulting has brought to the surface several areas exposing Blairmore strata. Each of these Blairmore areas represents a local structurally high area within the anticline. The shows of oil found in the wells drilled would seem to indicate that the oil may be distributed among a number of these locally high structural areas and there has not been a sufficient concentration in any one area to yield commercial supplies. A narrower anticline where a much better concentration into one high structural area could occur, would, therefore, look exceedingly promising. Between the Highwood and Bow rivers there are two such structures namely Fisher creek and the Two Pine anticline (Fig. 1), both of which were mapped by the Geological Survey and both of which are now being tested. Both of these anticlines are parts of one major anticline which on the Highwood includes the Highwood anticline and extends northwestward for 40 miles to Jumpingpound creek. This anticline is not everywhere of the same structural height. The Highwood area, extending northwest to the south end of Waite valley where the Calgary Development and Production Company's well is now drilling, is structurally high. Waite valley, where several wells were started, all of which are now abandoned or suspended, is structurally low. To the north of Waite valley is the structurally high Fisher creek area. Northwest of the Fisher creek area and south of Elbow river is another structurally low area, and north of Elbow river and south of Jumpingpound creek the Two Pine structure occurs. In the Fisher creek and Two Pine areas the Blairmore formation is exposed mainly in one large block and the anticline between the flanking Belly river is much narrower than on Highwood river. These two areas would seem, therefore, to have the necessary conditions favouring the concentration of any oil and gas that was present and from our knowledge of structural conditions are the most favour-

Fig. 3



able untested areas in the section of the eastern foothills under discussion. Drilling in the Highwood area has yielded shows of oil and the presence of salt water horizons may also be taken as evidences of porosity. If porous rocks that could act as reservoirs for gas and oil are present in the Fisher creek and Two Pine areas (and there is every reason to expect such will be the case) and if the gas and oil is sufficiently concentrated, as would be predicted from the character of the structure, the results of drilling should prove highly interesting. In narrow structures the presence of low angle thrust faults which thrust lower stratigraphic horizons over higher ones is always a menace, but it would appear from present data that the Fisher creek area in particular is fortunate in this regard and is wide enough to avoid striking low angle thrusts of any magnitude provided the wells are properly located. (Fig. 2.) The first location being drilled in the Fisher creek area is on the west side of the structure. If this well should prove to be too far down the west flank and strike salt water, a second well further east and higher structurally will be justified. Four gas seepages occur in close proximity to this well, which commenced drilling on Blairmore beds. It is thought the Palaeozoic limestone will be reached at a depth of 2,000 to 2,500 feet, which contrasts very favourably with wells in Turner valley where the limestone occurs at a depth of 3,500 to 5,000 feet or even deeper.

In the Two Pine anticlinal area Signal Hill No. 2 well is now drilling at a depth of 4,090 feet (October 11th). The well is located at a considerable distance down the west flank of the anticline.

The Calgary Development and Production Company well, the Cottonbelt well in the Fisher creek area and the Signal Hill well are considered to be the most important tests now being made outside of Turner valley in the eastern foothills between Highwood and Bow rivers. It can safely be said that the results of these wells will have a large place in the future of oil prospecting in the foothills.

Oil Fields in Structures Similar to the Foothills

One may well ask, are there oil fields in other parts of the world where structural conditions are similar to the foothills of Alberta. To answer this question reference should be made to Report III of the Federal Oil Conservation Board to the President of the United States, from which the following quotations are taken from the description of the oil fields in the foothills of the Carpathian mountains.

"The Polish Carpathians are characterized by a roughly parallel series of extensive overthrust faults, the overthrust mass of each fault overriding that of the fault to the north. In places the overthrusting has been so intense that two, if not more, overthrust masses lie upon one another. Such intense overthrusting has generally caused intense folding with much minor faulting. The resultant anticline and synclines range from gently symmetrical to highly overturned and recumbent folds, some of which are ruptured along the crest and grade into overthrust faults. In the steep overturned and overthrust folds of the Carpathians with their alternating beds of porous sandstone and impervious shale, petroleum natural gas and mineral wax or ozokerite have been produced in Galicia in a belt about 270 miles long and about 30 miles wide, commencing near Cracow and extending in an arc almost to the eastern boundary of Poland. Over 70 per cent of the oil produced in Galicia, however, has come from an area comprising 9½ square miles. This area includes the Boryslaw-Tustanowice-Mraznica field, which has produced from 1898 to the end of 1927 about 20,517,800 metric tons (approximately 100,000,000 barrels) of petroleum, exclusive of a considerable amount of oil which is burned at the wells for fuel or wasted. The oil-bearing anticlines range from gently to steeply overturned folds, and these may form parts of the overthrust masses at the surface or of the overridden masses lying beneath one or even two or more overthrust faults. The crude oils of Galicia vary in gravity from 53.5 degrees A.P.I. at Bitkow to 25.5 degrees A.P.I. at Harklowa."

From the above description it will at once be evident that the structural conditions in the Polish fields are analogous to the structural conditions found in the foothills of Alberta. The comparison, however, in regard to other conditions should not be carried too far, as the oil in the Polish fields comes mainly from Tertiary strata, whereas the oil-bearing formations of the foothills of Alberta are Mesozoic and Palaeozoic, which might be expected to carry more gas and a higher grade of oil, as is the case in Turner valley.

Acknowledgments and Conclusions

The data for this paper have been collected from several years geological work in the foothills of Alberta and from data collected from many sources of which it has not been possible to make detailed acknowledgments. Much of the data on the results of wells has been secured through the supervisory engineer's office in Calgary, and the comparison with the Carpathian structures was first suggested to the author by T. G. Madgwick. From time to time the problems of foothill structure have been discussed with the geologists of various oil companies drilling in western Canada and particularly with the geological staff of the Imperial Oil Company, to whom as well as to the geologists of other companies the writer wishes to express his thanks.
It seems highly improbable that Turner valley will be the only productive field in the foothills and although the search for oil has been long and expensive it is believed we are approaching the time when the application of our knowledge of the extremely complicated structural conditions will yield favourable results. In comparison with the country as a whole, oil fields are of very limited extent and difficult to locate, and although the results of the many wells drilled in the foothills outside of Turner valley may superficially seem like a condemnation of the oil prospects, it is believed that in selected areas outlined by careful and detailed geological work the search for oil will eventually lead to abundant rewards.

Automatic Block Signalling on the Canadian Pacific Railway

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Assistant to Signal Engineer, Eastern Lines, Canadian Pacific Railway Company, Montreal.

Paper to be presented before the Annual General and General Professional Meeting of The Engineering Institute of Canada, at Montreal, February 4th, 5th and 6th, 1931.

SUMMARY.—Railway signalling, which was originally developed in Britain on the semaphore system, has undergone many changes, largely due to the application of mechanical or electrical power for signal operation. The automatic feature, based on the idea of a track circuit, was conceived in 1872, and from that time the progress in automatic signalling for the control of trains has been continuous. To take full advantage of the track circuit system, power operated signals are a necessity, and these were at first disc or semaphore signals moved by electric magnets and motors. These are now being replaced by coloured light signals, in which the indication is given by a brilliant light both by day and night. Designs have now been perfected so that the beam has an effective range of vision of from three to four thousand feet in bright sunlight.

Modern signalling systems, which increase operating efficiency by speeding up traffic and avoiding collision and other hazards, involve the division of a railway into a series of sections governed by automatic signals. The most recent development of this automatic block system provides for the operation of considerable lengths of track by a centralized traffic control system in which all trains are moved by signal indication at the will of the despatcher, regardless of time table superiority and without train orders. Further developments, such as cab signalling, the automatic train stop, and automatic train control, are briefly touched upon.

Signalling may be said to be as old as man, as there always must have existed the necessity of communication at a distance between primitive man and his companions. A man's arms being the natural medium for giving such signs, it follows that they were probably used as the first semaphores. The semaphore was also used as a method of communication by the warring nations of the Old World before the Christian era and has continued in use, though its form and methods have changed, down to our day of railways.

The name semaphore is derived from Greek words meaning "a sign" and "to bear," and the first record of its application was to a signalling device invented in the year 1084 B.C.

As early as 1794, a practical semaphore was devised in France by three brothers, named Chappe. This semaphore was adopted by the French government; stone towers being erected on the coast and through some of the interior districts, and messages were transmitted from one tower to the other and read by telescope (a similar form of semaphore is in use in the navy today).

Semaphores, as applied to railways, originated in England, as did the railways themselves. After the first railway trains were placed in service the necessity for some form of signal to control their movements was felt, which soon resulted in the use of a large number of kinds of signals for giving information as to the position of switches, location of fouling points and train orders, etc.

One early type of signal was the ball signal, which consisted of a tall pole with two hoods suspended from a yard arm. There were two different coloured balls for the day indications with corresponding coloured lights for the night indications. This signal, shown in Fig. 1, is the one from which the well-known railway term "give 'em a high ball" has come down to us.

The variety of signals on several railways used for similar purposes naturally resulted in confusion, especially in jointly operated properties and numerous accidents resulted, which brought the attention of the operating officers to the necessity of adopting a standard signal. At a meeting held in the year 1841, a Mr. C. H. Gregory suggested the use of the semaphore to replace all other types of signals in use. This suggestion was adopted. The adopted signal gave the following indications: horizontal arm for the "danger" or "stop" indication; downwardly inclined arm for the "clear" or "proceed" indication. No record is found of night indications.

The indications referred to were shown in what became known as the lower quadrant and probably followed the method of hand signalling, which had previously been used to govern train movements. The latter method consisted of holding one or both arms in a horizontal position to stop a train and allowing them to drop to the side in a natural position to allow a train to proceed.

The application of semaphores for the control of trains was for a long time limited to the protection of facing switches, fouling points, railway crossings at grade, etc., due to the fact that these semaphores were mechanically operated by levers grouped together in a frame at some central point and connected, in the earlier days by means of wire, and latterly by pipe. The levers at first were so grouped simply for convenience of operation; then as their number grew and the possibility of clearing conflicting signals at the same time became apparent, interlocking between the levers was introduced; this however is another phase of the protection of train movements which is not included in the scope of this paper.

As the speed and tonnage of trains increased, the need for some means of conveying information to them along their entire route became a necessity and numerous systems were introduced, manual control being of course the only method in the early days. Block stations were established at certain locations along the route of the railway and different methods of conveying the necessary information to the trains were used. In 1851 Charles Minot, then general superintendent of the Erie Railroad, issued the first telegraphic train order for this purpose.

An early system of block signals was put into operation during the year 1863, between New Brunswick and Philadelphia, on the old United New Jersey Canal and Railroad Company (now part of the Pennsylvania system). This consisted of a box at the entrance to each block with a red banner displayed against a white background as a "stop" indication, and the electric telegraph used to keep the block tenders informed as to the arrival and departures of trains.

Following this method track treadles or track instruments came into a somewhat limited use for the control of block signals, but it was not until the year 1872, when Dr. William Robinson conceived the idea of the track circuit, that automatic signalling may be said to have been born, and from that time the progress in automatic signalling for the control of trains has been continuous.

The primary function of the track circuit is to detect the presence of a train within a certain track section. The occupancy of this track section will cause the signal at the entering end of the block to display a "stop" indication for a train which may be following. Incidentally, a broken rail, a misplaced switch, or a car foul at a passing track or siding will also cause a "stop" indication to be displayed, by breaking or short circuiting the continuity of the rail conducting circuit.

Fig. 1.—Ball Pole Signal.

Track circuit protection is accomplished by connecting both rails of a track to the terminals of a battery. At some distance from this battery, determined by the distance between signals, is an instrument which is called a track relay, connected to the rails in a similar manner to the battery. This arrangement is illustrated in Fig. 2. Insulated rail joints are used to confine the circuit to its effective length, the current from the battery flowing along one line of rail, through the relay, back through the other line of rail to the battery, the rails being bonded in a suitable manner to lessen the resistance due to rust in rail joints, etc.

The presence of a train on the rails will short circuit the current from the battery which will cause the track relay to drop, opening or closing auxiliary circuits as desired, and causing the signal in the rear to display the "stop" indication, thus protecting the train occupying the track section.

Coincident with the invention of the track circuit came the demand for a power-operated signal, which was necessary if the full advantage was to be obtained from the use of the track circuit. Various types of power-operated signals were soon on the market, one of the earliest types being the disc signal, similar to that first used on the Pennsylvania already referred, to, but improved and enclosed in a housing and actuated by an electro-magnet to display the required indications; the night indications being given by coloured glasses or roundels, displayed in proper order in front of an oil light, above the banner, (See Fig. 3.) Signals of this type were installed between Windsor Street station and Montreal West on the Canadian Pacific Railway in 1897 and extended to Vaudreuil in 1907. These were removed in 1913 and upper-quadrant semaphore signals installed in their place.

Railway officers however, were still very much in favour of the semaphore, and power operated semaphore signals were soon on the market. Among these were the electro-pneumatic in 1885, which was electrically controlled and operated by air. This signal was not used to any great extent owing to the necessity of air supply for its operation.

With the improvement in small electric motors and primary battery cells, the electric motor semaphore came into prominence a few years after the electro-pneumatic type, made steady progress, and was almost universally accepted as the best type of power signal until the advent of the light signal.

Another type of power operated signal which was put on the market about the same time as the electric motor signal, was the electro-gas semaphore, which was electrically controlled and operated by the expansion of highly compressed carbon dioxide. This signal did not come into general use, as the same objections applied to it, as to the electro-pneumatic, that is, the necessity for a gas supply for operation.

The electric motor semaphore has, since its inception, gone through a number of changes and improvements, and has been brought to a state of high efficiency. In the original signal, known as the "Bottom Post type," the semaphore arm was operated by an electric motor and gear train, which was located in a housing at the base of the mast, the energy being transmitted to the semaphore arm by a rod arranged inside of the hollow iron mast. The Canadian Pacific Railway has some 61 miles of this type of signal in service at the present time, as shown in Fig. 4.

Next in the line of development was the "Top Post type," in which the motor and transmission members were placed in a much smaller housing at the top of the post, adjacent to the semaphore arm.

Coincident with the early development of the power-operated semaphore, the question of the use of the semaphore arm in the lower or upper-quadrant came in for a great deal of discussion, largely due to the fact that owing to the increase of both speed and tonnage of the average train, a further indication other than that of "stop" and "proceed" was desired to give an approaching train advance information when it was approaching a "stop" indication. This led to the adoption of the third or "caution" indication, which in the case of semaphores operating in the lower-quadrant generally meant that a second arm, usually coloured yellow, with a yellow light for night indication, had to be mounted on the signal post in order to show this indication clearly. This second arm is not necessary for a semaphore operating in the upper-quadrant, the three positions of the latter being: arm horizontal "stop" indication; arm 45 degrees above the horizontal position "caution," and the arm 90 degrees above the horizontal, "proceed" indication. Coloured roundels or glasses are carried in the casting which holds the arm, and displayed in front of a light in such a manner to show red for "stop," yellow for "caution" and green for "proceed" indications at night.

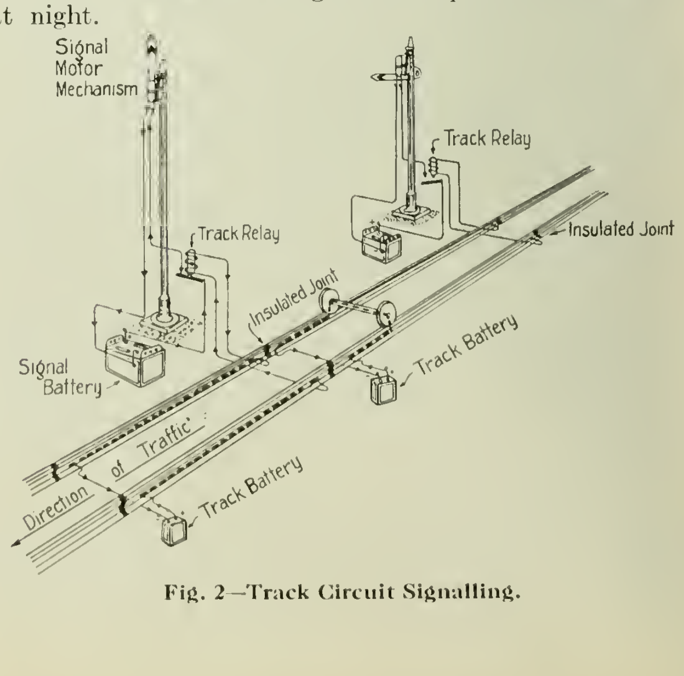

Fig. 2—Track Circuit Signalling.

Fig. 3.—Disc Type Signal.

The upper-quadrant semaphore, shown in Fig. 6, besides being considered more distinctive, has several other outstanding advantages over that operating in the lower quadrant. Among these may be mentioned its inclination to gravitate to its most restrictive position without the use of counter-weights, which had to be employed for this purpose in the lower-quadrant semaphore; also, accumulation of ice and snow on the semaphore arm tended to cause it to assume the "stop" position, which was not the case in those operating in the lower-quadrant.

The similarity of the operation of the lower-quadrant semaphore to the hand signal seemed to be the strongest argument in favour of the downward indication, and was for some considerable time allowed to outweigh the excellent reasons for the use of that operating in the upper-quadrant.

The Baltimore and Ohio Railroad, in 1903, was the first road in America to adopt the semaphore signal operating in the upper-quadrant, and the advantages were so well defined that other railroads were not long in following its example, although there are a number of railways still using the lower-quadrant semaphore.

The present day trend in signalling seems to be towards dispensing with mechanisms to move the semaphore arm (the electric motor and its attendant train of gears), for although they had reached a state of relatively high efficiency, trouble of one sort or another was experienced. This has led to the development of the most efficient signal to date, the light signal. This modern signal is on the market in several forms, but all types rely on light and that alone, the semaphore arm having been eliminated.

Fig. 4.—Lower Quadrant Semaphore Bottom Post Type.

The most popular form of this signal is perhaps the colourlight signal, in which the night indications of the semaphore signal have been used for both day and night, namely: red for the "stop" indication, yellow for the "caution" indication and green for the "proceed" indication.

The Pennsylvania Railroad developed a light signal retaining in effect the positions of the upper-quadrant signal using rows of lights, amber in colour, mounted on a background to simulate the position of the semaphore arm.

The Baltimore and Ohio Railroad has endeavoured to retain both the effect of the semaphore arm and colour of light, having developed what is known as the "Colour Position Light Signal," in which coloured rows of lights mounted on a background simulate the position and colours of the semaphore arm. Other forms of colourlight signals simply make use of the night indication of the semaphore, by means of lights placed behind red, yellow and green lenses, some forms having these lenses mounted in a vertical line, others in a horizontal line, and still others in a triangular form.

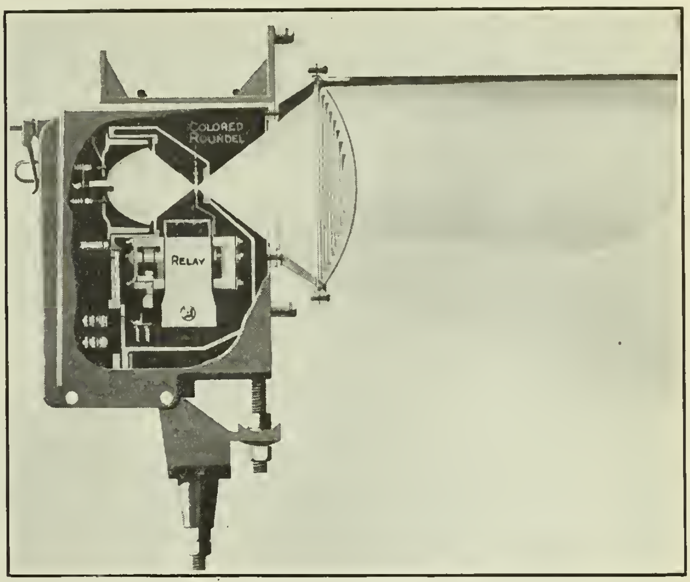

Fig. 5—Searchlight Type of Colour Light Signal.

The particular form of colourlight signal used by the Canadian Pacific Railway is the so called "Searchlight Signal," which was first installed in 1927 on a section of double track between Streetsville Junction and Guelph Junction, on the Ontario district, a distance of 16.5 miles. This signal proved so satisfactory that its use has been rapidly extended, some 355 miles of this type of automatic signal being in service at the present time. No more signals of the semaphore type have been installed on the Canadian Pacific Railway, eastern lines, since that time. As the existing semaphore type needs replacement the searchlight signal is installed in its place. In 1930 this type of signal was made the standard signal on both eastern and western lines.

This signal, shown in Fig. 5, employs a single light unit, consisting of a concentrated filament lamp with the filament located at the focal point of an elliptical reflector, which collects approximately 80 per cent of

Fig. 6.—Upper Quadrant Semaphore Top Post Type.

the light rays emitted by the lamp and concentrates them at the second focal point of the ellipse. At this point, which is coincident with the focal centre of a clear optical lens, the light passes through a miniature coloured roundel, enters the lens and emerges in a substantial light beam, which has an effective range of vision of 3,000 to 4,000 feet in bright sunlight.

The coloured roundels, of which there are three, namely, red, yellow and green, for the "stop," "caution" and "proceed" indications respectively, are carried in a moving member or vane, moving in a plane at right angles with the light beam which is actuated by a standard relay of the three-position type, so arranged that when de-energized it will assume the central position due to gravity and display the red indication. The signal relay also operates contacts from which the three positions of the signal can be repeated, a valuable feature which was present in the semaphore type of signal, but is not present in other existing forms of light signals; the latter depending on auxiliary relays for this purpose.

In the other forms of light signals it is not possible to use a reflector of any kind owing to the danger of an engine headlight having its beam of light reflected to the engineman. This is commonly termed a phantom indication, and may cause confusion and perhaps a false indication. This danger is not present in the searchlight signal, since should it happen, the reflected beam is of the right colour, as it has passed through the proper coloured roundel. The use of a reflector allows the use of a smaller wattage lamp, with no sacrifice of effective range, and it is more economical for that reason.

The Canadian Pacific Railway has at the present writing some 1,210 road miles of automatic signals in service, 855 miles being of the semaphore motor-operated type, and 61 miles being of the lower-quadrant type previously mentioned. The balance of the semaphore type, or 794 miles, is of the upper-quadrant type. The colour-light signal is in service on the remaining 355 miles.

An automatic signalling system involves the division of a railroad into a series of consecutive block sections governed by automatic signals. The length of these block sections and the location of the signals depend upon several factors, such as the density of traffic, and the physical characteristics of the railway, such as grades and curvatures, which affect the ability of a tonnage train once having been stopped by a signal to start again, etc.

The primary purpose of such a system is to increase operating efficiency by speeding up traffic, increasing track capacity, etc. The hazards of collisions (both head-on and rear-end, on single track), broken rails, open switches, cars foul of main track, or other obstructions in the block, are greatly reduced by providing a space interval in the case of the first mentioned and the detection of the others.

Some of the present day methods of control will be briefly mentioned here:

When automatic block signals are applied to double or multiple tracks, protection is generally provided only for trains moving in the established direction of traffic, except in some certain special cases where density of traffic, the peaks of which flow in different directions at different hours of the day, can be facilitated by having one or more of the tracks signalled in both directions. The Canadian Pacific Railway has such a section signalled in this manner between Windsor Street station and Glen Yard, where the third track is signalled for traffic in both directions. This allows the use of this track in either direction as traffic demands.

The application of automatic block signals to a single track presents a more complicated problem than that of double track, in that protection must be provided for train movements in both directions. In the first single track installations the method of control was what is generally known as the "Overlapped Control," in which the "stop" control of the signal was overlapped, that is, the control of a signal would extend to the second signal in advance of it or nearly so. This was necessary in order to give protection against opposing train movements but did not permit following movements from signal to signal. This lead to the development of the "Absolute Permissive Block system" by the General Railway Signal Company. This was a decided step in the advance of single track signalling and the first installation was in Canada on the Toronto, Hamilton and Buffalo Railway.

In the "Absolute Permissive Block system," the train is given an absolute block from passing track to passing track against opposing trains and a permissive block signal to signal

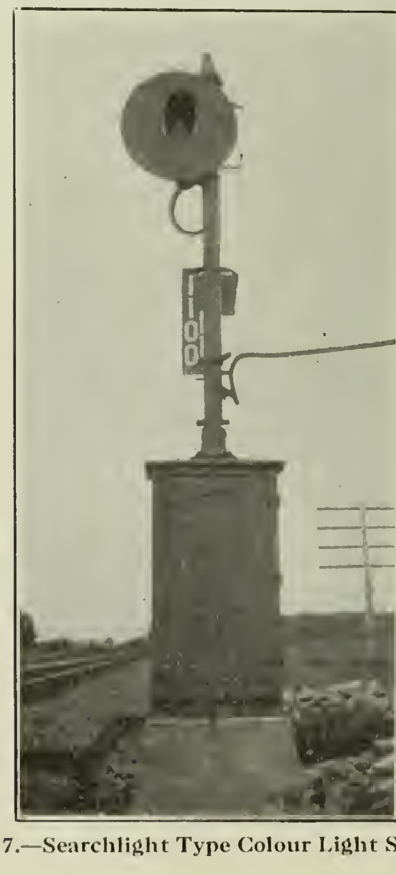

Fig. 7.—Searchlight Type Colour Light Signal.

for following trains. This system permits almost equal facility of operation for following trains as in double track operation, for the reason that the direction of traffic is established by the train that first enters the block. Trains may then follow as if the single track was one of the two main tracks of a double track line. All of these trains must pass out of this section between passing tracks before the signal indications will permit a train in the opposite direction to enter the block. This train will then in turn establish the opposite direction of traffic and trains may follow it, signal to signal, with the same facility as in the first case.

The control circuits are unique and ingenious, but do not require any appliance other than those ordinarily used in automatic block signalling. These circuits are so arranged that the system restores itself to the normal position as soon as the block is clear, regardless of whether or not a preceding train, or trains, have passed through the block. If a train enters an intermediate spur or siding and stands clear of the main track the system restores itself, so that another train could leave the passing track at either end of the block. When the train leaves the spur or siding, it establishes its direction on passing the first signal, the signals governing movements in the direction established display "proceed" or "stop" indications, depending upon the condition of the blocks in advance, and signals governing opposing movements display "stop" indication. The system is flexible and can be easily arranged to provide for any special requirements necessary.

Of the 1,210 road miles of automatic block signals in service on the Canadian Pacific Railway, 212 road miles have double track signalling, while the balance, or 998 miles, is made up of 243 miles of single track "Overlap Control" and 755 miles of "Absolute Permissive Block Signalling."

The use of train orders on automatic signal territory is decreasing and some railways have discontinued the use of "31" orders on automatic signal territory. A step further in the direction has been made by the introduction of the Centralized Traffic Control system, in which the despatcher has direct control of traffic. This system combines all the functions of control into one centralized unit. Protection, direction, and the actual operation of the switches for the passage of trains are brought about by this newly developed system, which is new only in the sense that it co-ordinates various signalling and interlocking functions of proved reliability previously used individually.

Under operation by the Centralized Traffic Control system, all trains are moved by signal indication at the will of the despatcher regardless of time-table superiority and without train orders. Trains are not detained, waiting the transmission and delivery of train orders at points along the railway, the movement of through trains is expedited and local trains can spend a larger proportion of their time in productive work.

Wherever there is a bottle neck on a railway, whether on a stretch of single or multiple track, this system provides facilities that will postpone the building of additional tracks for many years; the cost being but 10 to 15 per cent of what it would cost to build an additional main track.

The operation of the system is simple. The control board or machine, which is small and compact, is located in the despatcher's office and on it is a track model of the territory covered. Immediately below the track model is located a row of small levers for the operation of switches and signals, the position and operation of all switches, and if need be the signals also, being indicated to the despatcher by lights on the control board. The passage of a train in and out of a track section at each end of the passing track is also automatically indicated. This feature is generally used at "OS" points in the territory and is also made to register the time of such passage on the train-graph, which in this system replaces the despatchers train sheets. The Canadian Pacific Railway has four small installations of this system in service at the present time.

Mention should be made in closing of some other developments of the art, such as cab signalling, in which the indications of the way-side signals are repeated in the engine cab, an advantage in keeping the engineman continuously informed of track conditions ahead. Some railways have dispensed with the way-side signal entirely, except where a train is required to stop at a specific location.

Automatic train stop and automatic train control are systems in which the function is to stop or reduce the speed of a train, by applying emergency or service braking in the rear of a "stop" or "caution" signal as the case may be, should the engineman be incapacitated for any reason. The system does not in any way take the control of the brakes away from the engineman should he be alert and able to exercise this control. Space does not permit of a detailed description of these systems. They are comparatively expensive to install and railway officers are largely of the opinion that the money necessary to do this could be much more advantageously spent in other directions, such as extending automatic block signals or centralized traffic control systems and highway crossing protection.

A Method of Laying out Warped Surfaces of Hydraulic Structures

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Paper to be presented before the Annual General and General Professional Meeting of The Engineering Institute of Canada, at Montreal, February 4th, 5th and 6th, 1931.

SUMMARY.—This paper presents a description of the technique of determining and defining in detail the shape of warped surfaces of hydraulic structures. The matter discussed is workmanship in the design officer at her than the scientific or theoretical phases of design. Reference to hydraulic theory and mathematics is omitted, in order to emphasize the one point which the paper is intended to cover.

The designer of complicated engineering works, particularly hydro-electric developments, is of necessity somewhat of a "jack of all trades" and is quite often called upon to do things which he has not done before. It is his regular custom to produce a creditable solution of problems which are new to him, but he cannot hope to be an expert in all of the things which he is called upon to do, and his solutions of many problems fall just a little short of being 100 per cent perfect. It is convenient to be able to find the experiences of others on some troublesome detail recorded in a usable form. Many times in the course of the writer's work, he has been confronted with the necessity of working out a detail on which he had no experience, and concerning which he was unable to find a printed record of what others had done. The failure of engineers to record the methods of working out details is partly due to the fact that those actively engaged in construction are usually too busy to write, and partly because it is natural to choose a big and important subject, neglecting the details. For the above reasons, the writer believes that this paper, covering a relatively minor detail, will be of value.

In almost all hydraulic works there is a necessity for the construction of warped surfaces which it is very difficult if not impossible to define mathematically by curves and straight lines. Surfaces of this nature occur in intake structures, draft tubes, scroll cases, buckets of dams, branches in concrete lined tunnels, manifolds or branches in concrete pipes and in all transitions from one type of conduit to another, such as tunnel to canal, or canal to flume. Speaking in a broad, general way, all of these things might be called hydraulic transitions. The desirability of correctly curved surfaces is not limited to surfaces on which water flows. Under certain conditions there is a requirement for what might be termed a structural transition An illustration of a place where a structural transition might be used advantageously is an arch dam with gravity abutments. A section gradually merging from arch to gravity type with no abrupt change would result in a gradual change of load distribution from full arch action at the crown through partial arch and partial cantilever action to a full gravity dam at the abutment. There are no doubt cases where such construction would result in a more economical, safer and better appearing structure than if the section is changed abruptly from thin arch to heavy gravity abutment.

That the technique of shaping hydraulic transition structures is a matter in which the designer quite often fails to function to perfection, is evidenced by numerous structures which are satisfactory in a substantial sort of way, but which lack the indefinable touch of perfect workmanship. The reason for frequent failure to attain perfection is that the designer, no matter how skilled he may be in mathematics and hydraulic theory, cannot create a perfect hydraulic design until he has mastered the craft, or trade if you please, of the skilful layout of warped surfaces. He quite often attempts to economize by simplifying the shape of the structure, using as many straight lines as possible and making the curves all arcs of circles. This idea may work very well when dealing with something that is confined to a plane surface, but often leads to difficulty and unsatisfactory results when dealing with three dimensions. An attempt to save form costs in a structure like a large draft tube by simplification along the above lines, may actually make the construction more complicated and lead to costs greater than would obtain if the structure were shaped exactly correctly. The reason is obvious. Simplification by using straight lines, angles, and arcs of circles, results in an approximation to the ideal surface, and even though the approximation be fairly close, the departure from the ideal surface causes difficulty in bending, cutting and fastening form boards, which difficulty increases costs, and results in unexpected bumps, depressions and angles in the surface.

Slightly uneven surfaces do not necessarily introduce vital faults into the hydraulic characteristics of a structure, but there certainly is no justification for their existence if they increase costs. An imperfect, crude looking structure is a source of annoyance, while a beautiful structure is a source of pride which increases the pleasure and enthusiasm of all connected with a piece of construction work. Pride and enthusiasm are substantial factors in cost reduction.

The ideal shape of surface for a hydraulic structure may be defined as that surface which will cause the desired change of direction of flow of moving water with the least loss of energy. This definition will apply even to structures which are built for the purpose of destroying energy because we do not really "destroy" energy, we want to divert it away from destructive action on structures and cause it to be dissipated in the form of heat caused by water impinging upon water.

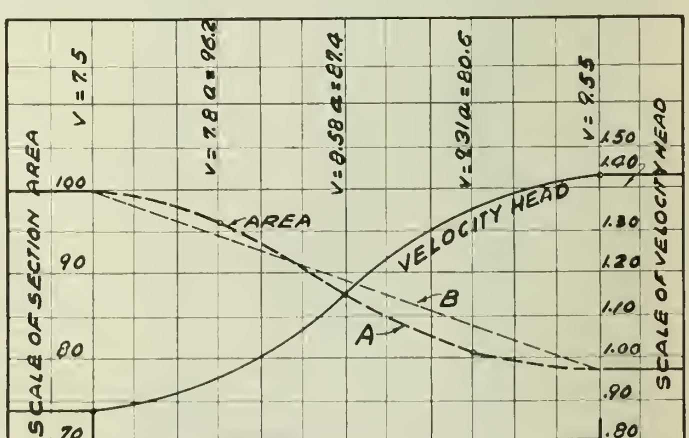

FIG-1
AREA AND VELOCITY HEAD CURVES

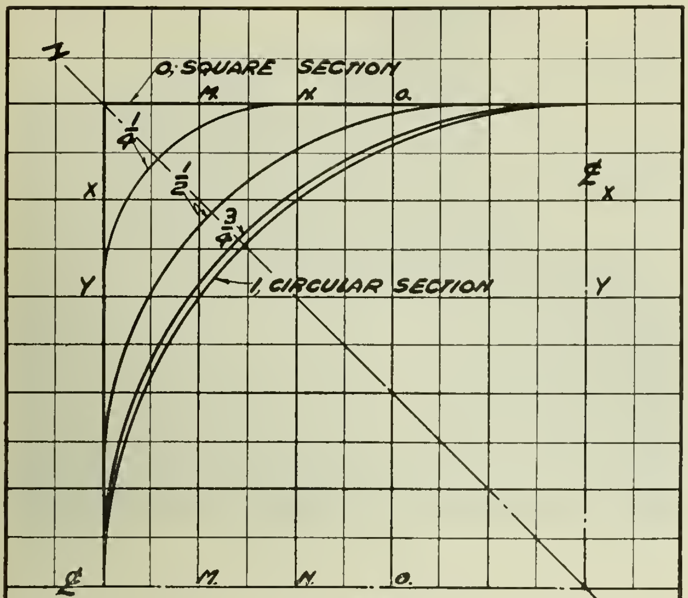

FIG - 2
CROSS SECTIONS

The elements of an ideal surface are composed of long, easy, smooth curves, with no angles and no abrupt bumps or depressions. It is to be noted that almost invariably a surface which is not pleasing to the eye is incorrect hydraulically. The converse is not so invariably true, because it is possible to build a nice appearing surface which is not suitable for the velocities of flowing water which will obtain. The appearance test is a good thing to keep in mind. If a job does not look pretty it is quite likely to be a poor job hydraulically.

An "ideal" surface is a surface the trace of which on a plane cutting it in *any direction whatever*, is a smooth, easy curve, pleasing to the eye. Such a curve need not be a circle or it need not be any curve which can be defined by a mathematical equation.

The method of definition and practical use of curves which are beyond the reach of mathematics and exact dimensions is simple. The procedure to be followed requires skill and practice, but it is not complicated or difficult to understand.

Drawings made with a fine hard pencil may be scaled with an error not greater than one-fiftieth of an inch. If the drawing is made on a scale of say one-half inch to the foot, the possible error is magnified to one-half inch in the finished structure. This is within the allowable error in the curved and warped concrete surface of a large structure, and is closer than forms are usually built.

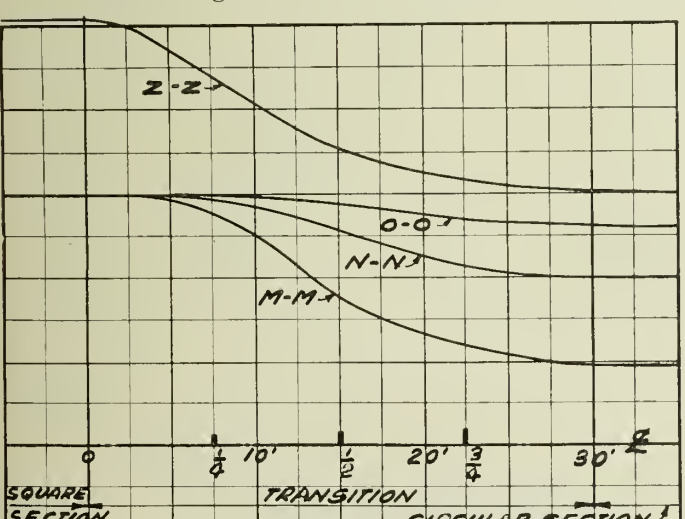

FIG - 3
LONGITUDINAL SECTIONS

The order of procedure is as follows:

First: Determine and fix the limits of dimensions and shape which are required for hydraulic reasons, such as velocity, tendency to scour, etc.

Second: Keeping within the limits defined as above, sketch the desired curves freehand.

Third: Define the curved surfaces exactly, using a spline and weights. In carrying out this process use planes passing in three directions, two series of vertical planes at right angles to each other, and a series of horizontal planes. Intersect the curved surface with a series of parallel horizontal planes at suitable intervals, obtaining a group of horizontal traces or contours. Simultaneously with

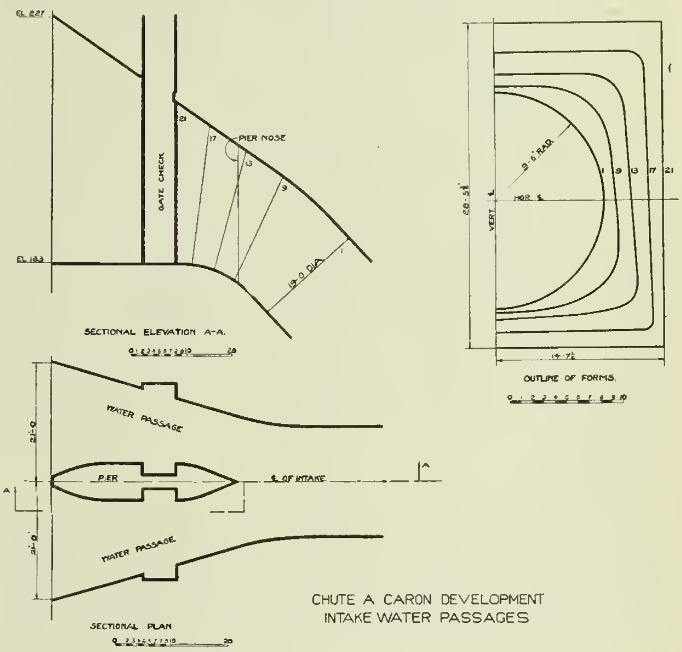

Fig. 4.

the above, obtain two groups of vertical sections on axes at right angles to each other. These three groups of curves should be carried forward on the same drawing, correcting all three sets of curves when a change is necessary at any point, as the work proceeds. Keeping within the limits of the first requirement, the curves should be made to look right to the eye and it should be kept in mind that the trace of the surface on a plane passed through it in any direction should be a smooth, easy curve. Usually the three groups of planes at right angled co-ordinate axes are sufficient, but it is often convenient and sometimes necessary to check up a critical part of a structure by passing a plane through the surface in some inclined direction, observing the appearance of the trace and correcting it if necessary.

As the work proceeds, let us say that one group of curves, say the horizontal ones, have been made to look right. The next step is to draw the intersection of the series of vertical planes with the horizontal sections, and using these points draw the vertical sections. Discrepancies will appear in these vertical sections which must be corrected by using a spline and weights, passing a curve through as many of the points as possible, but eliminating the obviously undesirable bumps and depressions. The newly drawn vertical sections should then be used as the origin of a series of points for the correction of the horizontal sections. A spline should be passed through the revised points for the horizontal sections, eliminating and correcting where necessary. In the above manner, transferring back and forth from one view to another, and carrying all corrections forward simultaneously, the drawing can be perfected to the point where all three views are in agreement, and all are pleasing to the eye. This process appears to be somewhat difficult to understand, but like most manual operations, skill can be quickly acquired by trying it.

Some fundamental points to be observed in the use of a spline and weights are:

First: Three points do not define a curve. Any number of fair, smooth curves may be passed through three given points with a spline. Four or more points are necessary to define a curve.

Second: A spline lies in a fair curve when, it being held in place by a number of weights, any one of the weights can be temporarily lifted without the spline moving.

A simple illustrative example is submitted.

Let us say that we wish to define a transition between a 10-foot square opening in an intake structure and a 10-foot diameter circular concrete lined tunnel. Let us say that the conduit is to carry 750 second feet. Let us say that by experience, judgment, or by the use of a hydraulic model, we have determined that a length of 30 feet will be suitable for the transition. The velocity in the square section will be 7.5 feet per second and in the circular section it will be 9.55 feet per second. A fundamental requirement for efficient hydraulic transitions is that there should be no abrupt change in direction of flow. Another fundamental requirement which is sometimes overlooked is that there should be no abrupt change in velocity head.

To proceed with the example:—

Draw first a curve of velocity heads, (see Fig. 1), which is a symmetrical "ogee" curve passing through the point of half the change in velocity head at half the length of the transition. Choose a number of points on this curve, at each point calculate the corresponding area, and

Fig. 6.—Apron of Chute à Caron Dam—showing warped Surface being constructed without Form.

draw the area curve "*A*." It is to be noted that this curve is an unsymmetrical "ogee" curve, more of it lying below the straight line "*B*" than above it. It is also to be noted that line "*B*" which is a straight line variation of areas, is sometimes erroneously used as the basis of a transition design. This basis of design is to be avoided. Another method which should be avoided in building a transition from a square to a circular section, is the construction of an approximation to a transition by using four quarter cones and four triangles.

The area curve having been fixed, the next step is to sketch, freehand first, sections which will have the required area. For simplicity in this example, the length of the transition is divided into only four equal parts. (For accuracy a finer subdivision is necessary.) Fig. 2 shows the outline of cross-sections at the quarter points which have the required area. Fig. 3 shows the intersection of the curved surface with vertical planes through *M-M*, *N-N* and *O-O*. It is to be noted that in a symmetrical structure such as this example, it is not necessary to use planes in the direction *X-X*, *Y-Y*, etc.,

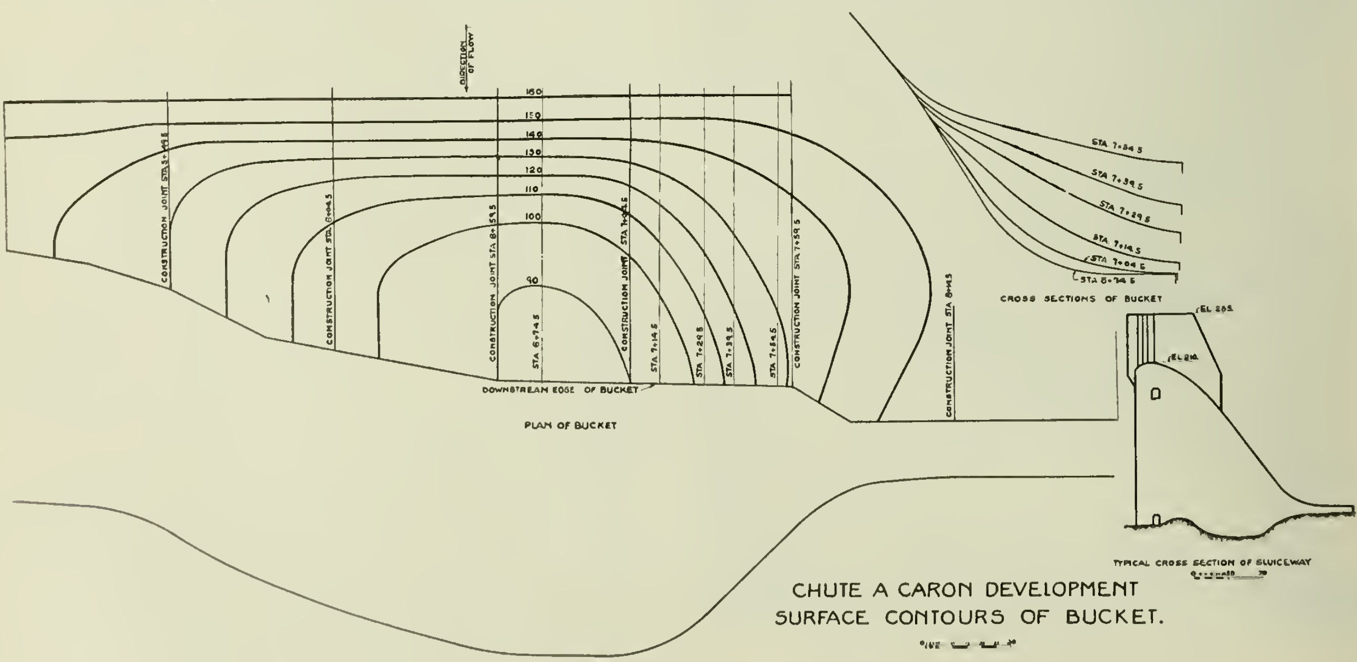

Fig. 5.

because these curves are identical with *M-M*, etc. If the structure were not symmetrical, it would be necessary to intersect the surface with planes in all three directions. Diagonal section *Z-Z* is used as a check on the work and this as well as the other sections is a smooth curve. In Fig. 3 a five-to-one distorted scale is used in order that discrepancies will be magnified and will be more easily and more accurately eliminated.

The foregoing will serve to indicate the method. This method is not original, it is merely the adaptation of the ship-builder's technique in shaping the hull of a ship. A ship is a hydraulic structure, and this method of shaping surfaces, developed by ship designers through a long period of years, cannot be improved upon as a method of shaping the surface of other hydraulic structures.

After the curves are satisfactorily determined on the drawing board, the necessary information is sent to the field for construction in the form of tables of offsets, or co-ordinates, in three dimensions. Quite often the offsets may be laid out full scale on the floor of the carpenter shop, and further refinement made with splines. A small scale wooden model of the surface to be constructed is quite often useful, but it is not necessary unless the surface is very complicated.

Two excellent actual examples in the writer's practice have occurred on the Chute à Caron project in northern Quebec. These are:—

(1) A transition from rectangular to circular section in the penstock intake structure. (See Fig. 4.)

(2) The surface of the bucket of the spillway section of the dam, which is warped to fit the topographic conditions rather than being stepped as is quite often done. This practice on this dam saved a considerable quantity of concrete, and resulted in a better structure hydraulically.

The procedure in this case was as follows:—

(*a*) An outline which looked right was selected by sketching concrete surface contours which followed the general topography of the river channel and allowed sufficient but not excessive thickness of concrete between the rock contours and concrete surface contours.

(*b*) A model was constructed which was tested and the flow of water over it observed. The model was altered several times before a satisfactory shape was secured.

(*c*) The dimensions of the satisfactory model were transferred to the drawing board, and were refined by the methods described in this paper.

The apron of the dam presents a striking and beautiful appearance. (See Figs. 5 and 6.) The accomplishment of this somewhat unusual construction with its attendant saving in cost was made possible by the skill of I. G. Calderwood, general superintendent, and I. E. Burks, concrete technician, and by the fact that substantial encouragement toward working out new and better ways of doing things was given by James W. Rickey, M.E.I.C., and James P. Growdon of the Aluminum Company of America, acting in a consulting capacity.

In conclusion it may be stated that in general, an abrupt change of section, shape or type of construction, in almost any engineering work, be it structural or hydraulic or what not, results in a weak or faulty spot. Abrupt changes seem to be contrary to natural laws, and are therefore to be avoided.

The Water Supply Problem in Southern Saskatchewan[1]

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Geological Survey, Department of Mines, Ottawa, Ont.

Paper to be presented at the Annual General and General Professional Meeting of The Engineering Institute of Canada, Montreal, Que., February 4th, 5th and 6th, 1931.

SUMMARY.—The paper presents the results of recent investigations on the ground water supplies in southern Saskatchewan. This question is largely a geological problem and has been studied not only by officers of the Geological Survey of Canada, but also by a number of independent engineers.

The ground water supply in glacial drift depends largely upon the contours of the underlying bedrock, to which surface topography gives little or no clue. Supplies of water are frequently found in connection with the occurrence of boulder clay sheets or morainic deposits. There are other areas, such as ancient lake basins, where extensive clay deposits yield little or no water. The water supplies found in the district are not as a rule abundant, and vary greatly in mineral character.

In prospecting for ground water consideration must be given to the permeability of surface deposits, and springs are of considerable importance as possibly indicating the existence of ground water reservoirs. Information is also derived from existing wells.

The paper outlines methods used in estimating the quantity of ground water, based on the proportion of precipitation passing into the ground and by comparison with similar areas in which the production is known.

Investigations around Regina have indicated several possibilities for additional supply of water to the city, and additional supplies have also been found for the city of Moose Jaw.

A large artesian area has been located between Moose Jaw and the Southern Saskatchewan river, and the possibilities of this source of supply are briefly discussed.

The problem of obtaining sufficient water to meet the demands of growing cities and towns in southern Saskatchewan is important, for, owing to climatic and other conditions, large supplies of good water are available in only a few places. The average annual precipitation over much of the region is only 10 to 15 inches, the rate of evaporation and transpiration of water by plants in summer is extremely high, and during the winter the ground remains frozen so that comparatively little of the rainfall enters the ground to form ground water. The South Saskatchewan river is the only stream from which large supplies of good soft water may be obtained, but many of the cities are far removed from it. Surface water supplies are made available in places by impounding small streams but the main source of supply is the ground water. Diversion of water from the South Saskatchewan river to supply the cities of Regina and Moose Jaw and surrounding districts was long ago proposed and was shown by elaborate surveys and investigations to be a feasible but costly scheme. The work, however, is not likely to be undertaken for some time, partly because of the large expenditure involved, and partly because there is sufficient ground water in the vicinity of Regina to supply the city for a number of years even allowing for a growth of the city equal to that of the past few years.

The object of the present paper is to describe briefly the mode of occurrence of ground water in southern Saskatchewan, the methods of prospecting for ground water supplies and the results of recent investigations. In 1929 the ground water resources of Regina were investigated by the Geological Survey and in 1930 those of Moose Jaw and the surrounding districts. As the investigation of ground water supplies is largely a geological problem, the work was undertaken, at the request of these cities, in order to aid them in their search for new supplies. The investigation of the ground water resources of Regina by the Geological Survey was done by Dr. Howard E. Simpson, water geologist, University of North Dakota. N. S. Hill, Jr., of New York, and R. O. Wynne-Roberts, M.E.I.C., of Toronto, also made a study of the same problem for the city of Regina. The three reports have been published jointly by the city of Regina. The ground water supply of Moose Jaw was investigated by R. T. D. Wickenden and the author.

Mode of Occurrence of Ground Water

Large supplies of ground water occur in places in southern Saskatchewan both in the unconsolidated surface deposits, largely glacial drift, and in the sandy members of the bedrock formations. It is important in drilling for water and in examining outcrops to determine when the bedrock is reached and to distinguish between the bedrock and the glacial drift, for in many places if the bedrock is reached there is no use in drilling any deeper. The bedrock formations in this region are fairly well known, they are nearly horizontal and extend over wide areas so that it is possible to predict in any particular area the approximate character and thickness of the formations that will be passed through in drilling. But this distinction is not always easily made even by the trained geologist; the upper part of shale beds may be weathered to clay, as for example at the elbow of the South Saskatchewan river, and parts of the glacial drift derived from the shale are nearly similar in character. The glacial drift can be distinguished as a rule by the presence in it of pebbles and stones of granitic and magnesian limestone rocks that are foreign to the district.

The bedrock formations in the vicinity of Regina and Moose Jaw do not yield supplies of potable water, but there is a large artesian water basin in the bedrock in the area about midway between Moose Jaw and the South Saskatchewan river. This basin is referred to in a later part of this paper.

The glacial drift ranges in thickness from a few feet to over 300 feet, and it is impossible to predict at any locality what the thickness of the drift is, for the surface topography gives little or no clue to the contours of the underlying bedrock. An important point in connection with the ground water possibilities of the drift is that there are two or three boulder clay sheets separated in places by stratified sands and gravels and these gravels frequently contain large supplies of hard but usable water. A large part of the drift consists of morainic deposits that were laid down at intervals at the edge of the ice-sheet as it gradually retreated or melted back towards the northeast. These moraines usually have some relief above the surrounding country, are several miles wide and are more porous as a rule than the lake clays and other deposits occupying the intervening depressions, so that they form good catchment areas to supply ground water. In places, for example, northeast of Regina, a large moraine causes a reverse slope towards the west and southwest, and forms the source of an important artesian water area which supplies the city of Regina. The water occurs in sands and gravels between two boulder clay sheets, the upper one forming in places a nearly impervious cover.

A part of the drift consists of glacial lake deposits of sand, silt and clay. One of these ancient lake basins extends southeast through Moose Jaw and Regina nearly to Weyburn. The lake deposits cover a large area and consist very largely of a very fine grained clay that is practically impervious to water. Over a large part of this heavy clay area there is practically no ground water. Numerous wells have been sunk to depths of over 300 feet without finding any water. In places small supplies of

[1] Published with the permission of the Director, Geological Survey of Canada, Ottawa.

water are found in wells located on slight rises in the generally level or slightly undulating plain. It may be that at these places the heavy clay is of small thickness or is absent and the rain water finds access to lower more pervious beds. Over much of the heavy clay area the only source of water is rain water caught in cisterns or in "dug-outs." As the area is a very important one for agriculture and is devoted almost exclusively to grain growing, the domestic water supply problem has not been very acute, but if the farmers are forced by soil drifting and by other factors to undertake mixed farming the water supply problem will be a very important one. The character of the clay plain is such that it is favourable for grain growing, as practically all the rainfall which does not evaporate is used by the growing plants; thus although there is a small precipitation good results in farming are obtained except occasionally in very dry years.

Ground water supplies are also obtained from the alluvial deposits along streams and generally throughout the region except in the heavy clay areas, though these supplies are not as a rule abundant and vary greatly in mineral character.

Prospecting for Ground Water

In examining an area to determine the ground water possibilities one of the first things usually done is to investigate the existing wells and records of wells that have been sunk in search of water, gas or oil. In this connection local drillers can be a great assistance, for though they rarely have complete records of wells drilled, they usually have a good general knowledge of the water possibilities of the districts in which they have worked. The Geological Survey has collected records of wells for many years and these records are available for the use of ground water investigators, but they are far from complete and indeed it would be a hopeless task to attempt to make them complete. They are of value not only to show at what depths water has been obtained by drilling, but to show the areas that have been thoroughly tested by drilling and no water found.

In a region such as southern Saskatchewan, where there is a small precipitation and a high rate of evaporation, a factor of great importance in determining whether there is any large ground water supply in any particular area is the permeability of the surface deposits or of the solid rocks near the surface. The ground water supply comes from the precipitation, and porous beds, which will permit the water to enter the ground, must exist in order to keep the ground water reservoir supplied with water which otherwise would be gradually drained away. Ground water, especially in the sandy beds in the bedrock, may flow for long distances away from its source and even in the surface deposits, for example near Regina, may flow for several miles out under the clay plain. Large areas, however, in which the surface materials are impervious are not likely to contain much ground water. The movement of ground water is extremely slow and the supply of water in artesian basins, such as that near Regina, is only slightly or not at all affected by variations in the amount of precipitation from year to year. The ground water in shallow wells is affected to a much greater extent.

Springs are of considerable importance as indicating possible sources of water not only as direct sources but as possibly indicating the existence of a ground water reservoir at depth from which the water escapes by way of the springs. They are generally of two kinds, one where the water issues at the top of an impervious bed, and the other, like those near Regina, where the water has found a way through an impervious bed along joints or cracks or some other line of weakness. The latter show that a ground water reservoir exists at some unknown depth. In this connection the temperature of the spring waters has some significance. In the Regina district well waters coming from depths of 50 to 150 feet range in temperature from 38 to 40 degrees F.,

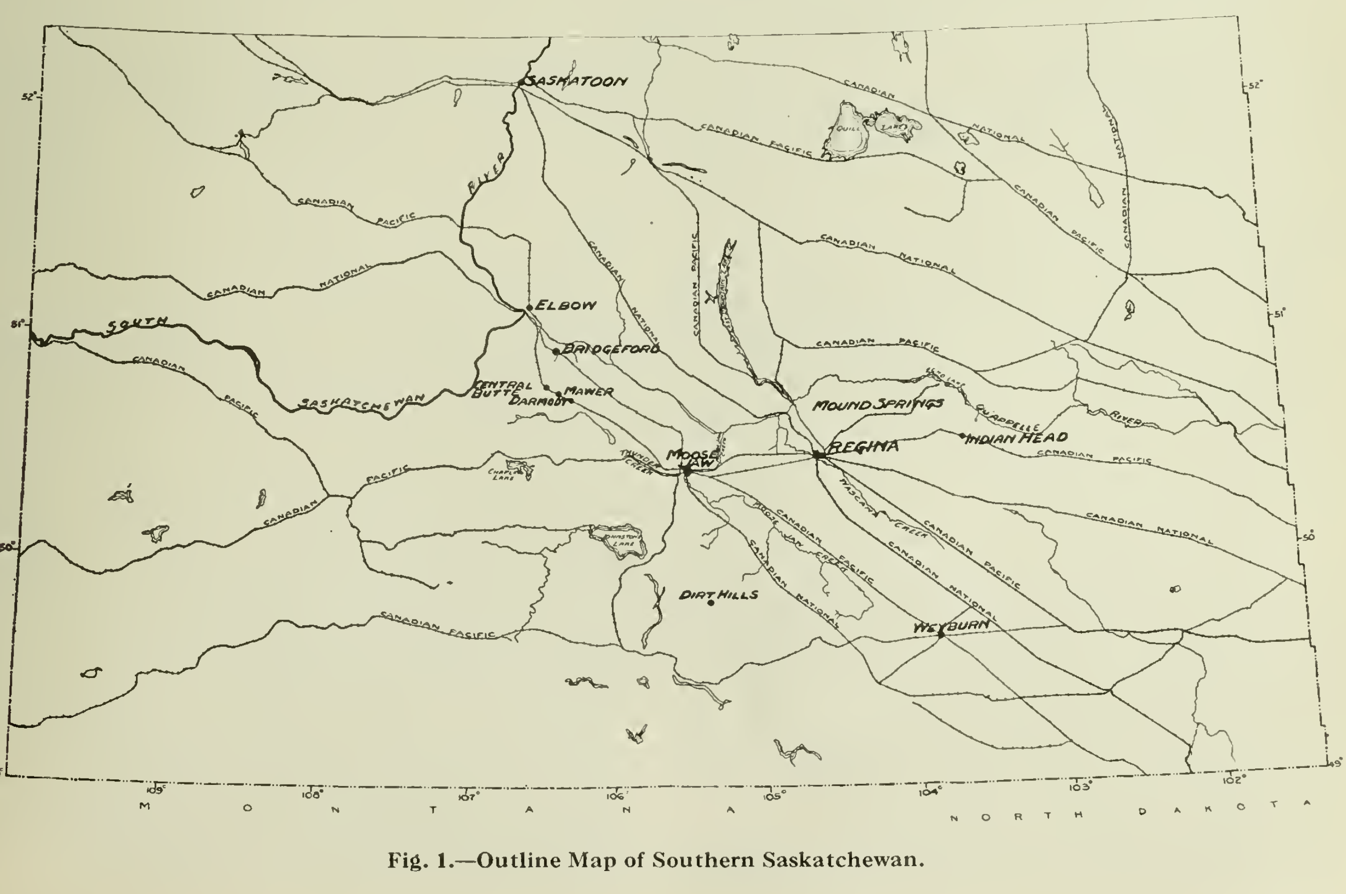


Fig. 1.—Outline Map of Southern Saskatchewan.

the mean annual temperature being 33 degrees, and are fairly uniform in temperature throughout the year. In some areas, for example the lower part of the Fraser river valley, where there is very little snowfall, the temperature of many of the springs is the same as the mean annual temperature. In southern Saskatchewan the blanketing effect of the snowfall and other conditions may cause the spring waters to have a higher temperature. The springs issuing from sandy beds overlying an impervious bed which comes to the surface usually vary in temperature according to the season and in the latter part of the summer have a relatively high temperature. Water coming from wells 400 to 450 feet deep in the area between Moose Jaw and the South Saskatchewan river has a temperature of 48 degrees F. The salty water coming from the deep well at Moose Jaw has a temperature of 60 degrees F. This water probably comes from a depth of about 1,000 feet. The water at a depth of 2,950 feet in this well is reported to have had a temperature of 81 degrees F.

Estimation of Quantities of Ground Water

In order to determine the quantity of water that can be obtained over a period of years from a ground water reservoir without depleting the supply it is obviously necessary to know the rate of replenishment of the reservoir. This rate depends upon the area of the catchment basin and the proportion of the precipitation that passes into the ground to form ground water. But neither of these factors can be readily determined. In the case of an artesian water reservoir the catchment area may be large or small depending upon the surface topography and the character and shape of the underground porous beds through which the water flows from the surface to the reservoir. These buried water-carrying beds may be continuous sheets of porous sand or be narrow ancient stream channels. In areas where a great many wells have been put down to the same water horizon it is possible to obtain from the records of these wells some idea of the character and extent of the water-bearing beds and of the catchment area. In areas where such information is not available there may be no way of determining the size of the catchment area which supplies the artesian reservoir.

The proportion of the precipitation which enters the ground to form ground water in southern Saskatchewan varies greatly depending partly upon the character of the soil. In sandy areas there is a fairly high rate of absorption, for the water left after a rain on these areas quickly disappears, whereas on the heavy clay lands it tends to remain in pools on the surface. Moreover, a part of the water absorbed by the soil descends only to slight depths and is again removed by transpiration by plants and by evaporation. It is held by some investigators that the snowfall adds little or nothing to the ground water supply, as the ground is frozen in winter and, therefore, is impermeable. But in some years the ground late in the autumn is extremely dry and may not readily freeze to any great depth; shrinkage cracks frequently form in frozen ground owing to temperature changes and these may furnish a means of access of melting snow to the ground water. The part of the precipitation which supplies the ground water in artesian basins such as that near Regina must be fairly small, but too little is known regarding conditions affecting absorption of ground water in the region to attempt to estimate what the proportion actually is. That there are very marked differences in the rate of absorption, apparently owing to variations in the character of the soil, is shown by the fact that ground water supplies sufficient for the city of Regina are found in the morainic area northeast of the city, whereas in the heavy clay area a few miles to the south and west there is scarcely any ground water.

Approximate estimates of ground water supplies, however, can be made by comparison with somewhat similar areas in which the production is known, or, better, by actual pumping tests. Measurement of the flow of springs coming from an artesian reservoir and the character of the springs may furnish evidence as to the extent and importance of the reservoir. The springs may vary greatly in flow from time to time owing to changes in atmospheric pressure. Springs that are permanent ordinarily have mounds of calcareous tufa built up around the points where they issue. In places they issue in boggy ground characterized by the presence of numerous 'buffalo' bones and have no mounds.

Results of Recent Work

One of the chief results of the work at Regina was to show that a large additional supply of water is available in the Mound Springs area, 14 miles directly north of the city and 100 feet above the city. This area was recommended for testing by drilling. Nine 6-inch cased wells have been put down and have found water at depths of 50 to 150 feet in the glacial drift. Three of the wells yield flows of between half a million and three quarters of a million gallons a day each, and have a static head of 10 or 12 feet above the ground level. There is little doubt, therefore, that the Mound Springs area will yield at least two million gallons a day and that this area together with other possible new sources will furnish an additional supply nearly equal to that used by the city at the present time which averages about four million gallons a day. The water is hard, but is a good wholesome water free from any possible source of contamination and is similar in character to that used by the city for many years.

The water supply of Moose Jaw is derived from several sources, with no very large supply from any one source, and is partly spring water of good quality derived from sandy beds near the surface and partly impounded water and seepage water from Thunder creek valley. The supply is affected by drought to a much greater extent than is the Regina supply, and during the past two exceptionally dry years there has been a shortage of good water. One of the main sources of supply is Sandy creek about 20 miles west of the city. Water is pumped from a collecting gallery and piped to the city and a gravel walled well recently put down by the Layne Canadian Water Supply Company Ltd. has increased the supply about half a million gallons a day. Another well has also been put down on Forsythe creek about 2 miles south of Caron and will be connected with the pipe line from Sandy creek. With these additional supplies it is believed that the water supply problem of Moose Jaw for the present will be solved.

A ground water supply which may prove to be of importance as a future supply for Moose Jaw and other places in the district is a large artesian area lying about midway between Moose Jaw and the South Saskatchewan river. Comparatively little appears to be generally known about this area although a number of wells drilled 10 to 15 years ago have been flowing ever since. The flowing wells occur in an area extending from Darmody nearly to Central Butte along the Canadian National Railway and north to within three miles of Bridgeford. The wells are 400 feet to 450 feet deep and derive their water from sandy beds that are overlain by shale which forms an impervious cover. Wells sunk to the same horizon are also obtained in the area extending west to the South Saskatchewan river and even beyond the river, but in most of these the water does not rise quite to the surface because of the higher altitudes. The water rises to about 1,987 feet above sea level. The source of the water is not definitely known, but the only possible source appears to be far up the South Saskatchewan river where these sandy beds are exposed along the river and become saturated with the river water.

An analysis of the water from the Canadian National Railways flowing well at Mawer in the artesian area was made by Andrews and Cruickshank, Regina, and is as follows:

Results in Parts per Million	
Calcium bicarbonate (as carbonate)	35.00
" sulphate	...
" chloride	...
Magnesium bicarbonate (as carbonate)	10.00
" sulphate	...
" chloride	...
Sodium carbonate	498.00
" sulphate	789.00
" chloride	163.00
Silica	2.00
Iron and alumina	2.00
Total solids by calculation	1,499.00
" " " evaporation	1,560.00
Temporary hardness	5.00
Permanent "	Nil
Total "	5.00

The almost entire absence of hardening salts in the water is a remarkable feature especially as most of the ground waters found in southern Saskatchewan are objectionable because of their hardness. The water comes from a sand which contains appreciable quantities of green sand, a water softening mineral, and therefore, is naturally softened. Unfortunately the water contains a fairly large proportion of non-hardening salts, is corrosive to some extent, and therefore, is objectionable. It has, however, been used for many years at Mawer as the town supply and at numerous other places with no apparent bad effects. It is possible that the water could be used satisfactorily when mixed with a proportion of hard water. In some of the wells which have a smaller flow than the one at Mawer the amount of salts present appears to be less, but only one analysis is available. Several of the wells flow at the rate of 30 gallons per minute from a one-inch pipe and there is no question that a very large supply of water exists. Further investigation is necessary in order to determine whether water of a more suitable character can be obtained from different parts of the basin or from different depths. The point nearest to the city of Moose Jaw at which the artesian water can be obtained is about 23 miles from the reservoir at the end of the pipe line at Sandy creek and is about 75 feet above it.

THE FORTY-FIFTH ANNUAL GENERAL

and

GENERAL PROFESSIONAL MEETING

of

The Engineering Institute of Canada
Will be held at the Windsor Hotel
Montreal

on

TUESDAY, WEDNESDAY and THURSDAY
FEBRUARY 4th, 5th and 6th, 1931

THE
ENGINEERING JOURNAL
THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIV JANUARY 1931 No. 1

The Institute's Library and Information Service

The commencement of a new volume of The Engineering Journal gives occasion to direct members' attention to the facilities offered by Headquarters for this work, principally in the form of bibliographies or lists of references to articles in current periodical literature.

Such a service would necessarily be very imperfect were it not for the development during the past few years in Europe and America of a number of indices to scientific and engineering literature, of which the outstanding example is the well-known Engineering Index, issued monthly in card form by the American Society of Mechanical Engineers. To this Index The Institute is now, and has been for many years, a subscriber. Its cards list and classify the titles of current articles in nearly two thousand engineering and scientific periodicals published all over the world, and thus constitute a survey of important communications dealing with every branch of the engineering profession. The items which it publishes are familiar to our members from the selected cards which have been reprinted in The Engineering Journal for the past thirteen years.

In view of the facility with which members, on application to Headquarters, can have prepared for them lists of references and photostats of such articles as they may desire, it has been thought no longer necessary to print in The Journal the list of Index items which has hitherto appeared each month. Members will please note, however, that we continue to receive the complete service at Headquarters, and its information is available for their benefit.

The Institute now possesses a valuable collection of sets of technical periodicals, which are continued and completed as opportunity occurs. Nearly two hundred such periodicals are regularly received, and in some cases the sets are complete for the past fifty years or more. These sets cannot be replaced in case of loss, and are, of course, not permitted to leave the library, but members, on request, are furnished with bibliographies or lists of references on any subjects on which information is available, and, at a moderate charge, can have photostat copies of such articles as they wish to consult at their offices. This service is used to a considerable extent, nearly two hundred inquiries having been received during the last three months. It is felt, however, that our membership at large is perhaps not so familiar with these facilities as it might be, and that the assistance offered by Headquarters in this matter could be utilized to a greater extent than is now the case. No charge is made for service of this kind, unless a considerable amount of clerical work is involved, members being required only to pay for the photostats which they obtain. The subjects on which information is asked from time to time are as varied as the occupations of our members. Inquiries range from a request to be informed as to the design, construction and performance of the steamship Great Eastern, to a question as to the extent to which large generators in Canada are operating with ungrounded neutrals, or an inquiry for a list of the most recent earth-filled dams in Canada.

As regards The Institute's library, it has been for some years the policy of the Library committee to expend the limited funds at its disposal on the maintenance and completion of our sets of engineering periodicals rather than on the purchase of works of reference for the library shelves. The reason for this is, that such books would be of use to a comparatively small number of our members, and many of them soon become obsolete when newer editions appear. The Library committee is, however, always ready to consider the purchase of special textbooks required for reference by individual members, but has not available sufficient funds to make a large appropriation for current technical books.

Textbooks and works of reference in the library are available for consultation, and are also mailed to members on loan for their use for two weeks on payment of a deposit of five dollars, which is repaid when the book is returned to Headquarters. Last year the library accessions, including review copies, books purchased, and books and reports presented, totalled seven hundred and fourteen.

Members may be assured that inquiries or requests for information, for textbooks available, or for bibliographies, will be welcomed, and replies furnished as promptly as possible.

An engineer's work, especially in its early stages, often requires investigation or experiment, and the collection of recent and reliable information as to the experience of others who have dealt with similar problems in the past. Sometimes this information is to be found in text books, but more frequently it is contained somewhere in the mass of technical periodicals, reports, proceedings and so on which cover our reading-room tables and fill our stack-room shelves. Few engineers maintain a large library, nor do they generally subscribe to more than a limited number of periodicals; those papers which do reach their desks are not always preserved for future reference. Thus a real service is rendered by an organization which can furnish promptly references to the titles and sources of scientific or technical papers dealing with any given engineering subject, and can obtain copies of them for consultation by the engineer.

Forty-Fifth Annual General and General Professional Meeting

The Annual General Meeting will be convened at Headquarters, 2050 Mansfield street, Montreal, on Thursday, January 22nd, 1931, at 8 o'clock P.M. After the reading of the Minutes of the last Annual General Meeting, the appointment of Scrutineers to count the Officers' Ballot, and the appointment of Auditors for the ensuing year, the meeting will be adjourned to reconvene at the Windsor hotel, Montreal, Que., February 4th, 5th and 6th, 1931.

Programme of Meeting at Windsor Hotel, Montreal

(*Subject to minor changes*)

Wednesday, February 4th

9.00 a.m. *Registration.*

10.00 a.m. *Annual General Meeting.*
Reception and discussion of Reports from Council, Committees and Branches. Discussions of proposed amendments to By-laws and other matters.

12.45 p.m. *Formal Luncheon.*
Welcome to members by A. Duperron, M.E.I.C., Chairman of the Montreal Branch, who will preside.

2.15 p.m. *Annual General Meeting.*
Scrutineers' report and elections of officers.
Retiring President's address.
Induction of New President.

7.00 p.m. *Annual Dinner of The Institute*, at which Ladies will be present.

9.30 p.m. *Smoking Concert.*
Ladies Bridge.

Thursday, February 5th

9.30 a.m. *Presentation and discussion of papers:*

Room A. *Train-Ferry Landings at Port Mulgrave and Point Tupper, N.S.*—by D. B. Armstrong, A.M.E.I.C., Erection Engineer, Dominion Bridge Company, Ltd., Montreal, and W. Chase Thomson, M.E.I.C., Designer, Dominion Bridge Company, Ltd., Montreal.

The Construction of the Steel Lock Gates of the Welland Ship Canal—by E. S. Mattice, M.E.I.C., Vice-President, National Bridge Company of Canada, Ltd., Montreal. Late Manager and Engineer, Steel Gates Company, Ltd.

Room B. *Breakwater Construction in Port Arthur Harbour*—by F. Y. Harcourt, M.E.I.C., District Engineer, Department of Public Works, Canada, London, Ont.

A Method of Laying out Warped Surfaces of Hydraulic Structures—by C. P. Dunn, M.E.I.C., Chief Engineer, Alcoa Power Company, Arvida, Que.

The Design of the Chute-à-Caron Diversion Canal—by G. O. Vogan, A.M.E.I.C., Chief Designing Engineer, Alcoa Power Company, Ltd., Arvida, Que.

12.45 p.m. *Buffet Lunch* (informal).

2.15 p.m. *Presentation and discussion of Papers:*

Room A. *Structure and Oil Prospects of the Eastern Foothills Area, Alberta, between the Highwood and Bow Rivers*—by Dr. G. S. Hume, Geological Survey, Department of Mines, Ottawa, Ont.

The Water Supply Problem in Southern Saskatchewan—by W. A. Johnston, Geological Survey, Department of Mines, Ottawa, Ont.

Automatic Block Signalling on the Canadian Pacific Railway—by A. J. Kidd, Assistant to Signal Engineer, Eastern Lines, Canadian Pacific Railway Company, Montreal.

Room B. *Alexander Power Development on the Nipigon River*—by T. H. Hogg, D.Eng., M.E.I.C., Chief Hydraulic Engineer of the Hydro-Electric Power Commission of Ontario, Toronto.

4.30 p.m. *Ladies Tea.*

Friday, February 6th

9.30 a.m. *Presentation and discussion of Papers:*

Room A. *Steam Station for the Head Office Building of the Sun Life Assurance Company of Canada, Montreal*—by F. A. Combe, M.E.I.C., Consulting Combustion and Steam Engineer, Montreal.

Mechanical Equipment in the Head Office Building of the Sun Life Assurance Company of Canada, Montreal—by E. A. Ryan, M.E.I.C., Consulting Engineer, Montreal.

The Plumbing Systems Designed for the Head Office Building of the Sun Life Assurance Company of Canada, Montreal—by A. Traver Newman, Consulting Engineer, New York, N.Y.

9.30 a.m.

Room B. *The Structural Engineering of the Head Office Building of the Sun Life Assurance Company of Canada, Montreal*—by A. H. Harkness, M.E.I.C., Harkness and Hertzberg, Consulting Engineers, Toronto.

The Electrical Equipment for the Head Office Building of the Sun Life Assurance Company of Canada, Montreal—by J. H. Mencke, Consulting Engineer, New York and E. A. Ryan, M.E.I.C., Consulting Engineer, Montreal.

12.45 p.m. *Buffet Luncheon* (informal).

2.15 p.m. Arrangements are being made for parties to visit the Sun Life Building and a number of engineering works of interest,

The new Head Office Building of the Sun Life Assurance Company of Canada, which is approaching completion, is designed for a population of 10,000 people, and has the most modern equipment. Its engineering features as regards structural work, heating and ventilation, lighting, sanitation and transportation, are of great interest.

The new shops of the Canadian National Railways at Point St. Charles employ the most advanced methods in locomotive construction and maintenance, and are amongst the most complete on the continent.

The Dominion Engineering Works at Lachine specialize in the construction of large turbines and paper machines.

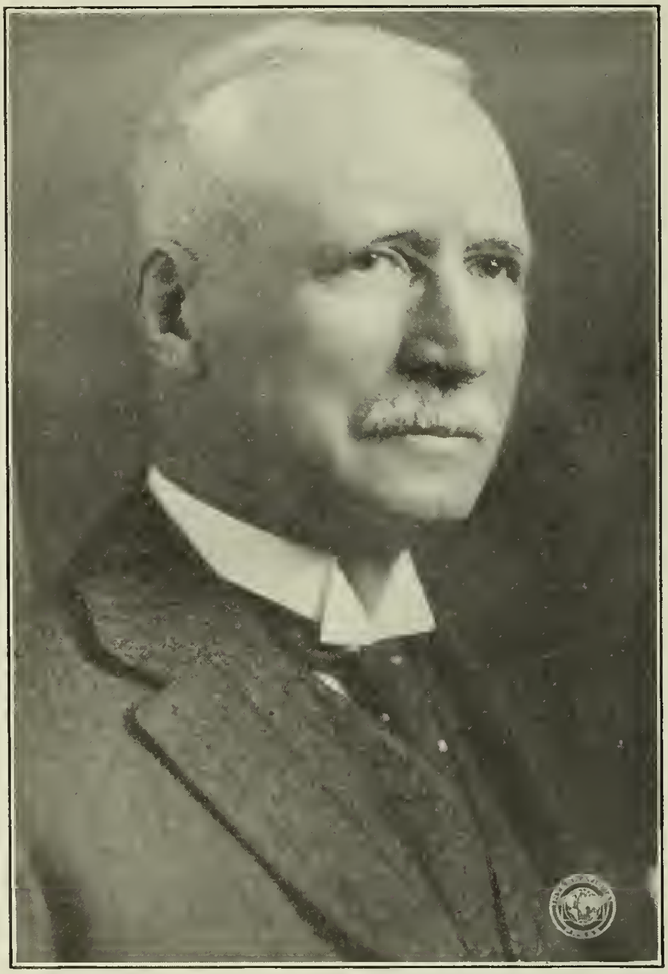
The Dominion Bridge Company, also at Lachine, have the largest bridge and structural shops in Canada.

The new bronze foundry of the Robert Mitchell Company at St. Laurent exemplifies the last word in modern foundry equipment.

9.00 p.m. *Dance and Supper.*

Award of the Sir John Kennedy Medal to George Herrick Duggan, M.E.I.C.

Established in 1928, the Sir John Kennedy Medal is the highest distinction in the gift of The Institute, and commemorates the great services rendered to the development of Canada, to engineering sciences, and to the profession, by the late Sir John Kennedy. It is given, 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 or to the benefit of The Institute.



GEORGE HERRICK DUGGAN, M.E.I.C.

The first award of this honour was made in 1929, when it was received by Lieut.-Colonel R. W. Leonard, M.E.I.C., whose recent death we now have to deplore. At its meeting on October 17th, 1930, the Council of The Institute decided that the second award of the Sir John Kennedy Medal should be made to Past-President G. H. Duggan, M.E.I.C., to whom the medal will be presented at the Annual Dinner of The Institute to be held on Wednesday, February 4th, 1931.

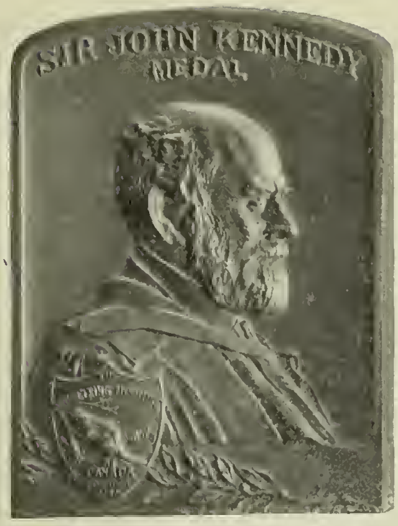
George Herrick Duggan was born in Toronto, in 1862, and was educated at Upper Canada College, and at the University of Toronto, graduating there in 1883, and taking a post-graduate course in 1884.

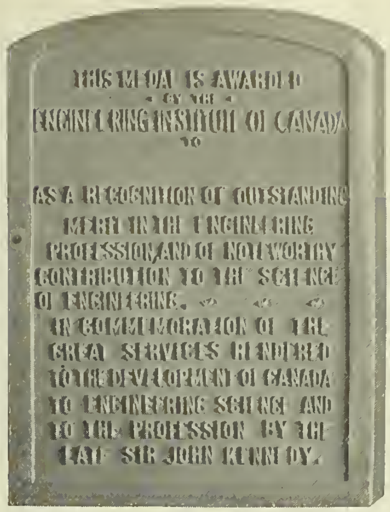
His professional experience began with the engineering department of the Canadian Pacific Railway; in 1886 he joined the staff of the Dominion Bridge Company as draughtsman, and in 1888 became resident engineer in charge of their Lachine works. He was appointed their chief engineer in 1891, and ten years later went to Sydney, Cape Breton, as assistant to the president, and consulting engineer, Dominion Iron and Steel Company and Dominion Coal Company. In 1904 he became second vice-president and general manager of the Dominion Coal Company, remaining in that capacity until 1910, when he returned to the Dominion Bridge Company as chief engineer. After serving as general manager for four years, he was appointed vice-president in 1917, and president of the company in 1918, the position which he still holds.

During his active engineering career he took a leading part in the construction of many outstanding works, among which may be named the Interprovincial bridge at Ottawa, the Quebec bridge, and the Montreal Harbour bridge.

Joining the Canadian Society of Civil Engineers as an Associate Member in March, 1888, during the second year of the Society's existence, he was elected a Member in 1890, serving on the Council for nine years, and as vice-president for five years. He was president in 1916, and has on many occasions since that time rendered valuable service to The Institute.

He is a Member of the Institution of Civil Engineers





(Member of Council, 1918), Member of the Canadian Institute of Mining and Metallurgy (vice-president, 1906; member of council, 1911-1913), and Member of the American Society of Civil Engineers. For many years he has been prominently identified with yachting in Canada, and is an accomplished yacht designer and sailor. He was instrumental in founding the Toronto Yacht Club, the Royal St. Lawrence Yacht Club and the Royal Cape Breton Yacht Club, in all of which he held office.

Mr. Duggan has been chairman of the Quebec division of the Canadian Manufacturers Association, and is a director of the British Empire Steel Corporation, the Royal Bank of Canada, the Montreal Trust Company, and other important industrial and financial organizations.

Meeting of Council

A meeting of Council was held on Friday, December 19th, 1930, at eight o'clock p.m., with President A. J. Grant, M.E.I.C., in the chair, and seven other members of Council present.

The Council noted with deep regret the death of Past-President R. W. Leonard, M.E.I.C., on December 17th, 1930, and on the motion of Fraser S. Keith, M.E.I.C., seconded by George R. MacLeod, M.E.I.C., the following resolution was unanimously passed, the Secretary being directed to send a copy to Mrs. Leonard:

> "On learning of the death of Past-President R. W. Leonard, the Council of The Engineering Institute of Canada desires to express its sincere sympathy and deep regret. Always active in promoting the welfare and advancement of the engineering profession, prominent in educational and philanthropic work, patriotic to a degree, the loss of Reuben Wells Leonard will be keenly felt by the members of The Institute and by the many who benefit from the Foundations he established."

The attention of Council was drawn to the death on November 13th, 1930, of George A. McCarthy, M.E.I.C., an active member of the Toronto Branch, and on the motion of Mr. MacLeod, seconded by J. A. McCrory, M.E.I.C., the following resolution was unanimously passed, the Secretary being directed to send a copy to Mrs. McCarthy:

> "The Council of The Engineering Institute of Canada records with regret the death of George Arnold McCarthy, for thirty-three years a prominent member of The Institute. Active in the affairs of The Institute as a councillor and as an officer of the Toronto Branch, he was always keenly interested in the advancement of the engineering profession. The Council desires to extend to Mrs. McCarthy and to his family its deepest sympathy and condolence."

Consideration was given to the amendments which have been proposed in Council to various sections of the By-laws, and after discussion it was resolved not to put forward this year the proposal to amend Section 34 of the By-laws dealing with the annual fees of members, which was lost on the ballot in May last. It was, however, decided to submit to the Annual Meeting for discussion, and to the membership for vote, the amendments proposed to Sections 66 and 67 dealing with the method of selecting the Nominating committee.

Council took action with regard to a number of members who are in arrears of fees for a considerable period, granting further credit in cases where members had replied to the communications addressed to them, and removing from the list the names of those who had ignored the reminders sent them. Thirty-two members of various classes were thus removed.

Discussion followed on the arrangements for the Annual General Meeting and the Annual Dinner to be held in February, 1931.

The report of the committee on Classification and Remuneration, together with a report on the Tariff of Engineers' Fees, was presented by Mr. Busfield, the chairman of the committee, these reports having been prepared owing to the need of a revision of the reports on these subjects issued in 1922. After discussion, the Secretary was directed to circulate these documents to all members of Council for their comment.

The Treasurer presented a draft budget for 1921, indicating the expenditures considered by the Finance committee to constitute a necessary minimum; additional expenditures approved by the Plenary Meeting of Council; and a further series of items recommended by the Special Committee on Publications. The impossibility of providing for all these was noted, and the matter was held over for discussion at the next meeting of Council.

The newly elected officers of the Kingston and Border Cities Branches were noted as follows:

Kingston Branch

Chairman	A. Jackson, A.M.E.I.C.
Vice-Chairman	L. F. Goodwin, M.E.I.C.
Secretary-Treasurer	L. F. Grant, M.E.I.C.
Executive Committee	A. G. MacLachlan, A.M.E.I.C.
	W. L. Malcolm, M.E.I.C.
	L. M. Arkley, M.E.I.C.
Ex-officio	D. M. Jemmett, A.M.E.I.C.

Border Cities Branch

Chairman	R. J. Desmarais, A.M.E.I.C.
Vice-Chairman	C. G. R. Armstrong, A.M.E.I.C.
Secretary-Treasurer	H. J. A. Chambers, A.M.E.I.C.
Executive Committee	J. D. Cummins, A.M.E.I.C.
	H. J. Coulter, Jr.E.I.C.
	R. C. Leslie, A.M.E.I.C.
Ex-officio	O. Rolfson, A.M.E.I.C.
	L. McGill Allan, A.M.E.I.C.
	A. E. West, M.E.I.C.

The Secretary presented a memorandum received from England regarding the possible terms of agreement with the Institution of Electrical Engineers in connection with the formation of joint radio sections of The Institute's branches, this arrangement being generally similar to that which has been approved by Council in connection with aeronautical engineering and co-operation with the Royal Aeronautical Society. While general approval was expressed the matter was held over for further discussion with the Institution.

The Council received with appreciation a replica of the Fiftieth Anniversary Medal of the American Society of Mechanical Engineers, and transcripts of the remarks of His Excellency Vincent Massey, Minister to the United States, presenting Brig.-Gen. C. H. Mitchell, C.B., C.M.G., C.E., D.Eng., M.E.I.C., for the medal, and the citation accompanying the presentation.

Eight resignations were accepted; three reinstatements were effected; five requests for Life Membership were considered, and a number of special cases were dealt with.

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

Elections		*Transfers*	
Assoc. Members	4	Assoc. Member to Member	1
Juniors	7	Junior to Assoc. Member	3
Students admitted	62	Student to Assoc. Member	5
		Student to Junior	3

The Council rose at one forty-five a.m.

ELECTIONS AND TRANSFERS

At the meeting of Council held on December 19th, 1930, the following elections and transfers were effected:

Associate Members

BICKLE, Warner Pentland, B.A., B.Sc., (Univ. of Man.), supt. of paving, Carter Halls-Aldinger Co. Ltd., Winnipeg, Man.

DREW, Arthur Edward, B.Sc., (Univ. of Sask.), Crystal Springs, Sask.

LEROUX, Louis Joseph, B.A.Sc., (Ecole Polytech.), engr. of bridges and tunnels, City of Montreal, Que.

MANNING, Ralph Clark, B.A.Sc., (Univ. of Toronto), district engr., Canadian Institute of Steel Construction, Toronto, Ont.

Juniors

FRITH, John Rowland, B.Sc., (McGill Univ.), 3429 Peel St., Montreal, Que.

GRIFFITHS, William Eric, 4th year Student, McGill University, Montreal, Que.

HYLLAND, Einar Nyson, C.E., (Tech. Univ. of Norway), designer, Beauharnois Construction Company, Beauharnois, Que.

LALAND, Arne, C.E., (Tech. Univ. of Norway), concrete engr., Messrs. J. M. Eugene Guay, Inc., Keefer Bldg., Montreal, Que.

LARRIVEE, J. Albert Edouard, B.Sc., (Univ. of N.B.), asst. divn. engr. and instr'man., C.N.R., Montreal, Que.

LAURENCE, Emile, B.A.Sc., C.E., (Ecole Polytech.), estimator and sales engr., George W. Reed and Co. Ltd., Montreal, Que.

TRACY, Edgar Herbert, B.Sc., (Univ. of N.B.), student test course, Canadian General Electric Co. Ltd., Peterborough, Ont.

Transferred from the class of Associate Member to that of Member

CIMON, Hector, B.A., B.Sc., C.E., (Ecole Polytech.), engr., Price Bros. & Co. Ltd., Quebec, Que.

Transferred from the class of Junior to that of Associate Member

DYER, Joseph Wilson, B.A.Sc., (Univ. of Toronto), bldgs. supervisor, general plant dept., Bell Telephone Company of Canada, Toronto, Ont.

FRASER, John Douglas, B.Sc., (McGill Univ.), plant engr., Moir's Ltd., Halifax, N.S.

TISON, Maurice, (McGill Univ.), electr'l. engr. in charge of mtce., Electrical Commission of the City of Montreal, Montreal, Que.

Transferred from the class of Student to that of Associate Member

GEALE, Charles Norman, B.A.Sc., (Univ. of Toronto), junior engr., Welland Ship Canal, Port Colborne, Ont.

HENDERSON, Gordon R., B.Sc., (Queen's Univ.), res. engr., Power Corporation of Canada, Ltd., Montreal, Que.

MASSEY, Denton, B.Sc., (Mass. Inst. Tech.), asst. to supt. of Toronto works, in charge of overhead and costs divn., Massey Harris Company, Ltd., Toronto, Ont.

NOTMAN, James Geoffrey, B.Sc., (McGill Univ.), asst. to gen. mgr., Dominion Engineering Works, Ltd., and works mgr., Charles Walmsley and Company (Canada) Ltd., Montreal, Que.

ROSS, Hugh Gordon, B.Sc., (McGill Univ.), design and development engr., Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

Transferred from the class of Student to that of Junior

BUTLER, Ernest W. R., B.Sc., (McGill Univ.), Western Canada manager, Bailey Meter Company, Ltd., Winnipeg, Man.

JOHNS, Charles Frederick, B.Sc., and Engrg. Cert., (Mount Allison Univ.), plant and heating engr., in charge of engrg. dept., Enterprise Foundry Company, Ltd., Sackville, N.B.

MOORE, Alexander Glydon, B.Sc., (N.S. Tech. Coll.), elect'l. engr., underground distribution dept., Montreal Light, Heat & Power Cons., Montreal, Que.

Students admitted

Undergraduates at Dalhousie University, Halifax, N.S.

BACON, Charles Ives, North Tryon, P.E.I.
CORKUM, Philip Byron, 2 Binney Street, Halifax, N.S.
FRAME, George Archibald, Shubenacadie, N.S.
FRASER, Campbell, 3 Payzant Avenue, Halifax, N.S.
FRASER, Innes Martell, 153 Walnut Street, Halifax, N.S.
HAMILTON, William Garrison, 39½ Fenwick Street, Halifax, N.S.
JOST, Burton Norris, Guysboro, N.S.
JOST, Victor Arthur, 3 Coburg Apts., Halifax, N.S.
KELL, Bryce Westhall Thomas, 90 Fraser Street, Quebec, Que.
LLOY, James Murray, 91 Argyle Street, Halifax, N.S.
LODGE, Gomer Angus, King's College, Halifax, N.S.
MACKIE, George May, 306 South Street, Halifax, N.S.
MATHESON, Joseph Silver, 327 South Street, Halifax, N.S.
MENZIE, Harold David, 8 Murray Place, Halifax, N.S.
McCOLOUGH, Edward Pearson, Great Village, N.S.
RIPLEY, Howard Andrew, Fairview, Hfx. Co., N.S.
ROOD, James Lindsay, Berwick, N.S.
WOOD, Albert Lewis, 14 Black Street, Halifax, N.S.
WOODS, William Daniel, Armdale P.O., N.S.
WRIGHT, Charles Abbott, 110 Oxford Street, Halifax, N.S.

Undergraduates at Nova Scotia Technical College, Halifax, N.S.

BAKER, Max Leo, 297 Morris Street, Halifax, N.S.
CAMERON, James Crofton Joseph, Halifax, N.S.
CHANDLER, Edward Sayre, Charlottetown, P.E.I.
CORNING, Keith Welton, 22 Harvey Street, Halifax, N.S.
FRECKER, George Alain, Halifax, N.S.
KEATING, Harold Johnston, 99 Charles Street, Halifax, N.S.
KNODELL, John Frederick, 96 Chebucto Road, Halifax, N.S.
LANG, John Taylor, 13 Mitchell Street, Halifax, N.S.
LEWIS, Daniel Urquhart, 9 Spring Garden Road, Halifax, N.S.
MITCHELL, Lawrence Everett, B.A., (Mount Allison), Campobello, N.B.
PEDDER, Arthur William, P.O. Box 440, Dartmouth, N.S.
RISLEY, Wilfred Cary, Jr., 22 Harvey Street, Halifax, N.S.
ROSS, George Victor, Halifax, N.S.
THOMPSON, Frank Lawrence, 96 Highfield Street, Moncton, N.B.
TIBBITTS, Angus Gordon, Halifax, N.S.

Undergraduates at St. Mary's College, Halifax, N.S.

COLGAN, Patrick, Halifax, N.S.
CONNOLLY, Jack, Halifax, N.S.
FEETHAM, Edward Joseph, Halifax, N.S.
FINLAY, Francis Joseph, Halifax, N.S.
GRANVILLE, Francis X., Halifax, N.S.
HAMILTON, Cecil Roy, Halifax, N.S.
MacDONALD, Leo J., Halifax, N.S.
O'CONNOR, Victor F., Halifax, N.S.
O'LEARY, Edmund C., Halifax, N.S.
SOMERS, John Stephen, Halifax, N.S.

Undergraduates at McGill University, Montreal, Que.

ATKINSON, Thomas Martin, 3637 University Street, Montreal, Que.

BACKLER, Irving Saul, 5331 Mance Street, Montreal, Que.

BLACHFORD, Henry Edmund, 7 Hudson Avenue, Westmount, Que.

CHAMPAGNE, Georges Albert, 6702 de St. Valier Street, Montreal, Que.

GERSOVITZ, Frank, 457 Argyle Avenue, Westmount, Que.

HART, Herbert Trench, 3592 University Street, Montreal, Que.

JOHNSON, Robert Ernest Lacey, 536 Grosvenor Avenue, Westmount, Que.

PHILLIPS, Frederick René, 26 Holton Avenue, Westmount, Que.

EVANS, Edward Norton, 352 Kitchener Avenue, Westmount, Que.

* * *

HYMMEN, Edmond B., (Univ. of Toronto), North House, University of Toronto, Toronto, Ont.

McQUEEN, Duncan R., (Univ. of Toronto), North House, University of Toronto, Toronto, Ont.

SMITH, Henry E., (Univ. of Toronto), North House, University of Toronto, Toronto, Ont.

JACOB, John Kenneth, (Univ. of B.C.), 2978-38th Ave. West, Vancouver, B.C.

SAUNDERS, Arthur Jackson, (Univ. of B.C.), 4501-7th Ave. West, Vancouver, B.C.

BRIDGE, David E., B.A.Sc., (Univ. of Toronto), engrg. ap'tice, Canadian Westinghouse Company, Hamilton, Ont.

LAWRENCE, Stanley Nelson, B.A.Sc., (Univ. of Toronto), test course, Canadian General Electric Co. Ltd., Peterborough, Ont.

ELLIOT, Donald George, B.Sc., (Univ. of Edinburgh), Monsarrat & Pratley, Drummond Building, Montreal, Que.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

PRESENTED BY THE SOCIETIES:
- American Society for Testing Materials:
  - A.S.T.M. Standards, 1930: Part 1: Metals.
  - A.S.T.M. Standards, 1930: Part 2: Non-Metallic Materials.
  - Tentative Standards, 1930.
- National Electric Light Association: Proceedings, Vol. 87, 1930.
- Purdue University, Engineering Extension Dept: Engineering Bulletin: Proceedings, Sixteenth Annual Road School, Held at Purdue University, Jan. 20-24, 1930.
- North-East Coast Institution of Engineers and Shipbuilders:
  - List of Members, 1st August, 1930.
  - Transactions, Vol. 46, 1929-30.
- American Institute of Electrical Engineers: Quarterly Transactions, Oct., 1930.

Reports, etc.

DEPT. OF THE INTERIOR, NATIONAL PARKS OF CANADA:
- [Booklets] Through the Heart of the Rockies and Selkirks.
  - Jasper Trails.
  - Kicking Horse Trail.
  - Prince Albert National Park.
  - Elk Island National Park.
  - Kootenay National Park and the Banff-Windemere Highway.
  - The Geological Story of Jasper Park, Canada.

DEPT. OF THE INTERIOR, DOMINION WATER POWER AND RECLAMATION SERVICE, CANADA:
- Water Resources Paper 61: Surface Water Supply of Canada, Pacific Drainage: British Columbia and Yukon Territory, Climatic Year 1927-28.

DEPT. OF THE INTERIOR, TOPOGRAPHICAL SURVEY, CANADA:
- [Map of] Dryden, Ontario, (Provisional edition), [1930].

DEPT. OF MARINE AND FISHERIES, HYDROGRAPHIC SERVICE, CANADA:
- Catalogue of Marine Charts, Sailing Directions, and Tidal Information, Apr. 1, 1928.

PUBLIC HEALTH SERVICE, UNITED STATES:
- Reprint No. 1404: Physical Impairments and Occupational Class.

BUREAU OF STANDARDS, UNITED STATES:
- Miscellaneous Publication No. 115: Annual Report of Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year ended June 30, 1930.
- Circular No. 386: Specifications for the Manufacture and Installation of Railway Track Scales for Light Industrial Service.
- Commercial Standard CS23-30: Feldspar.

BUREAU OF MINES, UNITED STATES:
- Copper in 1928 (General Report).
- Gold and Silver in 1928 (General Report).
- Gold, Silver, Copper, Lead and Zinc in the Eastern States in 1929.
- Magnesium and Its Compounds in 1929.
- Iron Ore, Pig Iron and Steel in 1929.
- Antimony in 1929.
- Platinum and Allied Metals in 1929.
- Gold, Silver, Copper Lead and Zinc in Colorado in 1928.
- Abrasive Materials in 1929.
- Feldspar in 1929.
- Clay in 1929.
- Gypsum in 1929.
- Technical Paper No. 478: Production of Explosives in the United States, during the Calendar Year 1929.
- Technical Paper No. 488: Restivity Measurements of Oil-Bearing Beds.
- Bulletin No. 332: Permissible Electric Mine Lamps.
- Economic Paper No. 3: Historical Summary of Gold, Silver, Copper, Lead and Zinc Produced in California, 1848-1926.
- Economic Paper No. 10: Economic Relations of Silver to Other Metals in Argentiferous Ores.
- Annual Report of the Director of the Bureau of Mines, June 30, 1930.

DEPT. OF MINES, ONTARIO:
- Bulletin No. 74: Metal Production of Ontario for the First Nine Months of 1930.
- Thirty-ninth Annual Report, Vol. 39, Part 5, 1930.

NATIONAL ELECTRIC LIGHT ASSOCIATION:
- Prime Movers' Committee, Engineering National Section: Oil and Gas Engines.
- Electrification of Steam Railroads Committee: Electrification of Steam Railroads.

UNIVERSITY OF CALIFORNIA:
- Publications in Engineering:
  - [1]. Forced Vibration of Axially Loaded Continuous Beams and Shafts.
  - [2]. Heat Transfer in Automobile Radiators of the Tubular Type.

OHIO STATE UNIVERSITY:
- Engineering Series: Bulletin No. 50: A Description of the Engineering Experiment Station of the Ohio State University.

UNIVERSIDAD DE BUENOS AIRES:
- Facultad de Ciencias Exactas, Fisicas y Naturales: La Investigacion de las Tensiones Elasticas Mediante la Luz Polarizada.

GOVERNOR OF THE PANAMA CANAL:
- Annual Report, for the Fiscal Year ended June 30, 1930.

THIRD (TRIENNIAL) EMPIRE MINING AND METALLURGICAL CONGRESS (SOUTH AFRICA, 1930):
- Final Congress News.

Technical Books, etc.

PRESENTED BY PERRINS, LIMITED, LONDON:
- Water Power Around the World.

PRESENTED BY JOHN WILEY & SONS:
- Wind Stresses in Buildings, by R. Fleming.

PRESENTED BY THE CHLORINE INSTITUTE, INC., NEW YORK:
- Sewage Chlorination—Reprint from Sewage Works Journal, Vol. 2, No. 3, July, 1930.

PRESENTED BY AMERICAN RAILWAY ASSOCIATION, SIGNAL SECTION:
- American Railway Signaling Principles and Practices:
  - Chapter 9: Rectifiers, Including Fundamental Theory of Alternating Currents.
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PRESENTED BY NORTHERN ELECTRIC COMPANY, LTD.:
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- [3]. Bulletin No. 71: A List of Trade Names of Indian Timbers.
- [4]. Bulletin No. 72: Instructions for the Operation of Timber Seasoning Kilns.

PRESENTED BY THE INTERNATIONAL NICKEL COMPANY, INC., NEW YORK:
- Literature and Patent References to Nickel, Vol. 3, No. 15, October, 1930.

PRESENTED BY SIR ISAAC PITMAN & SONS:
- Experimental Mechanics of Materials, by H. Carrington.
- Engineering Materials, Vol. 3: Theory and Testing of Materials.

PURCHASED:
- Steam Tables and Mollier Diagram, by J. H. Keenan. (Published by The American Society of Mechanical Engineers.)
- A.S.M.E. Boiler Construction Code: Section 8: Rules for the Construction of Unfired Pressure Vessels, 1930.

Catalogues

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- Catalogue of Drawing Materials, Surveying Instruments, etc.

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- Catalogue of Drawing Materials, Mathematical Instruments, etc.

Reuben Wells Leonard, M.E.I.C.

On December 17th, 1930, death closed the career of Reuben Wells Leonard, M.E.I.C., who leaves behind him a record of outstanding services to his profession, to Canada and to the British Empire.

Born at Brantford, Ontario, on February 21st, 1860, he was educated at the Brantford Collegiate Institute and the Royal Military College of Canada, where he received the silver medal in 1883. His early engineering experience with the Canadian Pacific Railway on surveys and construction in the Lake Superior Division was followed by military service in the North-West Rebellion, as staff officer of transport, and in other capacities. After a further period on the engineering staff of the Canadian Pacific Railway in Manitoba and Ontario, in 1886 he became chief engineer of the Cumberland Railway and Coal Company in Nova Scotia. In 1891 he was engaged on surveys for important branch lines for the Canadian Pacific Railway in Ontario, Quebec and British Columbia, and in 1892-1893 was in charge of the construction of the first hydro-electric power development at Niagara Falls, for the Park and River Railway Company. In 1895 he became chief engineer and manager of construction of the St. Lawrence and Adirondack Railway, occupying a similar position in succeeding years on the Montreal and Ottawa (short line). His next appointment was as chief engineer of the Cape Breton Railway, and later he entered the mining field as engineer for the Lake Superior Corporation in the Sudbury and Michipicoten districts. In 1902 he became engineer in charge of the hydro-electric development at De Cew falls for the Hamilton Cataract Power Co. and later held a similar position at Kakabeka falls near Fort William, Ont., for the Kaministikwia Power Company. Returning to mining work in 1906, he was promoter and president of the Coniagas Mines, and the Coniagas Reduction Company, Limited. He was appointed chairman of the National Transcontinental Railway Commission, Ottawa, in 1911, and in 1918 he became president and promoter of the Electrical Steel and Engineering, Ltd., at Welland, Ont.

REUBEN WELLS LEONARD, M.E.I.C.

Entering the financial field in his later years, he was more particularly interested in mining work and served as a director of a number of important companies.

His work on behalf of the engineering profession was noteworthy. Joining the Canadian Society of Civil Engineers as one of the original members in January, 1887, he served on Council during the years 1905, 1908 and 1909, was elected vice-president in 1910, and became president of The Engineering Institute of Canada in 1919. His untiring interest in its affairs was shown by his activity on its behalf, by his contribution of papers to its proceedings, and by his foundation of the Leonard Medal in 1918. The Council of The Institute recognized his services to the profession and to the science of engineering by the award to him in 1929 of the Sir John Kennedy Medal, the highest distinction in the Institute's gift.

Colonel Leonard was connected with many other engineering and scientific societies, being a past vice-president of the Canadian Institute of Mining and Metallurgy; a corresponding member of the Council of the Institution of Mining and Metallurgy, Great Britain; a Member of the Institution of Civil Engineers, and a Member of the American Institute of Mining and Metallurgy. He found time to devote to educational affairs, serving as a governor of the University of Toronto and of Queen's University, and being associated also with the direction of other educational institutions.

In 1916 Lieut.-Colonel and Mrs. Leonard created the Leonard Foundation for the purpose of establishing Leonard Scholarships in specified schools and colleges of the Dominion of Canada; the scope of this foundation was extended and revised in 1920, at which time the endowment was increased to half a million dollars. Colonel Leonard believed that the stability of civilization and the peace of the world can be best promoted by the education in patriotic institutions of selected and deserving children, and the benefits of the foundation are accordingly available (under certain restrictions) for students who, without financial assistance, would be unable to enter any of the institutions named. The aims and objects of the Leonard Foundation are furthered by an association of past students who have enjoyed the benefits of Leonard Scholarships and who, in their turn, will aid in carrying out the intentions of the founders.

During the Great War, Colonel Leonard gave much of his time and money to patriotic movements and he was enthusiastic in his advocacy of closer union of the various members of the British Commonwealth of Nations. His interest in international relationships was shown by his munificent gift to the British nation of Chatham House, the historic building in St. James's Square, London, which serves as the headquarters of the Royal Institute of International Affairs. This action was received throughout the Empire as a tribute of loyalty from one of the Dominions.

Sensitive and generous in disposition, he was filled with enthusiasm in national or charitable causes, but avoided publicity or self-advertisement. Although suffering severely from illness during the last six years of his life, he retained his interest in Canadian and world affairs. His true worth was realized by those who knew him, but owing to his retiring nature, there has been no adequate general recognition of his services as financier, philanthropist and patriot.

PERSONALS

R. L. Dunsmore, A.M.E.I.C., is on the staff of the Imperial Oil Refineries, Ltd., and is located at Dartmouth, N.S. Mr. Dunsmore was for some years with the International Petroleum Company at Talara, Peru, S.A.

S. Farquharson, A.M.E.I.C., formerly designing engineer with the Alcoa Power Company, Arvida, Que., has organized the firm of S. Farquharson and Associates, industrial consultants, Montreal. Mr. Farquharson was for a time with the B.C. Electric Railway Company, later becoming connected with the Power Corporation of Canada, Ltd., at Montreal.

P. Hughes, S.E.I.C., is now connected with the Dominion Rubber Company, Montreal. Mr. Hughes, who graduated from McGill University in 1926, with the degree of B.Sc., was for a time on the staff of the Bureau of Tests of the International Paper Company at Glen Falls, N.Y. and was later with the John S. Metcalfe Company, Ltd.

W. L. Langlois, Jr.E.I.C., who was formerly assistant engineer in the town department of the Canadian International Paper Company at Temiskaming, Que., has joined the staff of the city engineer at Hamilton, Ont. Following his graduation from the University of Toronto in 1923, Mr. Langlois spent a year in China, and was later engaged for a time on municipal work with the township of Etobicoke, Ont. In 1925 he was in the employ of H. G. Acres and Company at Niagara Falls, Ont., and was later with the Hippo Products Company of Toronto.

J. C. Nutter, A.M.E.I.C., has joined the staff of Price Brothers and Company, Ltd., Quebec, Que. Mr. Nutter, who prior to accepting his present position was superintendent of the Nashwaak Pulp and Paper Company, Ltd. at Saint John, N.B., was at one time electrical engineer with the Groveton Paper Company, Inc., at Groveton, N.H.

M. D. Stewart, A.M.E.I.C., has recently been appointed resident engineer for Lucerne-in-Quebec at Montebello, Que. Mr. Stewart, who was formerly on the staff of the Foundation Company of Canada, Ltd., at Montreal, is a graduate of the University of Toronto of the year 1922. Following graduation he become connected with Bremner Norris and Company, Ltd., as purchasing agent and estimator in charge of construction of warehouse for the Dominion Cartridge Company at Brownsburg. In 1924 he accepted a position with Price Brothers and Company Ltd., at Chicoutimi, Que., remaining with that firm until 1929.

W. H. Greene, M.E.I.C., formerly with the Canada Creosoting Company at Edmonton, Alta. is at present with the Alberta Wood Preserving Company, and is located at Calgary, Alta. Mr. Greene was for a number of years assistant city engineer of Moose Jaw, Sask. He is a graduate of the University of Toronto, having received his degree in 1909, following which he joined the staff of the Teton County Co-operative Irrigation Company as district engineer on irrigation construction in Montana, U.S.A. In 1910 he was appointed by the Department of the Interior as engineer-in-charge of a party investigating the Moose Jaw river as a source of water supply for the city of Moose Jaw, and in the following year carried out, for the same department, an investigation of stream-flow under ice cover in southern Alberta. In 1912 Mr. Greene received his appointment as assistant city engineer of Moose Jaw, and in 1921 was made acting city engineer and also superintendent of waterworks and building inspector. He was later made city engineer, which position he held until he resigned in January, 1929.

An incorrect version of this personal appeared in the November, 1930, issue.

H. F. Bennett, A.M.E.I.C., receives Appointment

Harry F. Bennett, A.M.E.I.C., formerly senior assistant engineer, Department of Public Works, Canada, at Halifax, N.S., has been appointed district engineer for the Department at Sault Ste. Marie, Ont. Mr. Bennett was educated at the University of New Brunswick, graduating with the degree of B.Sc. in 1908. He joined the Department of Public Works immediately after graduation, and served as assistant engineer until 1916, when he was attached to the Canadian Expeditionary Forces, serving in France with the 48th How. Battery, 2nd Brigade, C.F.A. Returning to the Department in 1919, Mr. Bennett remained on the Saint John, N.B., staff until 1924 when he was appointed to the office in Halifax held by him until the present time. Mr. Bennett has taken an active interest in engineering affairs, having served as chairman of both the Saint John and the Halifax Branches of The Institute, as Councillor of both the Association of Professional Engineers of New Brunswick and Nova Scotia, was Maritime vice-president of the Professional Institute of the Civil Service of Canada in 1926-1927, and represented the Halifax Branch on the Council of The Institute for the current year.

HARRY F. BENNETT, A.M.E.I.C.

H. B. Dickens, A.M.E.I.C., is at present reinforced concrete designing engineer for the city of Hamilton, Ont. Mr. Dickens was surveyor and assistant manager at the Amrir tin mine, Nigeria, West Africa, during 1913-1915, and was on active service in the Cameroons and Nigeria, West Africa, from May, 1915, to September, 1919, being in charge of the Mama and Mada patrols in Nigeria for the greater part of 1917-1919. Following the war, Mr. Dickens was engaged on timber limit surveys in northern Ontario, later joining the engineering staff of the Underwriters' Survey Bureau, Toronto. In 1923 he was employed by Frank Barber and Associates; in 1924 he was with the township of East York, and in 1925 with the Welland Ship Canal at Port Colborne, Ont. Later Mr. Dickens was associated with Messrs. Lang and Ross on transmission line survey in connection with the Flin Flon mine, and prior to accepting his present position he was with the Dominion Reinforcing Company at London, Ont.

C. H. Donnelly, A.M.E.I.C., has been appointed technical assistant to the general superintendent of the American Can Company at Simcoe, Ont. Mr. Donnelly is an honour graduate of Queen's University from which he received the degree of B.A. in 1914 and that of B.Sc. in 1919. His first engineering work was with the Donnelly Salvage and Wrecking Company, Kingston, where he was employed during the summer months of his university course. He served overseas with the Canadian Field Artillery from 1915 until the end of the war. From 1920 to 1926 Mr. Donnelly was with the construction department of the Hydro-Electric Power Commission of Ontario as assistant to the superintendent of the Queenston power house, and from May, 1926, to the present time he has been on the staff of the United States Light and Heat Corporation at Niagara Falls, N.Y.

BOOK REVIEW

Estimating Construction Costs

By G. Underwood. McGraw-Hill, New York, 1930, leatherette, 5¾ x 9 inches, 620 pp., figs., charts, tables, $6.00.

The author is already well known in this field, through his work on "Standard Construction Methods," issued by the same publishers.

His new book deals with the art of estimating and gives unit costs for the various classes of work based on the rate of wages, together with the unit cost of various materials based on the price of the materials making up the unit in question. Evidently great care and thought have been used in assembling the information now presented.

It must be borne in mind that estimating cannot be learned from books alone, but requires also practical experience, best gained by working with experienced estimators.

It would seem that the last two chapters of this book should be read before making any reference to those treating of unit costs, as they deal with the important question of overhead charges and the manner of analyzing an estimate, both of which must be clearly understood before attempting to set unit prices in an estimate.

The author bases his costs on practice in New York, where there is small variation in climatic conditions. In the reviewer's experience, with an allowance for heating materials and temporary heat after the building is closed in, work can be done in winter for the same cost as during warm weather. This is probably due to the fact that there is considerably less work being carried out in the winter, when the demand for men is often below the available supply. These remarks, of course, only refer to work in cities, and are not applicable to the same extent to work in isolated localities where the men must be brought from centres of large population. On the other hand it must be remembered that wages are usually lower in the country districts.

In using prices from a book such as this, due allowance must be made for any unusual conditions, and particularly allowance should be made for the cost of installing special plant or machinery, more especially on smaller work where this item may greatly increase unit costs beyond those shown on the charts.

An outstanding feature of "Estimating Construction Costs" is the type of chart used. This chart is of the same form for labour items and for material items, and also the same form of chart is used for the different trades. It is thus very easy to read any chart after the comparatively simple method is understood for any one trade. Each chart is headed by a statement of the basis on which the chart is made up, giving the amount of work that one man can do in 8, 9 and 10 hours respectively, and in the case of materials, the quantities of the various materials required to make one unit. The day's work units would appear to give a very fair average, and should prove most useful in estimating. When the wages of one man for one day are known the labour cost of one unit can be read off the chart for the 8, 9 and 10 hour day. In the same way for materials, when the cost of a unit of the material is known, the chart shows the cost per square yard or cubic yard, etc., as the case may be. It should be noted that some of the information on freight costs is based on rates in the United States, and should therefore be used with caution when dealing with Canadian work. Generally speaking, this book should be very useful to the estimator, but must be used with care and due allowance made for local conditions and for the items of overhead, winter work and the installation of special plant and equipment.

L. H. D. Sutherland, M.E.I.C.,
Engineer,
E. G. M. Cape Company, Ltd., Montreal.

A new principle in automatic control of chlorination has recently been developed by Wallace and Tiernan with their new automatic residual chlorine recorder and controller.

The orthotolidin test, generally accepted as the criterion of correct chlorinator operations, positively controls chlorine flow with this apparatus. The tests are automatically made at ten minute intervals and "residual chlorine" of the treated water recorded on a chart.

Any fluctuations in flow or chlorine demand are reflected in varied "residuals" and immediately compensated for by the automatic controller. Recorded "residual chlorine" curves show no appreciable lag between chlorine demand and automatic adjustment of chlorine flow.

The Association of Professional Engineers of the Province of British Columbia

The Eleventh Annual Meeting of the Association of Professional Engineers of the Province of British Columbia was held at the Hotel Georgia, Vancouver, on December 6th, 1930, with a large and representative attendance. The following were elected as officers and members of Council for 1931: President, Major J. C. MacDonald, M.E.I.C.; Vice-President, A. S. Gentles, M.E.I.C.; Council, W. R. Bonnycastle, M.E.I.C. (President 1930), W. M. Cunliffe, A. G. Langley, J. I. Newell, W. H. Powell, M.E.I.C.

The remaining four members of Council are to be appointed by the government of the province.

At the luncheon meeting the principal speaker was the mayor of Vancouver, W. H. Malkin, and the guests included a number of members of the Education department of the provincial government, officers of the Vancouver School Board, and others interested in educational problems. The visitors were interested in a description by A. S. Wootton, M.E.I.C., outlining the educational requirements and the scheme of study established under the terms of the Engineering Act of the Province of British Columbia for entry into the profession.

At the business session in the afternoon the retiring president, W. R. Bonnycastle, M.E.I.C., gave an account of the Association's activities during the past year. He noted that the Provincial Legislature had now defined the terms Civil Engineer, Electrical Engineer, etc., where these appear in provincial enactments, as meaning engineers registered in these branches under the terms of the Engineering Act of the Province. The retiring president was able to announce that four inquiries had been instituted by the Council of the Association into

J. C. MacDONALD, M.E.I.C.

cases of professional misconduct, and that in two cases the charges originally made in the public press had been completely disproved. In the other two cases the charges had been proved, the license of one engineer had been cancelled and suitable action had been taken in the other case. He would impress upon all members of the Association the necessity of adopting high standards in engineering design and construction. The Council had been active in discouraging the too prevalent custom whereby a consulting engineer is subordinate to or paid by the contractor on an engineering work.

The formation of the Vancouver Professional Engineers Club was noted, and the address also covered the activities of the Association's Board of Examiners during the year. Seventy-two candidates had passed, or, as university students, had been exempted from, preliminary examinations; fifteen non-university candidates had taken the intermediate examination, and thirty-seven had been granted intermediate status on graduation; nineteen non-university candidates had passed their final examinations, and eight graduates' theses had been accepted. After touching on the subject of possible federation among the engineering organizations in Canada, the speaker congratulated the Association on the rapid development of the true conception of professional status in the province.

In the evening the annual banquet of the Association was held, at which about two hundred and fifty were present, and at which a certificate of registration and life membership in the Association was awarded to the guest of the evening, His Honour Robert Randolph Bruce, Lieutenant-Governor of the Province, who received a license to practise Civil and Mining Engineering in the Province of British Columbia, he being a graduate of the University of Glasgow.

BRANCH NEWS

Border Cities Branch

R. C. Leslie, A.M.E.I.C., Secretary-Treasurer.

The May monthly meeting of the Border Cities Branch was held on Friday, May 23rd. On this occasion Mr. Thomas Adams, who has been engaged by the city of Windsor to present a report on the planning of this city, gave an address on "Town Planning," at the conclusion of which he outlined briefly some of the suggestions contained in his report.

The "Town Planner" Mr. Adams stated, is the liaison between the engineer and the architect. He is concerned with the welfare, health and safety of the community and his work includes not only arranging for proper expansion but the correcting of wrong development.

When making a study of the planning of a city, the speaker stated, the three main items requiring consideration are the railways, the highways and streets, and the open spaces. The railways present the greatest difficulties. Not only are railways controlled by a railway company or by the Dominion government and are consequently beyond civic control, but it is difficult to obtain any information regarding what they intend doing in the future. Because of this, the town planner should, after careful consideration and after obtaining whatever information the railway companies will divulge, propose the arrangement which he considers best, this proposal being as adaptable to whatever may arise as is possible.

Highways and streets are within the jurisdiction of the city council. They can, and should therefore, be laid out according to the best possible arrangement. Lanes and streets should be made proportionate to one another, and one should avoid assuming that a city plan is a street plan.

By open spaces Mr. Adams stated that he meant parks, court-yards, gardens, etc. Controlling the open spaces means simply regulating building density, and the allowable building density should be definitely fixed to prevent overcrowding and congestion. Open spaces similarly to highways and streets come within the jurisdiction of the city council and consequently this can be done.

The speaker went on to say that the three needs of any community for its development, are: means of transportation, facilities for development and an adequate supply of labour.

The requirements of any potentially great community, Mr. Adams stated in conclusion, are ample transportation facilities (provided by railways, wide highways and streets and ample sidewalk widths), controlled building heights, segregated building types, a suitable site, a fair administration of justice, uncorrupt political direction, and engineering and architectural leadership.

With reference to the Border Cities, Mr. Adams pointed out that here all these needs were satisfied. The problem of the town planner was, however, made more difficult because of the five separate communities which in reality were one. These five communities, in his opinion, should amalgamate.

The October meeting was held on Friday, October 10th. Before the introduction of the speaker, L. McGill Allan, A.M.E.I.C., gave a verbal report on the Plenary Meeting of Council held in Montreal on September 22nd.

O. Rolfson, A.M.E.I.C., chairman, then introduced the speaker, Mr. W. H. Furlong of the firm Furlong, Furlong, Awrey & St. Aubin, barristers.

The subject of Mr. Furlong's address was "Some Aspects of The Local Improvement Act." Briefly outlined were the changes that have been made in the act since 1852 when sewers were the only construction work which could be done by the municipality. The speaker also interpreted such words as bridge, corporation engineer, frontage, life-time of work, lot pavement, etc. The speaker then went through the Act picking out clauses of importance to the engineer and giving his interpretation of these clauses.

Following the address the speaker was the centre of a barrage of questions regarding the application of the act to the various problems the members had encountered in their work.

Moved by Mr. R. Armstrong, seconded by Ray J. Desmarais, A.M.E.I.C., a hearty vote of thanks was extended to Mr. Furlong by Mr. Rolfson, the chairman of the Border Cities Branch.

The November meeting of the Border Cities Branch was held on Friday, November 14th. The speaker on this occasion was Mr. C. F. Halliday of the General Motors Corporation, who gave an address on the General Motors Proving Ground.

This ground, Mr. Halliday stated, was established in 1924, having been found necessary at that time because of the increased congestion of traffic on the highways. With traffic congestion, accidents more frequently occurred and about 35 per cent of all test cars were wrecked. Not only were these accidents sometimes fatal, but any car which participated in an accident was no longer of use for test purposes owing to the fact that the results obtained from further tests upon it would be unreliable. These test cars were hand-made and the loss of a car meant the loss of a great deal of money. In addition to accidents the congested highways made it practically impossible to duplicate tests and test conditions, and since the testing of motor cars is done chiefly by comparing the test car with other cars under as similar conditions as possible, a specially constructed proving ground was found essential.

Motor cars are compared under four main headings, namely,—performance, appearance, durability and comfort. Performance refers to such qualities as ability to be quickly accelerated or decelerated, to run at very high or very low rates of speed, etc. Apperance means simply style. Durability is defined as the ability of a car to give long service at a minimum cost for repairs. Comfort refers to the riding quality of a car, its freedom from noises, vibrations, etc.

Following his address, Mr. Halliday showed by means of moving pictures the developments in car testing. He showed how standards for performance, etc. were arrived at, and later the means by which it was found how closely a car to be tested approached these standards.

After the motion pictures a lively discussion followed, in which all members present took an active part.

Calgary Branch

A. W. P. Lowrie, A.M.E.I.C., Secretary-Treasurer.
W. H. Broughton, A.M.E.I.C., Branch News Editor.

A general meeting was held in the Board of Trade rooms under the chairmanship of B. Russell, M.E.I.C., at which some twenty-five members and friends were present.

The chairman introduced L. H. Bennett, M.R.A.I.C., who spoke on the "Planning of a House."

The houses, palaces and churches of an era or of a country reflect the economic conditions and state of progress of the inhabitants, and a house reflects the individuality, character and social position of the owner as well as his reaction to the spirit of his time.

There are many factors to consider in planning a house, continued the speaker, climate, site, building regulations, the particular requirements of the family, the exterior appearance, the interior decoration and finish. While some would reverse the order of importance, he thought that the order given was the correct one.

In Calgary a style was being developed, and our existing buildings reflected our history. We had the Colonial, English Cottage, California Bungalow, Elizabethan and others imported from every country in the world in addition to our locally developed "Log Cabin."

In outward effect we aimed either at a symmetrical appearance or one which incorporated a primary mass offset by a less insistent secondary mass and this provided a very pleasing appearance if successfully carried out.

The shape of the land and the orientation of the house to sun and weather often materially affected the shape of the floor plan but convenience should be kept in view in grouping together kitchen and living rooms, bed and bath rooms. These would be better placed on the north or east with living room on the south and west. Large rooms were better than small ones and space should never be wasted in halls that could be used in rooms. There should be sufficient but, in this climate, not excessive window area; about one-tenth of floor area was usual.

There were many different types of construction, but whether frame, concrete or brick is selected, the walls should be insulated by air spaces broken by stops or filled with shavings or other fibrous material. Such filling was an investment that would pay for itself in comfort and should return its cost in five years.

Heating should receive very serious consideration but depended on insulation of building and existence or lack of doors between rooms. The heating and plumbing had an engineering background and was better left to the experts. However, plumbing should never be located in outside walls in this climate.

Interior decoration and lighting should be quiet, restful and subdued. There was, as yet, no measure of agreement, even among experts, as to the best quantity or colour of lights.

There appeared to be a movement towards group dwelling in apartment and duplex houses. The disadvantages of these, however, might outweigh the conveniences and there might yet be a reversion to the individual home.

The address proved the stimulus for a very lively discussion between builders, plumbers, heating engineers and electricians and thereby demonstrated the value of a paper that was not too technical and specialized, and on a subject of which every member, being a home-builder, had some knowledge.

L. A. B. Hutton, A.M.E.I.C., proposed and W. H. Snelson, A.M.E.I.C., seconded, a hearty vote of thanks to the speaker, which was carried with acclamation by the members present.

The opening meeting of the Calgary Branch was held at the Hotel Palliser on October 30th with about one hundred and seventy present. It was ladies' night and quite a few members were accompanied by their ladies.

The speaker of the evening, Dr. T. B. Williams, a prominent local geologist, was introduced by the chairman, B. Russell, M.E.I.C.

Dr. Williams, in introducing his subject of "The Red Coulee Field," spoke of the joys and tribulations of the geologist in the never-ending search for oil. While he encounters much discomfort and hard work in the search, these are amply compensated for by the joy of bringing in a well or a field and by the prosperity thus brought to the district concerned. The curiosity and even suspicion with which he is regarded at first are always forgotten when the oil begins to flow.

The first oil brought in in Alberta was from the foot-hill district near Waterton lakes. In a prairie district the work of the geologist is very different from that in a foot-hill district, yet the proximity of the Sunburst field just south of the International boundary led to the expectation that oil would be found to the north also.

The geologist, continued the speaker, is always hopeful of finding a "structure," a dome or anticline which holds beneath its surface a store of the precious fluid, or at least a sloping plane which has been closed by faults caused by the upheaval of the mountains; it is further necessary that the structure, when found, shall not be at too great a depth.

It is necessary for the geologist to possess himself of such topographical maps as may be in existence or to survey the ground and make them for himself. The character of the structure must also be investigated by the drilling of shallow test-holes. These maps will increase in accuracy from time to time as the result of this more intensive exploration. This work in the Red Coulee field led to the conclusion that the Madison sands, in which production might be expected, would be reached at a depth of about 3,000 feet, a depth well within the powers of modern drilling equipment.

Drilling, continued the speaker, was started in July, 1929, and a flow of 3½ million cubic feet of gas was struck at 2,390 feet below the surface, at 2,466 feet oil was struck in October, 1929, and was thrown clear over the derrick by the force of the gas. Steady production of fifty barrels per day began on January 21st, 1930, which has since increased to 55½ barrels per day and 15,500 barrels at $1.65 per barrel have been sold to the refinery to date. The oil has a gravity of 32 degrees A.P.I. and produces about 27 per cent gasoline and 2½ per cent kerosene. The gas also finds a considerable local market.

Since the oil was struck in the Vanalta No. 1, eighteen wells have been completed as producers, eight as dry holes, and thirteen are still drilling. The present production of the field is about 300 barrels per day on the Canadian side and 500 barrels per day on the United States side of the International boundary.

All indications of the exploration were so promising that the speaker anticipated a renewal of activity in this field in the spring of 1931. The opening out of the field has already resulted in very large growth to the towns of Sweetgrass and Coutts.

The lecture was illustrated by a cinematograph film which was followed by some stills of the district and of the geologist and his crew.

At the conclusion of the address a buffet supper was served, superintended by Mrs. B. Russell and Mrs. T. Lees.

An extremely interesting evening was spent by some fifty members and friends on November 25th in hearing an address by Mr. G. C. Bateman on "Nickel."

The speaker traced the history of the nickel industry from the first discovery of the ore on the north shore of Lake Superior in 1848, its rediscovery in 1856 and again in 1883 when the Canadian Pacific Railway built its line through Sudbury.

The first smelter in Canada was installed at the Copper Cliff mine in 1888 to obtain the copper from the ore.

The Canadian Copper Company was formed with a capital of $2,000,000 in 1886, which acquired large interests in the field, mined copper and shipped it to the United States for treatment. It was impossible to treat the ore so as to separate the copper with the smelters then in use and the trouble was traced to its nickel content. Colonel Thompson tried to treat them at his Orford works with no better success until he obtained particulars of the then secret process used by the H. H. Vivian Company at their smelting works at Swansea, Wales. Finally, after much experimenting Colonel Thompson mastered the process.

The Canadian Copper Company built their first smelter of 100 tons per day capacity in 1888 and their second of 300 tons in 1889. This was the largest smelter on the continent at that time and produced more nickel than the world could use. Mr. Ritchie went to Europe and interested James Riley of Glasgow in the subject. Mr. Riley read a paper on nickel before the Iron and Steel Institute which marked the beginning of the nickel steel industry. This interested the secretary of the United States Navy who had samples of nickel steel armour plate tested against carbon steel with the result that the Congress voted $1,000,000 for the purchase of nickel.

The speaker traced the trials and tribulations of the Orford Company and the Canadian Copper Company up to the formation of the International Nickel Company in 1902. The growing demand for nickel necessitated the development of further supplies and a shaft 2,000 feet deep large enough to handle 10,000 to 12,000 tons per day was proposed. It was found that very high grade ore could be mined at points considerably deeper than 2,000 feet and this necessitated changing their whole plan of campaign.

The company operates the largest smelter in the British Empire and one of the largest in the world, with a capacity of 6,000 tons per day to handle an ore containing 7 per cent combined nickel-copper with substantial values in gold, silver and platinum.

The International Company and the Mond Company subsequently amalgamated as their properties were adjoining and so simplified production and eliminated the necessity for leaving pillars of valuable ore in the workings. The company now produces over 90 per cent of the world's nickel.

Much credit, continued the speaker, is due to the personnel in meeting and solving problems that arise from day to day and are different at one level from those at other levels and even at one stope from those at other stopes in the same level. There is too much talk about the romance and greatness of these mines and too little about the men underground who are daily meeting constantly changing conditions.

Mr. Bateman concluded by making a plea for a better organized and more specific utilization of our greatest natural resource—our young college graduate—who is often left to sink or swim, after obtaining his diploma, entirely on his own resources.

The paper provoked much discussion by the members of The Institute and members of the Calgary Chemical Club who were the guests of the Branch.

A vote of thanks proposed by L. Stockett, M.E.I.C., seconded by F. M. Steel, M.E.I.C., and supported by Mr. Campbell, chairman of the Chemical Club, was very heartily endorsed by the members and visitors present.

Cape Breton Branch

S. C. Mifflen, M.E.I.C., Secretary-Treasurer.
Louis Frost, Branch Affiliate, Branch News Editor.

The scientific application of aerial photography to surveying was the theme of a lecture given by F. H. Peters, M.E.I.C., Surveyor General, Department of the Interior, Ottawa, to a large meeting of members held in the Bank of Commerce building, Sydney, on Friday, November 21st. A. L. Hay, M.E.I.C., Branch chairman, presided.

Introducing the speaker, the chairman referred to the wide present-day application of aerial photography to the pursuit of the economic investigation of the natural resources of this country, and the impetus given by the war to the development of this system, and also the part played by Canadian aviators during that period in the furtherance of scientific research in the realms of aerial photography. The perfection of the present system was in no small degree due to the persistency of research and ingenuity of Mr. Peters, who was a pioneer of this class of work in Canada.

The speaker in his opening remarks brought the members a greeting from the Ottawa Branch of The Institute. He then described the aims of the Department of the Interior in the development of aerial photography, and illustrated his lecture by a large number of slides, which indicated the various phases of aerial photographic surveying in the field and also the subsequent plotting to produce the finished map. The instruments used, which included cameras, range-finders, aneroid barometers, were also shown on the slides.

The object of the Topographical Survey Branch of the department was to produce accurate maps of the Dominion showing the fullest detail upon which engineers and others could base their operations. In the development of railways, waterways, harbours, telegraphic routes and power development sites, accurate topographical data was an absolute necessity, and could not always be obtained by a preliminary survey in regions where the ground was heavily wooded. An aerial photograph, on the other hand, reproduced every feature faithfully with a wealth of detail not otherwise possible, a fact which resulted in material economy in the elimination from later surveys areas which would not be of special concern. As for example in the classification of timber lands for the Forestry Branch of the department, of which a great deal had been done, barren areas which showed up pretty well on the photographs could be avoided, resulting in a great deal of economy.

Accurate maps, indicated the speaker, could not be obtained from photographs alone, sufficient information obtained from ground surveys was necessary to correlate the data obtained by photographs. The work was undertaken in co-operation with the Royal Canadian Air Force who supplied the pilots, while the department supplied the observers. The work of the airmen was exceptionally difficult and required a great deal of courage and fortitude.

Oblique and vertical methods were employed in obtaining photographs, the latter method was used principally when photographing level areas, the oblique photograph was, however, used wherever possible because of the greater areas which could be covered with the same amount of work. The camera used is mounted in the nose of the plane and is automatically operated by electric current, the camera being capable of taking 100 shots without refill.

The general arrangement of the work is to lay out a route in relation to a ground survey for the airmen to follow. They are then instructed to traverse the area by a series of parallel flights about six miles apart, and to maintain a certain elevation and focal angle during the flight. The usual elevation when taking vertical photographs is 10,000 to 12,000 feet and about 6,000 feet when taking oblique photographs. The aeroplane, or hydroplane as the case may be, travels at a ground speed of 80 m.p.h., therefore only exposures of short duration can be tolerated, and to ensure accuracy three sets of exposures are made for each area, and the photographs overlap by as much as fifty per cent in the case of the vertical photograph. When the photographs are completed the ground surveyor locates them in relation to his traverse.

The plotting was somewhat difficult until a method was developed to suit the various focal lengths at which the photographs were taken. In the preliminary work, the photographs are laid out in relation to a general azimuth line. The plotting is then done on squared paper, the photograph being placed under a glass grid chosen in relation to the focal length of the picture.

The lecturer also described the method employed to locate contours when plotting, and indicated upon the screen the wealth of geological and hydrographical data which could be determined directly from the photographs. He concluded the lecture with a series of photographic views of the principal cities of the Dominion.

A hearty vote of thanks was tendered the speaker on the motion of F. W. Gray, M.E.I.C., and seconded by M. Dwyer, M.E.I.C.

Halifax Branch

R. R. Murray, A.M.E.I.C., Secretary-Treasurer.

Minutes of meeting of the Halifax Branch of The Engineering Institute of Canada, held October 15th, 1930, this being the first of the fall and winter programme of 1930-31:

This meeting was held in the assembly hall of the Nova Scotia Technical College and it was called to order at 8.00 o'clock p.m. by the chairman, W. P. Copp, M.E.I.C.

Before the regular programme began, Professor Faulkner called the attention of the meeting to the loss sustained by the Branch and by The Institute in the death of the late Professor W. F. MacKnight. In respect to his memory, all present stood for a minute in silence.

A large number of the engineering students at Dalhousie, St. Mary's and the Nova Scotia Technical Colleges were present as the guests of the branch. For a few minutes, after the meeting opened, the time was spent in singing popular songs.

At the request of the Chairman, H. F. Bennett, M.E.I.C., member of Council for the Branch, addressed the students, pointing out the advantages of membership in the organization and urging that they join as Student members. Mr. Bennett had prepared a sheet on which those who wished to join could sign and later these applicants would be furnished the regular application blank.

The chairman then introduced the speaker of the evening, Mr. McDonald, who gave a most interesting and instructive address on the manufacture and fabrication of structural steel shapes. Mr. McDonald's address accompanied a motion picture film which had been made particularly for showing before engineering organizations and educational institutions. The film showed the ore being unloaded at docks and followed it through a plant until it had been finally turned into rolled steel shapes.

The films were of great educational value, not only to the students but to the older engineer as well, not every engineer having had the privilege of being associated with the steel industry. The various processes of smelting, pouring, soaking and rolling were clearly illustrated, not only in the pictures, but by Mr. McDonald's very clear explanations. He held his audience for nearly two hours.

At the conclusion of the address, a vote of thanks was moved by C. H. Wright and seconded by Dr. F. H. Sexton. Following this part of the meeting, the students and members of the Branch spent a social hour during which light refreshments were served. During this period a large number of students signed the sheet indicating a desire to join The Institute.

On November 16th last, at 1.00 o'clock p.m., a special combined meeting and luncheon was held at the Nova Scotian hotel by the Halifax Branch of The Institute and the N.S. Professional Engineer's Association, jointly.

This was a complimentary farewell luncheon tendered to H. F. Bennett, M.E.I.C., Senior Assistant District Engineer of the Public Works Department at Halifax, who left about November 20th to take over the position of District Engineer at Sault Ste. Marie, to which he had been recently promoted. Professor W. P. Copp, M.E.I.C., chairman of the Halifax Branch, and R. J. Bethune, A.M.E.I.C., president of the N.S. Professional Association, were joint chairmen of the meeting.

Professor Copp explained the reason for the meeting and was glad to see so large a gathering, fifty-three being present, and called on Mr. T. J. Locke, C.E., District Engineer at Halifax, to propose the health of Mr. Bennett.

Mr. Locke, in proposing the toast, said he would not speak in a personal, but in a semi-personal, vein.

He referred with feeling to the high personal qualities of Mr. Bennett; to his professional ability and special fitness for his new position; to his loyalty to his chief and to his duties as senior assistant at Halifax.

Mr. Locke was in a happy mood and invented a few yarns to suit the occasion, completing his remarks by wishing Mr. Bennett much anticipated success and expressing the hope that it may be our pleasure to again greet him from time to time in the old "City by the Sea."

Mr. Bethune seconded the toast to Mr. Bennett and expressed his own pleasure at being present and being able to supplement the good words of Mr. Locke and the same wish for future success.

The toast was enthusiastically drunk by those present, who joined in singing "He's a jolly good fellow," after which Mr. Bethune presented Mr. Bennett with a brass desk reading lamp on behalf of the two organizations.

Mr. Bennett in his reply to the toast was visibly affected by the testimonials to himself, the present tendered him, and the kindly references to Mrs. Bennett.

He said he had been only six years in Halifax but his professional and social contacts had been so enjoyable and satisfying that he found it very difficult to be reconciled to leaving the old city. He also referred to the work of both The Institute and the Professional Association and the advances made by both organizations in the work of forwarding the interests of engineers generally. He thanked all for their kindnesses and assistance and promised to see us all whenever opportunity presents itself.

Professor Copp announced the receipt of a telegram from Moncton, N.B., Branch congratulating Mr. Bennett on his promotion.

Mr. Bennett is a past-chairman of the Halifax Branch and a member of the executive of the Professional Association; he is also a Councillor of The Institute, representing this district.

Mr. Bennett's brother engineers at Halifax are well satisfied that he will be a valuable addition to the Branch at Sault Ste. Marie and are very sure that the loss by Halifax Branch will be the gain to Sault Ste. Marie Branch.

Mr. Bennett was also very active in religious and social work in this city, and contributed largely to any work in which he interested himself and will be much missed by those with whom he was associated, in all quarters.

Lethbridge Branch

Wm. Meldrum, A.M.E.I.C., Secretary-Treasurer.

The Lethbridge Branch held its regular meeting on November 1st, when Mr. R. M. Gourlay of the Canadian Western Natural Gas Co. spoke on "Prevention of Waste of Natural Gas."

One of the greatest problems confronting the operators in the Turner Valley field is the finding of a commercial outlet for the large volumes of surplus gas which comes out of the wells along with the naphtha. Some of the wells have a daily production of about 13 million cubic feet of gas and 150 to 175 barrels of naphtha. In others these figures run up to 45 million cubic feet of gas and 500 to 600 barrels of naphtha. The problem of conserving this large flow of gas which cannot be directly utilized is now engaging considerable attention.

Enough natural gas went to waste in Turner Valley last year to supply the needs of all present Alberta users for 15 years. On a B.t.u. basis compared with coal, enough gas goes to waste in Turner Valley each day to equal 9 train loads of high grade coal, each train having 50 cars and each car containing 40 tons. In other words the equivalent of 18,000 tons of coal goes to waste daily, and in one year this amounts to 3,285 train loads or 6,570,000 tons of coal. With coal at $6.00 a ton, nearly $40,000,000 worth of heat is being wasted each year.

The value of the naphtha and crude oil output in Turner Valley amounts to about $41,000,000 annually. Utilization of this gas would therefore remove a very serious waste.

This brings up the question of repressuring depleted gas fields. The principal requirements in selecting an underground reservoir for this work are: that one company must control the entire field; the depleted gas field must be accessible to the main gas line and the old wells must be reconditioned so as to permit the pumping of gas under high pressure without it again escaping to other sands which are not suitable for gas storage. The gas company selected a field at Bow island for their experiments in repressuring. This field has an area of about 22 square miles. It was discovered in 1909 and 27 wells drilled in the following 10 years having an average depth of about 1,900 feet.

The Bow island field which originally contained 45 billion cubic feet of gas had produced 38 billion feet in 12 years and any further withdrawal would accelerate the encroachment of water and the drowning out of the field.

In 1927 the first repressuring experiments were undertaken by the introduction of gas from the Foremost field 30 miles away. Thirty-seven million cubic were feet introduced into the Bow island sands in five days and the rock pressure raised from 256 pounds per square inch to 286 pounds or slightly less than one pound for every million cubic feet stored. The success attending this experiment led to the decision to carry out further repressuring work. Accordingly, in April 1930, work was started on reconditioning such wells as could be used for storage, some 12 of the 27 original wells still being in the proper condition. To overcome rock pressure and force back the encroaching water having an estimated hydrostatic pressure of 730 pounds per square inch, it was necessary to install compressors capable of high pressures.

The Turner Valley gas used is carried through a 16-inch main for about 150 miles arriving at the plant at 75 pounds pressure and is regulated to 40 pounds for the compressor intake and 15 pounds for fuel gas in the power end. The intake gas is compressed in the low pressure cylinder to 150 pounds and then piped through a series of cooling coils called the intercooler. Then it enters the high pressure cylinders where it is increased to 400 pounds and after passing through another set of cooling pipes it enters the field lines leading to the wells. Since operations started on August 4th, 3 to 5 million cubic feet of gas have been pumped into the field every day.

It might be asked why gas is blowing open in one field and an expensive plant being built to pump it back into the ground in another field 150 miles away. The answer is that anyone may buy petroleum or gas leases from the government and drill for gas and oil. As long as the company is making a commercial success by extracting gasoline it will carry on and the well would not be shut in pending a satisfactory market for the gas which accompanies the crude naphtha. While there is no difficulty in capping in a producing well until the supply is needed, there is no law at the present time to cause the well to be shut in. This waste of gas has been going on for years and should the government desire to conserve the gas, an enormous sum would be required to indemnify the owners for work already done, let alone the value of their acquired leases. The desire for conservation resulting in this repressuring work is based on the generally accepted idea that the generation of gas in a field is negligible and that every foot of gas once used is gone for ever. It is necessary then to conserve all the gas possible to take care of future demands.

Mr. Gourlay, after his address, showed lantern slides of the wells at Turner Valley and of the repressuring plant at Bow island. A vote of thanks was moved by J. A. Carruthers, A.M.E.I.C., after an interesting discussion on the address.

The meeting was preceded by the usual dinner and community singing, music being rendered by the Brown orchestra, a 'cello solo by Mr. Henderson and a vocal solo by Mr. T. Smith.

The Lethbridge Branch held its regular meeting on November 15th at the Marquis hotel. After an excellent dinner, during which orchestral music was rendered by the Brown orchestra, community signing was indulged in and banjo solos by Mr. Solomon and vocal solos by Mr. Stott were appreciatively received.

The speaker of the evening was Mr. E. G. Hazell, proprietor of the Summit Lime Works of Crow's Nest, who discussed the history of the lime industry in Alberta and the uses of its products. It was in 1901 that one Harry Pelletier opened the first lime plant in the Crow's Nest pass two or three years after the railway had pushed its way through the mountains. His plant was literally a hole in the ground cut out of the side of a mountain. He produced 8 cars of lime in his first year of operation. By 1912 the pass kilns were producing 800 cars annually.

In 1902 another plant was opened and the industry grew rapidly. The speaker's plant, which he took over in 1904, consisted originally of one pot kiln 16 feet in diameter and 18 feet high and had a capacity of 150 tons in 9 days. Wood was originally used as fuel, but as the adjoining timber stands were depleted it was necessary to find another fuel supply. A gas producer plant was installed and found quite successful. Steam coal from the adjoining coal mines made a cheap fuel supply possible.

Following 1912 the lime industry declined somewhat due to the growth of the large gypsum and cement companies, but is now on a steady and productive footing. Part of the production at present is pulverized and is blown onto the tunnel walls of coal mines as a means of decreasing fire hazards.

The development of a glass industry in the vicinity of Medicine Hat provides an outlet for a large quantity of lime. Again, the newly established sugar industry in the irrigated area of southern Alberta takes a considerable amount of the lime stone which is burned at the factory, both the gases and the burned lime being used in the sugar refining processes. The growing use of stucco has led to the erection of a stucco plant at the lime works and a market for lime stucco is being built up.

The present kilns used in the Crow's Nest pass are of the upright type, built of steel and lined with fire-brick, and fed continuously from the top. The gas from the producer plant enters a few feet above the bottom, and near the bottom are openings for removing the burned lime.

In the uses of lime in the United States, it is found that 40 per cent is used for construction and agricultural purposes, the remaining 60 per cent being used by chemical industries. In the chemical industry it is used in paper mills, metallurgical processes, tanning, bleaching and so on. It is also valuable in the purification of water for drinking purposes and for water softening.

In agriculture, it is of value in replenishing the lime content of the soil which is heavily depleted by the growth of clover and alfalfa. As a bone builder it is useful in the livestock industry.

Besides its well-known uses in building construction, lime is valuable when mixed with cement for making concrete, producing a more waterproof product.

The Lethbridge Branch held its regular meeting on Saturday, November 29th, at the Marquis hotel. Following the dinner at which 34 were present, a musical programme including selections by the Brown orchestra and vocal solos by Fred Teague was enjoyed.

J. B. deHart, M.E.I.C., drew the members attention to a suggestion that had appeared in the local press that day, that a central organization for administrating unemployment relief in the city be set up and that the usual Christmas cheer funds be consolidated for relief work throughout the winter. The members felt that this was an excellent suggestion, and the meeting went on record as favouring it and requested the city council to call a meeting of representatives of the various organizations to discuss the matter. His Worship Mayor Barrowman, who was present, stated he was personally in favour of such a scheme and would give the matter his full support.

The speaker of the evening was E. E. Eisenhauer, A.M.E.I.C., of the Alberta Wheat Pool, who spoke on "The Alberta Wheat Pool and the Handling of Wheat."

Agriculture, said Mr. Eisenhauer, is Canada's basic industry. In 1929 the total agricultural investment in the country was about $8,000,000,000, and the total revenues about $1,000,000,000. In Alberta, agriculture was responsible for 78 per cent of the total produced wealth of the province in the same year. Agricultural production is necessarily carried on in small units, and the farmers were in the past in a poor position to market their grain to the best possible advantage. To protect their interests they formed their own marketing organization: the Wheat Pool. There were separate pools in each of the three prairie provinces and they have a central selling agency, which handles the marketing of the crop.

The growth of the pools has been phenomenal. The Alberta Pool started operations in 1923 with three country elevators and now owns 439 out of the total of 1,700 elevators in the province. Its investments in the province amount to about $8,000,000. The pool has been instrumental in bringing about many improvements in the design of country elevators, a very important one being the substitution of direct electric drive for the old gasoline engine-operated rope-drive.

With the aid of slides, Mr. Eisenhauer illustrated the handling of the grain crop from the time the farmer delivers his truck loads of wheat at the country elevator. Cars are sampled by government inspectors at Calgary and Winnipeg, and they determine the grade of wheat. At the terminal elevators at the head of the lakes and at Vancouver, the grain is unloaded by machinery, one car being emptied in about seven minutes. Other machinery cleans the dirt and weed seed from the grain which is then stored until ready for transferring to ships, which transfer is accomplished at a great rate of speed, it being possible to load several hundred thousand bushels into a lake boat in the course of a few hours. On arrival of the grain at European ports, it is usually trans-shipped to barges and lighters, which carry it to the mills.

The cleaning operations at the terminals represent a very important part of the work of handling the grain. In 1928 the elevators at Fort William extracted ten million bushels of dirt and weed seeds from the grain they handled. Here, Mr. Eisenhauer drew an interesting comparison, saying that this ten million bushels is equivalent to five years wheat shipment from Vulcan, Alberta, which town ships more grain than any other initial loading point in the world. (Vulcan is about 60 miles north of Lethbridge.)

A lucrative business has been built up lately in disposing of the wild oats which are separated from the wheat at the terminals. Formerly, the farmer was penalized for wild oats, which have, however, a very high feed value. In the last year or two, large quantities have been sold to farmers in Ontario and a substantial profit returned to the western farmer.

Mr. Eisenhauer then touched on some of the economic conditions that have so depressed the wheat market. One of these factors was the Argentine wheat crop of 1928. In most years the Argentine crop grades considerably lower than the Canadian crop and therefore does not command such a good market. However in 1928, the Argentine crop graded just as high as the Canadian product. The Argentine markets its grain on a different basis from Canada. Most of their grain is shipped to England unsold and is purchased on arrival at its destination. The English millers had plenty of wheat on hand and a tremendous amount of Argentine wheat was held under load in English ports. The owners were forced to almost give away this wheat to forestall the rapidly mounting demurrage charges while it was under load. The result was that the English purchasers were able to take delivery of a large quantity of good grade wheat, which was right on hand in their harbours, and available at almost sacrifice prices. So they naturally turned their backs on the Canadian product which was still on the other side of the Atlantic.

A second factor was the decline in the value of silver in the Orient. Oriental countries furnish a large market for the lower grades of Canadian wheat, but the marked depreciation in the value of silver money so reduced the Orient's credit that it was unable to purchase the amount of grain it was accustomed to take.

A third factor was the sudden and thorough raising of high tariff walls in European countries. These countries also compelled their millers to use a high proportion of home-grown grain. This has considerably reduced Canada's market.

A fourth factor is that the world's wheat production has grown faster than the demand, and this year the supply exceeds the demand for the whole world by some 400 million bushels. These four factors together with the general financial depression, have brought about the admittedly serious situation which confronts the pools today.

Following Mr. Eisenhauer's address, a lively discussion took place, numerous pertinent questions being put to the speaker by those present. In fact, the argument waged far into the night, and it was 11.15 o'clock p.m. before P. M. Sauder, M.E.I.C., could get a chance to move a hearty vote of thanks to Mr. Eisenhauer for one of the most interesting evenings the Branch has enjoyed.

The Lethbridge Branch held its regular dinner and meeting at the Marquis hotel on December 13th. It being the last meeting before Christmas, the hotel management served a real Christmas dinner which put the members in the proper shape for the sing-song that followed. Vocal solos by R. S. Lawrence, A.M.E.I.C., and violin solos by G. S. Brown, A.M.E.I.C., were appreciatively received.

The speaker of the evening was J. H. Doughty-Davies, Town Planning Engineer for the city of Calgary, who gave a talk on "Town Planning."

In arriving at a definition of what town planning is, the speaker undertook to outline a few of the things that it is not, and which often cause misunderstandings on the part of the layman. It is not a wonderful and weird new art, nor yet does it consist solely of reams of plans outlining hypothetical ideas, nor is it the idea of tearing down whole portions of a city and rebuilding to a new scheme. Rather is it the listing of common sense information for the purposes of making a constructive plan for the development of a town and for making normal expenditures, when and where the occasion arises throughout the years.

Town planning divides itself into several phases, the first of which deals with major streets and arterial highways. Such streets are necessary for the quick and uncongested movement of traffic from the outskirts to the centre of the city and as by-passes for the purpose of diverting through traffic from the more congested business areas. It is a wise principle to have a system of major streets about half a mile apart throughout the city. These streets are wide and well paved and tend to direct vehicles in certain definite routes. The minor streets within the areas bounded by major streets need not be so wide or heavily paved as their traffic will be more nearly local. The following of such a principle leads to economy in paving programmes.

Another phase is the planning and locating of rapid transit facilities such as street cars, elevated railways and subways. Here topography and population distribution are important factors, as they are in most considerations in town planning.

A third phase is that of transportation and is concerned with the location of railway stations, freight sheds, bus terminals and industrial trackage and convenient interchanges among transportation companies.

Public recreation is another consideration. Playgrounds, playing fields and parks should be located to best serve the people using them and be of proper size to take care of not only the present population but also the prospective increases. For instance, a study of playgrounds has shown that nearly all the children using a particular ground come from within a quarter of a mile radius. This indicates that playgrounds should be about a half mile apart, and suggests that one playground be located nearly centrally in the half mile area bounded by major streets, thus avoiding the necessity of children crossing these busy arteries. Similar studies are applied in the determining of school locations and so forth.

Civic art is a general term applied to the efforts to beautify the community. It includes the studies of the approaches to the town with a view to giving the newcomer a good impression as he enters. Boulevarding is also considered. Another feature is the elimination of unsightly poles and wires from the streets, placing them in lanes and sometimes underground.

Last but not least comes the question of zoning, a matter which has been much discussed in Alberta of late. The intrusion of certain industries or activities into a given area may have a depreciative effect on property values and living conditions. This makes it desirable to guide and direct the various interests into those portions of the town which are best suited for the particular purpose and for the general welfare of the town.

It is necessary to consider the adequacy of street, water and sewer facilities in determining the type of construction to be permitted within these areas.

An interesting discussion followed Mr. Davies' address, and a vote of thanks, moved by A. J. Branch, A.M.E.I.C., was heartily passed.

London Branch

F. C. Ball, A.M.E.I.C., Secretary-Treasurer.
Jno. R. Rostron, A.M.E.I.C., Branch News Editor.

The opening meeting of the 1930-1931 session was held on October 29th, in the Science building of the University of Western Ontario.

The speaker was Dr. R. C. Dearle, B.A., M.A., Ph.D., Professor of Physics, University of Western Ontario, and his subject "Ulta-Violet Light."

E. V. Buchanan, M.E.I.C., presided in the unavoidable absence of the Branch chairman, W. G. Ure, A.M.E.I.C.

A large body of students were present in addition to a fair number of members.

The speaker demonstrated his remarks by various lanterns and instruments for measuring the quantity of ultra-violet rays both in sunlight and artificial light. He also had an elaborate projector which threw on the screen a graduated dial with a registering needle by means of which a comparison of the quantity of ultra-violet light passing through or reflected from various materials could be made at a glance.

Dr. Dearle gave an interesting comparison of the amount of sunlight in each month of the year compiled from observations taken during the last six years. As might be expected July is the sunniest and December the dullest month of the year and as these observations were taken between sunrise and sunset only, they showed that during the hours of daylight the sun is obscured by far the major part of the time, consequently, observations are now being taken daily, and data made, to determine how much ultra-violet light reaches the earth when the sun is obscured.

Demonstrations were made, by means of the projector mentioned, showing the amount of ultra-violet light passing through glass. Ordinary window glass cuts off the ultra-violet almost entirely while various kinds of glass specially made to admit the ultra-violet allowed some of it to pass in varying degrees but the best of these still cut off about 35 per cent. It was obvious that in any room fitted with this special glass unless the reflected light also contained the ultra-violet, the only persons who would benefit from this source would be those directly in the sun's rays and this might be objectionable from other reasons such as heat and the strong light. Experiments were, therefore, being made to determine what kind of materials and colours reflected the ultra-violet the most. Demonstrations were made, with the aid of the special projector, with wood, paper, specially treated paint, etc. Of the various kinds of wood, bass wood was found to reflect the greatest amount of ultra-violet light and was far ahead of most of the others. Likewise, the special mauve-coloured paint was well ahead of the other special paints. The object of these experiments is to find out how hospital sun rooms, classrooms, etc., may best be equipped with materials which will give the occupants the full benefit of the maximum amount of natural ultra-violet light that it is possible to get in an enclosed space. The greatest benefit to be derived from this natural ultra-violet light is, of course, obtained by exposing the nude body to the sun's rays in the open air, but as this is liable to result in severe sunburn, blistering, etc., if overdone, a treatment of five or six minutes daily was recommended. The professor said that undoubtedly the ultra-violet light had been found to be of therapeutic value, yet to just what extent was still uncertain. Another interesting demonstration was made showing the way in which smoke interfered with the passage of ultra-violet light; thus proving that the murky atmosphere over towns and cities where this condition prevails would seriously hamper any benefit derived from the sunlight. Regarding the use of artificial light for this purpose he also stated that it was possible to do more harm than good and recommended the patient to obtain the advice of his physician as to the time of exposure to the rays, if at all.

A hearty vote of thanks to the speaker was proposed by J. A. Vance, A.M.E.I.C., seconded by D. M. Bright, A.M.E.I.C., and unanimously carried.

During the discussion which followed a proposal was made that the students of the university and also of the technical school be invited to attend the meetings of the Branch.

There was also a proposal that the university would provide a special short course of possibly six lectures in co-operation with the Engineering Institute and any other organizations that might be interested. A small fee would be charged to cover expenses and the lectures would cover scientific subjects such as chemistry, physics, botany, zoology, geology, etc. The proposition will be considered by the Executive and it is possible a working arrangement will be evolved.

The regular November meeting of the Branch was held on the 19th in the board room of the Board of Education, Public Utilities building.

The chairman of the Branch, W. G. Ure, A.M.E.I.C., presided, and the speaker was Mr. R. B. Steele, assistant chief engineer of the Canadian National Telegraph System.

The title of Mr. Steele's paper was "The Telegraph—Yesterday and Today," and he opened his remarks by stating that his chief, Mr. J. C. Burkholder, was not able to be present and that he had been requested to convey his regrets.

The definition of the word "Telegraph" before the use of electricity was "A means for conveying intelligence to a distance by means of signs." A later meaning for the word arrived at after the adoption of the electric current was "A means of producing signals visible, audible, or printed at a distant place." The first part of Mr. Steele's paper was devoted to a historical sketch of the means employed in the old days for signalling intelligence such as signal or beacon fires, columns of smoke, light signals, illuminated signs, flags and peculiar windmills with adjustable arms. Flag signals were introduced about the middle of the 17th century by the Duke of York (afterwards James II of England), who was at that time admiral of the English fleet.

This scheme was introduced for directing the manœuvres of the fleet and modifications of it are in use today in practically all the navies of the world. Another outstanding method of signalling in the old days was inaugurated by two French college boys—Claude and Ignace Chappé, and consisted of semaphore arms hinged on a pole and secondary short arms again hinged on the ends of the main arms. These arms could be set at different angles and were capable of conveying nearly 200 distinct signals and by the use of a code conversations could be carried on between any two points where visibility was possible either by the naked eye or the use of telescopes. This was in 1784, and ten years later the French government adopted it and retained Claude Chappé as chief telegraph engineer. This system was in use for many years and a modification of it is still in use today along many railway tracks for conveying a simple set of signals to the locomotive drivers.

This system and that of the flag signals were capable of transmitting about five words per minute but, of course, these messages were entirely dependent on good weather conditions and good visibility.

Coming to the electrical era—Stephen Gray in 1729 discovered that it was possible to transmit electric current to a distance by means of an insulated wire. Between 1767 and 1800 scientists, including Galvanti and Volta, discovered the phenomenon connected with the Voltaic pile and constructed this device for providing a sustained voltage. In 1805, Romagnesi found that a wire carrying an electric current was capable of deflecting a magnetic needle. In 1820, Schweigger discovered that if a coil of several turns of wire carrying a current was employed the deflecting force was increased. In 1825, Sturgeon discovered that a bar of soft iron was rendered temporarily magnetic if surrounded by a coil of wire through which an electric current was passing.

About 1830, Henry worked out the design for electro-magnets suitable for responding to currents received over long telegraph lines and about 1833, Gauss and Weber discovered that they could transmit telegraph signals over a line making use of induced currents produced by the motion of a coil of wire surrounding a bar magnet. These are the fundamental discoveries upon which our present electric telegraph is based.

In 1832, Schilling introduced a telegraph which, with improvements and modifications, is still in use today. Further, this system had the novel feature of using the current reversals, the current flowing first in one direction and then the other to form the signals. In 1831, Henry was first to set up a telegraph system making use of the electric magnetic receiving device.

The first outdoor line was constructed by Webber in 1833. This two-wire line was built at Göttingen using Schilling's system and was eight-tenths of a mile in length. In 1831 Steinheil discovered that a telegraph could be operated by one wire using the ground for the return current. In 1837 Morse patented a form of self-recording electromagnetic telegraph and because of the publicity his invention received he became known as "The Father of the Telegraph." Alfred N. Vail associated with him, and so improved Morse's instruments that they have come down to us today with only minor changes and refinements in design. Vail is also responsible for the code still in use today and known as the "American Morse Code."

The first commercial telegraph was constructed between Washington and Baltimore, financed by the United States government, and built on the lines of the original Morse equipment as improved by Vail. Service was opened on May 24, 1844. The two telegraph companies now in existence in the United States resulted from this venture and a good deal of their business is still handled over the simple Morse circuits.

In England and on the continent the present-day telegraph system is based largely upon Schilling's system with refinements and improvements introduced by many scientists including Cooke and Wheatstone.

The speed of transmission of this period was about 35 words per minute but by the introduction of automatic printing devices, etc., the speed was increased to 360 words per minute by 1900. In 1871, Stearns solved the problem of conveying more than one message at a time over a single line wire and in 1874 Edison devised a method of transmitting two messages in each direction over one wire. Four 50 word a minute messages are now sent each way making a total of 400 words a minute.

In 1909, Major-General Squier of the United States Signal Corps conceived the carrier telegraph system. This, briefly, consists of transmitting low power radio waves through the ether but guided by the telegraph wire and carrying the signal to a much greater distance than would be possible otherwise with the same radio sets. It has also the advantage of not interfering with the direct current messages in the wire itself. This system has been so improved that by using it on a pair of line wires together with the direct current a speed of 4,120 words per minute can now be obtained.

Further developments are still being made and it is impossible to say when the endeavour to obtain greater speed of transmission will cease.

Telephones are now being installed on the main line trains and these will be operated on the carrier system, the radio waves being caught and guided by the telegraph wires paralleling the line.

A hearty vote of thanks to the speaker was proposed by A. H. Smith, A.M.E.I.C., township engineer, and seconded by W. C. Miller, M.E.I.C., city engineer of St. Thomas, and unanimously carried.

The meeting was largely attended, many Bell Telephone employees being present together with a number of technical school students.

Montreal Branch

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

On November 6th, Mr. L. M. Sheridan, chief engineer of the International Nickel Company, described the new Copper Cliff plant of the company to the members of the Montreal Branch.

As this paper was printed in the December number of The Journal, no further description will be given here. However, it is of interest to note that considerable favourable comment was offered during the discussion relating to the successful completion of the work. Amongst those taking part in this discussion were Major J. H. Brace, M.E.I.C., G. H. Duggan, M.E.I.C., C. E. Fraser, M.E.I.C., and D. C. Tennant, M.E.I.C. At the conclusion of the meeting a hearty vote of thanks was proposed to the speaker by Dr. R. A. Ross, M.E.I.C., consulting engineer of Montreal. L. R. Wilson, M.E.I.C., occupied the chair.

Mr. F. A. Hamilton Jr., engineer for the Central Station Department of the General Electric Company, addressed the Montreal Branch on November 13th on the subject "The Practical Aspects of System Stability." Arrangements are being made to have this paper printed in full in a later number of The Journal and therefore no synopsis of it will be given at this time.

Professor C. V. Christie, M.E.I.C., presided.

The Montreal Branch were addressed on November 20th by Wing-Commander L. S. Breadner, D.S.C., A.M.E.I.C., Director of the Royal Canadian Air Force.

Commander Breadner chose as his subject "The Royal Canadian Air Force as a Career," and pointed out the exceptional opportunities offered to young men having the necessary qualifications. These qualifications are that the applicants must be British subjects, holders of a university degree in Applied Science, having the physical fitness and temperament suited to aviation work. It's popularity is attested to by the fact that some 400 to 500 applications for the R.C.A.F. are received every week from young men between the ages of 16 and 20.

This new branch of the Service offers permanent employment with good pay, opportunities for promotion and a pension upon retirement. Commander Breadner stated that officers of the R.C.A.F. were being used, according to their initiative and ability in the various fields, either as pilots, observers, navigators, photographers or in the office or stores. Training is carried out at Camp Borden and a brief description of the life there was given by the lecturer.

Every year a certain number of qualified officers are sent to England for further experience and training, and in addition, the members of the R.C.A.F. in Canada co-operate to fight bush fires, survey new tracts of land, map out mail routes and assist the various branches of the government whenever called upon.

Professor C. M. McKergow, M.E.I.C., vice-chairman of the Aeronautical section, occupied the chair.

On November 27th a very interesting film was shown before the Montreal Branch in connection with a description by M. S. Blaiklock, M.E.I.C., of the Lyon creek trestle fill.

The Lyon creek trestle is on the Canadian National Railways main line between Edmonton and Vancouver about a hundred miles east of Kamloops. The creek is a tributary of the North Thompson river and the trestle itself was 1,500 feet long and 110 feet high. It was constructed in 1914 and the actual fill began in 1925, being finally completed in 1928 after three years of very arduous labour and many severe hardships encountered by the contractor.

The work was carried out in three stages, the two lower sections being filled by dumping from temporary trestles erected a short distance from the main structure and only the third and last section was dumped from the right of way itself.

The film was loaned by the courtesy of the Canadian National Railways, and at the conclusion of the lecture refreshments were served. W. K. McAllister, A.M.E.I.C., presided.

Niagara Peninula Branch

R. W. Downie, A.M.E.I.C., Secretary-Treasurer.

At Bridgeburg, on November 19th, about seventy engineers gathered to hold a dinner meeting and listen to the historical reminiscences and miscellaneous researches of an erstwhile newspaper editor.

It is always a pleasure to listen to Louis Blake Duff, and when lined with a good dinner and properly lubricated, he runs as smoothly and sweetly as one of the immense hydro-electric generators at Queenston. That is why engineers appreciate his utterances probably as much, or more, than the average layman.

Councillor C. H. Scheman, M.E.I.C., and his efficient staff attended to all the details and the success of the party is largely due to their forethought and discrimination.

At the commencement of the programme, Mr. Farnum and Mr. Strickland were invited to say a few words on behalf of the Engineering Society of Buffalo, followed by a "habitant" poem composed and read by Mr. F. S. Drummond of old Niagara. This poem is of such general interest that, through the courtesy of the author, a reprint is given on another page.

Mr. Blake Duff dealt with the early history of Canada, particularly the place-names and their origins, around the Niagara (pronounced Nee-agara) peninsula. The river, with its falls and islands, is full of historical relics. Navy island was a shipyard under the French regime and the vessels that harboured there, or were under construction, when the British took possession in 1759, were towed over to Grand island and burnt in the bay or creek which still retains the name of "Burnt Ship" bay. The same Grand island, with an area of 17,000 acres, was at one time a principality, somewhat of the same nature as Monaco is to-day. After the island was purchased by New York state from the Senacas in 1815, a period of seven years elapsed before full title could be obtained, and it was during this period that the inhabitants established "Prince" Clarke upon the throne and refused to acknowledge other allegiance. In 1825, shortly after Prince Clarke's reign came to an end, a city of refuge for the Jewish people was promoted by one Major Mordecai Manuel Noah, with Grand island for a site, but very little ever came of it and now Buffalo has usurped that honour.

At this point Mr. Blake Duff interrupted his chronological sequence by relating an incident about a vessel named "Le Griffon" which was built at Cayuga creek for trading purposes about the year 1679, when Father Hennepin and LaSalle were exploring these waters. This vessel set out upon her maiden voyage and was never again heard from until this summer, when Harry Tucker of Owen Sound came upon an old wreck which is believed to be that of "Le Griffon," lost for 250 years.

The names of many points and bays along the north shore of Lake Erie give clues to records which reveal secrets of the bygone days. Point Abino was given to a certain Peter Abino by the Jesuit Fathers in 1743. Windmill point was named after Carter's grist mill which existed in 1832 and drew its trade from districts as far west as Simcoe and Port Dover. Sugar Loaf point, so named on account of the peculiar mound or hill of sand, was known as early as 1784 when Henry Zavitz constructed the first flour mill in the district and, in 1787, a survey was made to this point by an engineer, one Phillip Rockwell Frey. It has been seriously suggested on many occasions that this mound was "hand made," but the evidence is not conclusive. Morgan's point was named after a Pennsylvania Dutchman and later the name was officially changed to Point Industry which was suggestive of the character of the inhabitants. Mariners, however, could or would not bend their manner of referring to favourite landmarks at the behest of officialdom and today the locality is again known as "Morgan's point."

John Graves Simcoe was responsible for naming much of the Upper Canada area but for some unexplainable reason he chose names originating in the county of Lincoln rather than from Devon where he was born. At that time, 1791, the county of Lincoln in Upper Canada extended from the Niagara river to beyond Hamilton and it was not until many years later split up into the present counties of Wentworth, Haldimand, Welland and Lincoln.

William Jarvis was an aide of Governor Simcoe and served as the first provincial secretary. Before coming to Canada he was swirled through thirty-two degrees of Masonry in one evening by the Duke of Ancaster, who was at that time Grand Master in England, the object being to allow Jarvis to institute a lodge in Upper Canada similar to that which already existed in the Lower Provinces. Ancaster township derives its name as a grateful recognition of that "swirl."

The township of Sherbrooke was originally known as Wetterburn and was used as a reserve for the Haldimand Indians. A man named Dickson coveted ths piece of property and plotted the acquisition thereof. Bringing the Indian chiefs together at a grand banquet he plied them with firewater, finally succeeding in securing their approval. A rare example of early supersalesmanship, but he forgot to reckon with the squaws. The opinions of these ladies carried considerable weight when opposed to such a transaction as the sale of their homeland, and Mr. Dickson had to go so far afield as Governor Sherbrooke of Lower Canada before he could muster sufficient influence to achieve his desires. Finally however he won and in grateful recognition of the aid thus rendered he renamed the track Sherbrooke township.

Some of the more remote townships had less excuse than a "grateful remembrance of favours received" for their nomenclature. Perhaps in those days they were not considered sufficiently attractive to be considered on the honour list. Perhaps there were not enough influential or notorious names to go around. Be that as it may, it is sad to have to record that three townships will hand down to posterity the names of pet poodles belonging to Lady Maitland, Tiny, Floss and Tay.

Coming to some places of lesser importance or of smaller area, we find Sarnia derived from the early Roman name for the Island of Guernsey, Port Colborne after Sir John Colborne, Port Maitland after Sir Peregrine Maitland, Port Robinson, formerly Port Beverley, after John Beverley Robinson who was attorney general of Upper Canada at the early age of eighteen years. The thriving and striving village of Allanburg was the consequence of another act of gratitude when Sir Wm. Allan allowed the promoters of the first Welland canal to overdraw at his bank. "Amigari" was an error, or the result of an error, made when the county registrar could not decipher the writing of Chris. Bunting, M.P., who wished the name to commemorate the castle of "Amigan" in Ireland.

In proposing a vote of thanks to the speaker, E. G. Cameron, A.M.E.I.C., took occasion to draw a parallel between the hardships which these pioneers had to contend with and the present-day tribulations of a temporary depression.

The meeting was adjourned by chairman Walter Jackson, M.E.I.C. at about 9.30 o'clock p.m.

The "Royal Sauvage"

You lak my ol' stick mistaire. No shes not ash.
Dats a piece from de deck of de "Royal Sauvage."
Never hear of dat ship? Well, long tam it has been
Since shes sunk by de British off ol' Fort St. Jean.

Oui. T'ank you. I'll take a cigar mon ami.
I can tell you de story my grandpere tol' me.
De grandpere of him was de captain in charge,
An' sail to de war on de "Royal Sauvage."

It seems when Napoleon's armies at war
Kept England so busy defending her shore,
De people just South of us thot it good tam
For tak all dis countree, an' over dey came.

But lak all bad causes, our good Curé says
Dey nevaire succeed wit' de one dat is bless.
That numbers don't count when you have a good cause
An' a fas' sailing ship lak de "Royal Sauvage."

Firs' built by de French under Monsieur Montcalm
Shees de bes' of white oak, wit' de fines' of gun.
When war is declare she is sail down Champlain;
Knock down all dere fort an' return home again.

Bye an' bye dey is build dem four ships dat have gun.
An' from dem our ship is pretending to run.
Till strung in a line she halts in her course;
De firs' of dose ship it is nevaire look worse!!

It mak' for de shore, and is sink on de san',
What is lef' of de crew she is manage to lan'.
Den de nex' ship is comin' close up to our gun.
When down comes his mas' and his yards on de run.

De two smaller ship dey is start for de shore
But de "Sauvage" is after dem quickly, encore.
Dey shoot bote together, wit' terrible crash
An' cut de bowsprit from de "Royal Sauvage."

He was Sauvage before but hees Sauvager now
An' waits till he gets dose two ship on a row.
His guns double shotted, he swings in his pride.
Knocks hell out of bote of dem wit' a broadside.

But as time she'll pass on over ten thousand men
Wit' dozens of boat sailed up Old Lac Champlain
De "Royal Sauvage" she is damage dem sure
But what can one do wit' a dozens or more.

She anchor herself by de Fort of St. Jean
But de Garrison leaving, hees spike all de gun.
More sooner be sunk dan an enemy's prize
De "Royal Sauvage" is blow up to de skies.

You know all de res' of it Monsieur Ami
De invaders, defeated, returned dere countree.
We're friends for a century. More I should judge.
Here's a toas' to Kebec, an' de "Royal Sauvage."

An' now when low water and even time comes.
When de girl wit' hees fella walks 'long by de guns.
She sees, near de shore jus' de tip of a beam
Where de bow of de "Sauvage" looks at Fort St. Jean.

F. S. DRUMMOND.

Niagara-on-Lake, January, 1930.

NOTE.—The writer, who took his overseas training at Fort St. John barracks (Que.), has two sticks made from the timber of the "Royal Sauvage."

The December dinner meeting of this Branch was held at the Hotel Reeta, Welland, Ont., on December 16th, but being so near the festive season the attendance suffered accordingly. The guest of the evening was Mr. G. C. Bateman, secretary of the Ontario Mining Association.

As this was the first meeting this season of the Branch that was not a joint meeting with some other association, Walter Jackson, M.E.I.C., chairman of the Branch, took the opportunity of tendering the thanks to the members for his election, afterwards asking A. J. Grant, M.E.I.C., president of The Institute, to make a few remarks on Institute affairs.

Mr. Grant reported that the suggestion of this Branch to have The Journal made 6 inches by 9 inches was not accepted by the Councillors at the last Plenary Meeting.

Mr. Grant also stated that the membership was not increasing at the rate it should, and it was suggested that next year the branches take up a campaign to secure new members.

After Mr. Jackson had asked the members not to lose their ballots for president and local representatives but to turn them in, he introduced Mr. G. C. Bateman to the meeting.

Mr. Bateman said he felt rather nervous in lecturing on "Nickel" as there were two visitors from the International Nickel Company's plant at Port Colborne who knew more about the subject than he did, so he would confine himself to the history of nickel.

Nickel, which had been considered by the general public lately more from a speculative than a practical point of view, has been known since 1700. The first authentic find however was in 1856, by a surveyor named Salter and confirmed by Murray, a Dominion geologist. This find, which subsequently became the Creighton mine, was lost for many years. When in 1883 the Canadian Pacific Railway was constructed through the Sudbury district, a vein of what is now the Murray mine was cut; this property was sold to Vivians of London. This led to prospecting in this district by Frood, Stobie and many others. The original find was rediscovered in 1886 and formed the Creighton mine, the first smelter being erected in 1888.

In 1882 S. J. Ritchie of Cleveland, Ohio, opened up iron deposits in Hastings county and started the Central Ontario Railway, but a shipment of iron to Cleveland proved unsatisfactory. So he then went to Sudbury, acquired large holdings including the Frood, Copper Cliff and Creighton properties, and organized a company with a capital of $2,000,000, the original Canadian Copper Company.

Rich Copper Cliff ore with 15 per cent copper was shipped to smelters who were unable to get any copper out of it. Colonel Thompson found that the difficulty was due to the presence of nickel, and constructed the Orford works, at Bayonne, N.J., but was unsuccessful at first in treating the Copper Cliff ore.

He however experimented with a sodium sulphate salt, which he had found out was used in a secret process by a Welsh firm at Swansea which had solved the problem, and finally solved it himself. He decided then to build a smelter at Sudbury and one capable of dealing with 200 tons a day was erected by Dr. Peters, metallurgist.

Vivian's now came into the field, but, as has often been the fate of Canadian industries managed from London, failed to make a success.

Ritchie at this time was shipping more nickel than was in demand, so he had to find new sources for his output.

Experiments were being made for combatting yellow fever by freezing the germs, a ship being fitted out with refrigerators, but it was found out that cast iron would not hold the ammonia gas, so nickel iron was tried and found perfectly good for the work.

Ritchie went to Europe with Canadian and United States representatives and visited most of the European steel plants, with the result that Riley of Glasgow made a special study of nickel steel and read a paper on it.

Nickel steel armour plates in comparison with compound steel armour plates then in use for battleships were tested on Annapolis proving ground. The nickel steel plates proved so much superior that an order for 1,000,000 pounds of nickel was given by the United States government.

Jules Garnier, a nickel expert from the French mines in New Caledonia, erected a Bessemer converter in Sudbury and refinery in Cleveland but did not make a success of it. Electrolytic refining was also tried but was found to be too expensive.

The Mond process was also tried but was unsuitable for the Canadian climate, and the only economic process the Canadian Copper Company could find was that used by Colonel Thompson.

In 1902 The International Nickel Company was formed taking over four nickel companies and the Orford works.

The Creighton and Copper Cliff mines were well known but on the Frood, the biggest of them all, and staked in 1884, no work was done for 15 years. Then during two years 100,000 tons of ore were shipped. It was afterwards neglected till 1929, and the only ore taken in 45 years would equal what could be done in 45 days if the new plant were operated to capacity.

The reason the Frood was investigated in 1899 is that the Creighton mine was flattening out and thinning, but later by drilling deeper it was found to widen out again and the work on the Frood was stopped.

Mond found that below 2,000 feet there was an increase in the metal contents of the ore and that metals of the platinum group were found. This was also proved on the Frood especially at the 2,800-foot level. An analysis by the Mond Company gave 20 per cent copper, 1½ per cent nickel and ⅔ ounces of the platinum group at that depth.

The shaft on the Frood is sunk to 3,000 feet and between 1,000 and 3,000 feet there are 45,000,000 tons of ore and above the 1,600-foot level, 60,000,000 tons.

Mr. Bateman then gave a short description of the new smelter which will be the largest in the British Empire. The dimension of the smokestack, which is 510 feet high, 60 feet diameter inside at bottom and 45 feet at top with 7-foot walls, gives an idea of the enormous size of the plant.

After giving some details of the method of mining the ore, Mr. Bateman made a plea for the young engineer, and the men who work underground and tackle all the various difficulties incidental to extracting the ore. He expressed the opinion that these men had not been given enough consideration, we had thought more of the speculative side. In this country the importance of the development of natural resources is being continually stressed, but the most important resource is the young engineer who is not enough utilized. In the mines they are replacing the old time shift bosses by young engineers and more should be done to utilize and encourage them.

E. P. Murphy, A.M.E.I.C., proposed a hearty vote of thanks to Mr. Bateman for his very interesting paper, which was passed with acclamation.

W. Seymour, M.E.I.C., of the Sault Ste Marie Branch on a visit to Port Colborne, expressed himself as glad to be at the meeting and enjoyed the talk. This was his first visit to another branch and he wished to offer his congratulations to a live and active branch. They were so far from other centres they had to depend on local industries for papers.

After Mr. Jackson had given a résumé of prospective attractions for the January meeting, the adjournment was made.

Ottawa Branch

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

Recent Developments in Acoustical Practice

At the noon luncheon on the 20th November, Major G. M. Thomson, Director of Research for Gypsum, Lime and Alabastine, Limited, addressed the meeting upon the subject of recent developments in acoustical practice. John McLeish, M.E.I.C., acted as chairman and was given a special round of applause when he rose to speak as a welcome back after several weeks' illness. Among those at the head table with the chairman and Major Thomson were the following:—L. L. Bolton, M.E.I.C.; Ray Tubman; Victor M. Meek, M.E.I.C.; G. E. Bell, M.E.I.C.; W. H. George; Lieutenant-Commander C. P. Edwards, A.M.E.I.C.; John Murphy, M.E.I.C.; Lieutenant-Colonel C. J. Burritt; Honourable Senator Smeaton White; E. Viens, M.E.I.C.; C. R. Reynolds. Major Thomson in rising to speak said that he felt he was among old friends, for he recognized college classmates, comrades overseas and associates from other walks of life.

Major Thomson characterized any sound that is not pleasant to the ears of the listener as a noise. He stated that noises in general had proved themselves to be among the most insidious and harmful agencies that ever afflicted the human race. We are careful to conserve our eyesight but are not so careful in endeavouring to suppress noises which we dislike.

The recent developments in mechanical transportation that have taken place since the Great War have accentuated the great problem of the evil effects of noise. In fact man, originally silent, is not accommodating himself at the present time to new noises as rapidly as he is adding to them.

In Great Britain there is a commission studying the problem of the abatement of road traffic noises. This problem has also extended itself to the continent. In New York city there is a Noise Abatement Commission and in Germany a Society of Industrial Hygiene which has as one of its problems the cutting down and elimination where possible of unnecessary noise.

Major Thomson quoted authorities with regard to the amount of noise caused by different agencies and the effects of it upon the human system. At a busy New York street intersection, for instance, he stated that trucks were credited with about 40 per cent of the noise to be heard there.

Although engineers have been pioneer crusaders against noise, during the War they missed one of the greatest opportunities to do something really big, by failing to invent a soundproof helmet or protector to cover the ears. Had engineers thought of such a helmet they would have made one of the greatest contributions of the War toward economy of man power. Soundless explosions would not have reduced normally courageous men to a state of nervous collapse.

It is a fallacy that people get used to noise. For executives and those in administrative positions there is likely to be a serious loss or impairment of working capacity operating against their processes of clear thinking, if their offices are so situated that they are subject to the noise of typewriters, adding machines, babble from the outside world, etc. Such noise is in the nature of a constant strain upon the nervous system and ultimately may lead to nervous exhaustion and neurasthenia.

With regard to the prevention of the effects of noise, in such cases three remedies are suggested. The first, the use of some method of preventing noise reaching the eardrum is hardly practicable. Secondly, by mass co-operation it would be possible to reduce or eliminate sounds, whether on the street or in a room or enclosure. And thirdly, it is possible by the use of proper structural means to dissipate unavoidable sounds.

A smooth wall, for instance, may reflect as much as ninety-eight per cent of the sound waves and absorb two per cent. Associated with this is the problem regarding the proper audition in theatre buildings, churches, etc. Sound foci caused by the reflection of sound from domed ceilings may cause interference such that various sound waves neutralize one another giving rise to "dead spots." The remedy for this is the use of felts, carpets, soft materials, etc., to dissipate the sound waves.

With regard to the correct treatment of walls to dissipate sound waves, it has been necessary to expend much effort in order to produce the ideal material for absorbing noise. Such material must be of moderate cost, easy to apply, suitable for decorating, fire-resistant and lend itself readily to cleaning and redecorating. It should also be of some material which will not harbour bacteria, this being particularly true in the case of hospitals. Materials with a mineral content have been worked out and are proving very satisfactory for the purpose.

In the study of noise prevention and abatement Major Thomson paid a great tribute to two men in Canada who had done pioneering work in this regard for many years, one of them for well over thirty years. These men had made available the mental machinery to meet the problem before the engineer of today. They are Professor G. R. Anderson of the University of Toronto and Professor H. E. Reilly of McGill University.

Major Thomson's address proved to be most interesting; it was received with the closest attention by the large gathering present at the luncheon.

Speeding Up Telegraphic Communication

On December 4th, at the regular bi-weekly noon luncheon of the local Branch, the guest speaker was Mr. J. C. Burkholder, Chief Engineer of Canadian National Telegraphs, who spoke upon the subject of "The Telegraph—Speeding up Communication." John McLeish, M.E.I.C., chairman of the local branch, presided and in his introductory remarks stated that engineers were most fortunately situated in that they were constantly being afforded the opportunity for doing something that had never been done before. This applied to the speaker of the day in connection with the work which he had done in instituting a method of telephonic communication from a train in motion.

Mr. Burkholder, in commencing his remarks, stated that the desire of mankind for speed, including speed in methods of communication, was not a new one. He outlined methods of communication from the earliest historic times down to the present, tracing them through the various phases from word of mouth, by the sending of messengers both afoot and mounted often in relays, by the use of signal flags, signal fires, semaphores, and finally by electrically controlled devices.

Flag signals, for instance, were first made use of in the 17th century by the Duke of York, later James II of England, in directing the manœuvres of the English fleet. In a modified form they are still used for certain purposes. Another most successful form of early message system was the invention of the Chappé brothers in France in 1784 who communicated with each other by semaphore signals worked out to a pre-arranged code. In making use of these semaphores some 200 combinations of characters were used. The French government adopted the scheme and extended the system throughout the country, establishing semaphore signalling points upon hilltops. The code, however, was very cumbersome and when a great distance was to be covered it would often take several days to transmit a simple message of only three or four words.

Previous to this, in 1729, Stephen Gray discovered the means of conveying an electric current along an insulated wire and subsequently Galvani, Volta, Schweigger, Sturgeon and their successors in electrical research added their contributions. In 1837, Morse patented a form of self-recording electro-magnetic telegraph. At this time, the Morse code was also developed by Bell who was associated with Morse and two others in certain developments relating to recording and relay systems in connection with the telegraph.

From that time until 1900, practically nothing was done in telegraphic development such as we see it today. In the decade from 1900 to 1910 automatic equipment began to be used. Such equipment allowed a message to be printed out at the receiving end of the telegraph somewhat the same as would be printed on the typewriter. The method was quite satisfactory and by its use 50 words a minute were possible over a pair of wires.

The necessity for further speed was continually being felt. The cost of copper wire—or its equivalent—and the physical limits of construction of the telegraph lines, etc., made it imperative that this speed be attained with the least amount of equipment necessary. Thus development followed along the line of making use of a single wire for operating a number of printing telegraph machines instead of one machine as formerly. At the present time, for instance, with the carrier current system now under development, if multiplex printing telegraph were superimposed, a maximum signal transmission of 6,000 words per minute per wire, or 12,000 words per minute over a pair of wires, would be allowed. Mr. Burkholder stated that it is expected to go even further than this and that within the next decade this figure of 6,000 words per minute should be doubled.

Mr. Burkholder also described the means used to cut down delay or to speed up communication in the matter of handling the messages as they are received at the receiving end of the telegraph line. In each case this is a local problem and may be solved by the use of belt carriers, underground tubes, etc. In Toronto, for instance, a new belt system has recently been installed between the various offices whereby the average time of handling individual messages is cut down some five seconds. Thus it will be seen that the old cry for speed still holds, only today it is a matter of seconds or fractions of seconds whereas formerly it was a matter of minutes, hours or even days.

Toward the end of his address, Mr. Burkholder made a brief reference to the recently developed method of telephone communication from moving trains. He characterized it as being still more or less experimental and he hoped that it would be considerably improved and simplified in the course of time.

Mr. Burkholder's address was listened to with a great deal of interest by those present. At the head table in addition to the chairman and the speaker there were the following:—Brig.-Gen. C. H. Mitchell, C.B., C.M.G., C.E., D.Eng., M.E.I.C., Dean of the Faculty of Applied Science, University of Toronto; Group-Captain F. Lindsay Gordon, A.M.E.I.C.; Dr. R. M. Stewart, M.E.I.C.; T. D. Boomer; T. F. McVeigh; G. J. Desbarats, C.M.G., M.E.I.C., Deputy Minister, Department of National Defence; G. P. Mackenzie; Dr. S. J. McLean; Dr. Chas. Camsell, M.E.I.C.; C. C. Stewart; John Murphy, M.E.I.C.; J. A. N. Cauchon, A.M.E.I.C.; P. H. Holmes; F. H. Peters, M.E.I.C.; J. L. Rannie, M.E.I.C.; A. E. MacRae, A.M.E.I.C., and O. O. Lefebvre, M.E.I.C., chief engineer, Quebec Streams Commission, Montreal.

Saguenay Branch

W. P. C. LeBoutillier, Jr.E.I.C., Secretary-Treasurer.

A meeting of the Saguenay Branch of The Engineering Institute of Canada was held in the United Church of Canada, at Kenogami, Que., on the evening of November 12, 1930.

The meeting was open to member and their friends, and the success of the gathering may be judged by the attendance, which numbered close upon seventy men.

The meeting was called to order by N. D. Paine, A.M.E.I.C., the chairman of the Branch. He introduced the speaker, C. P. Dunn, M.E.I.C., chief engineer for the Alcoa Power Company at Chute-à-Caron, P.Q., and also Mr. George Low, engineer in charge of expropriation claims for the Duke Price Company, who had very kindly consented to show a movie film of the construction and dropping of the obelisk at Chute-à-Caron.

Through the courtesy of the Canadian General Electric Company Ltd., a number of very interesting films on various engineering and scientific topics were shown.

Mr. Dunn started by describing the tests that were carried out in connection with the design of the obelisk. These tests were made, chiefly, to arrive at the cushioning effect the water would have on the block when it was dropped into the river. All models were made to scale and the strength of the concrete was also proportioned according to the size of the models.

In order to determine the shape of the bottom of the obelisk, a hydrographic survey was made under very difficult conditions, but as it proved later, it was done very accurately, as the difference in elevation between the ends of the obelisk, when placed, was only a matter of a few inches.

The mathematics involved in the design were then briefly explained and the speaker concluded his talk by asking Mr. Low to present his film, which proved to be most interesting.

The chairman then closed the meeting by thanking both Mr. Dunn and Mr. Low for a very interesting and pleasant evening.

Saint John Branch

A. A. Turnbull, A.M.E.I.C., Secretary-Treasurer.
(Reported by F. M. Barnes, A.M.E.I.C.)

On Monday evening, November 17th, 1930, at 8 o'clock, the Saint John Branch of The Engineering Institute of Canada inaugurated the regular monthly meetings of the winter programme at the Board of Trade rooms, Prince William street, Saint John, N.B.

F. H. Peters, M.E.I.C., Surveyor General of Canada, gave an address on "Aerial Photographic Surveys" illustrated with lantern slides during the lecture, and followed by motion pictures showing the actual operations of aerial photographing large areas of Saskatchewan.

The meeting was open to the public and members of the Saint John Flying Club were special guests.

W. J. Johnston, A.M.E.I.C., chairman of the Saint John Branch, introduced the speaker. In his opening remarks, Mr. Peters voiced the sentiments of the Ottawa Branch in conveying the greetings of the Ottawa Branch for a successful season.

Owing to the large amount of forest lands in the Dominion of Canada and the great difficulty of making accurate surveys of large areas on foot, the speaker stressed the ease with which large areas of land could be covered by the aeroplane.

To enable the department to decide on the area or section of Canada to be aerially photographed, an index map has been prepared showing the whole of the Dominion of Canada divided into squares of latitude and longitude, scale 16 miles to the inch. Each of these squares is again subdivided into two hundred and fifty-six smaller squares, scale 1 mile to the inch. In each of these squares or parallelograms are numbers denoting certain areas, hence at any time it is desired to designate territory to be surveyed all that is necessary is to point out the locality by the number on the map. The methods used were developed in Canada and worked out by Canadians. There are four hundred thousand photographic prints now in index at Ottawa, and during the year one hundred and twenty-five thousand prints were added to the collection.

The two main methods used in plotting are as follows:

1. Accurate control of major points.
2. In between these points to fill in the topographical details.

The speaker mentioned that it was impossible to make an accurate map from air work alone and that it was necessary to have ground control points. These are first obtained over the areas required to be mapped or surveyed and the aerial work arranged accordingly. In places where lines, fences or concession lines are well defined, the four corners are photographed in correct position. All photographs must be taken with the camera lens at a fixed focal length. The photographic plates are 7 by 9 inches and the magazine of the camera contains one hundred negatives. It is of interest to note that small camera were used many years ago for topographical work in the Rocky mountains. The road and fence lines etc. actually show up on the aerial photographs. From these and the control points you can divide the areas into squares and take off what is necessary.

The two main methods in taking aerial photographs are vertical and oblique. The oblique method is most desirable in that it is possible to cover a larger area of territory, but it is not desirable in hilly country, as the angle of depression which the line of the centre of the camera meets the ground shows that the land in the rear of the hilly country is cut off and its value lessened.

After the location has been decided upon, the area to be aerially photographed is divided into several large strips where control points have been established. These strips are then each separately photographed and overlap each other 50 per cent so that a portion of the overlapping appears on each picture. In the Maritime provinces the vertical method has been chiefly used. On account of the hilly country, the oblique method is not desirable. The use of the stereoscope is of tremendous value in picking out topography and contours.

In the case of the oblique photographs more difficulties are encountered. The first thing to be considered is to try and find the control points as laid down by the surveyor on the ground. The system of squares or grid for plotting is then drawn on the map and must be in the same perspective as the photograph. From this is developed the grid which when plotted converges near the camera and widens out towards the horizon. It is very important to get the horizon in the photograph as from this the tilt of the camera can be measured. If you have chosen the correct grid lines the control points will agree and are easily recognizable on each photograph.

The speaker then illustrated how by a system of base lines, orientation lines and control points, an area of about twenty-five square miles was plotted, after which the preliminary organization of an aerial photographic survey party under the direction of the graphic flying operations in the field, were shown in moving pictures.

A hearty vote of thanks to Mr. Peters for his interesting paper was then proposed by G. G. Murdoch, M.E.I.C., seconded by C. B. Bates, A.M.E.I.C., and carried unanimously by the Branch.

Refreshments were served before adjournment.

On Wednesday evening, November 19th, at 8 o'clock, a meeting was held in the Board of Trade rooms with the Branch chairman presiding.

The speaker of the evening was W. P. Dobson, M.E.I.C., Chief Testing Engineer of the Hydro-Electric Power Commission of Ontario, who addressed the Branch in connection with the work of a modern testing laboratory, illustrating his talk with lantern slides.

Mr. Dobson first touched upon the rapid growth of the testing force from a small to a large force, representing a large investment of capital. The laboratory work covered the preparation of specifications, the testing and inspection of all material entering into a product and the final test of the product itself, such as steels, towers and concrete. Studies were made in great detail of all materials entering into the manufacture of equipment, paint, oils, rubber gloves and numerous other items. He stressed the importance of their contact on this work with the Canadian Engineering Standards Association.

Equipment testing in itself formed an important division of the laboratory. Electrical, mechanical, and chemical tests were applied to household appliances and materials, materials used in wiring, line work and many other items, all with the object of safety. Similar to this work is that of the Underwriters Laboratory in the United States. Approval work undertaken involved the visiting of a large number of cities, both in Canada and the United States, and covered work for about 1,700 manufacturers which in some cases involved 200 items for each manufacturer.

A certain amount of research was undertaken, although not of the fundamental type involving pure physics and chemistry, but of an industrial or engineering nature such as power production equipment and power distribution equipment.

The results of the laboratory work were compared to a sinking fund. All work was undertaken with the idea of improving construction, methods of design and operation. Mr. Dobson stressed the importance of the personal qualities of the staff employed on this work.

Following an interesting discussion, a vote of thanks was extended to the speaker on motion of G. A. Vandervoort, A.M.E.I.C., seconded by G. Stead, M.E.I.C.

Before the meeting adjourned refreshments were served.

A special business meeting was held in the Board of Trade rooms, on November 25th, 1930, with the Branch chairman presiding, at which J. L. Busfield, M.E.I.C., chairman of the Committee on Remuneration of The Institute, gave a very interesting account of the work of this committee, followed by a general discussion of the subject.

On motion of G. Stead, M.E.I.C., seconded by J. L. Feeney, A.M.E.I.C., a hearty vote of thanks was extended to Mr. Busfield.

On motion, the meeting adjourned.

Sault Ste. Marie Branch

A. A. Rose, A.M.E.I.C., Secretary-Treasurer.

The regular October meeting of the Branch was held in the Y.M.C.A., March street, on November 7th, at 8 o'clock p.m.

It was expected that a member of the firm of McLartys, Harten and Wiber would give a talk on the construction of the New Windsor hotel for which they are contractors, but all the members of the firm happened to be out of the city on this date.

In such case the members present engaged in an informal discussion of matters of local interest such as traffic by-laws and unemployment.

On Saturday, November 8th, a number of the members visited the new hotel and were shown through it by the contracting firm. The view from the roof drew special applause.

The November meeting was held on November 28th, at 8 o'clock p.m., in the Y.M.C.A. March street, following a dinner at the Savoury cafe.

The chairman, C. H. E. Rounthwaite, A.M.E.I.C., introduced the speaker of the evening, Dr. Nelson Graham, Branch Director of the Provincial Board of Health, to speak on the subject "Sanitation."

Introducing his subject, Dr. Graham stated that as sanitation problems are present wherever people reside the medical man and the engineer should work together in their solution. The engineer should be consulted regarding their solution more often than he is.

Continuing, the speaker said that of prime importance to the community is the water supply, which is not a difficult one in Sault Ste. Marie. The intake is in the wall of the power canal and contamination is not at all constant. There is no water supply which is safe that is not chlorinated, the only trouble in connection with chlorination being the extra taste on occasion and it is the speaker's belief that this is due to wash water from the coke plant which drains into the river through a creek with very little fall. A solution of this difficulty would be to have the creek drain into the lower river and so below the intake.

The care of garbage and refuse is another problem in a city. Present opinion favours the incinerator for a place the size of the Soo, and it should be placed near the source of the most garbage, which should reach it by the most direct route in water-tight wagons, which could be washed after each load. The incinerator should be sufficiently large to completely burn all garbage at a high temperature to destroy all bacteria. Dumping of refuse along the waterfront is objectionable to the eye, to the water supply, and to fish, and is strictly against the law.

Sewage disposal is a problem; the most approved method being the activated sludge as in Toronto, the cost of equipment being about ten dollars per person. Draining sewage into the river is a real danger—a source of typhoid and other diseases and particularly dangerous to bathers. The use of chemicals has been tried in various places but has proved too costly.

Next to water supply in importance is the milk supply. The milk by-law should be revised to require complete pasteurization and constant inspection by a trained inspector. Without this no board of health can succeed. The board of health should be able to trace and eliminate any epidemic of communicable disease at its start. The key to this is medical inspection of schools which would be much less costly than fighting disease with individual care in homes. A dental clinic is also required in the Soo as the focus of infection in the teeth of a child is a menace to its health. All these things are an absolute benefit to the health of the community.

Discussion followed the giving of the paper, much interest being shown in the way in which these problems are being met in the Soo.

A hearty vote of thanks was tendered Dr. Graham for his most interesting and instructive address, on motion of J. H. Jenkinson, A.M.E.I.C., and F. Smallwood, M.E.I.C.

Toronto Branch

J. J. Spence, A.M.E.I.C., Secretary-Treasurer.
A. B. Crealock, A.M.E.I.C., Branch News Editor.

The first meeting of the Toronto Branch of The Institute for the 1930-1931 season was a joint meeting in conjunction with the American Society of Mechanical Engineers (Ontario section) and the American Institute of Electrical Engineers (Toronto section.) Between the hours of 4.00 o'clock p.m. and 7.00 o'clock p.m. an inspection tour took place and the following places were visited: The Royal York hotel, where the mechanical and electrical equipment was inspected; the steam plant of the Toronto Terminal Railways and the mechanical and electrical equipment of the new building of the Canadian Bank of Commerce. At 7.00 o'clock p.m. dinner was served and following this J. J. Traill, M.E.I.C., introduced J. B. McAndrews, A.M.E.I.C., who spoke on "The Mechanical Features of the Welland Ship Canal." The speaker explained the mechanism for operating the gates, the sluice gate valves, weirs, and gate hoisting derrick, all of which were well illustrated by lantern slides. Following this Mr. L. P. Rundle described the electrical features of the canal, going into considerable detail on the lighting system, bridge operating mechanism, gate equipment, safety devices and the proposed future generating plant. A hearty vote of thanks was tendered to both speakers and expressions of regret were expressed at the unavoidable absence of A. J. Grant, M.E.I.C., our President. R. J. Durley, M.E.I.C., our Secretary, expressed in a few well-chosen words his appreciation of being able to be present on this occasion.

A regular meeting of the Toronto Branch of The Engineering Institute of Canada was held in the Mining building of the University of Toronto on the evening of Thursday, October 30th, 1930. Mr. Traill introduced the speaker of the evening, Dr. H. A. Innis, Professor of Political Science, University of Toronto. Dr. Innis took as his subject "The Hudson's Bay Railway." He described the route chosen from The Pas to Fort Churchill and discussed the advantages pro and con from an economic standpoint of this latest venture in railway activity. By means of numerous slides the speaker showed the right of way, roadbed and equipment of the newly built railway. In additon he took his listeners further on to Chesterfield inlet some 500 miles north of Churchill. Following this address there was an open discussion of the subject and on conclusion a hearty vote of thanks was proposed by L. W. Wynne-Roberts, A.M.E.I.C.

A regular meeting of the Toronto Branch of The Engineering Institute of Canada was held on the evening of Thursday, November 13th, 1930, in the Mining building of the University, with J. J. Traill, M.E.I.C., in the chair. On this evening the Branch was favoured with two speakers, General Sir Charles Delme-Radcliffe and Mr. William Snaith.

Sir Charles spoke first on "Aero Photometric Surveys," in which he described by means of slides a new method in three dimensions by which much greater than usual speed in reduction of results is obtained by a vertical projection of the camera. Pictures are taken from an aeroplane flying at a height of from 2,500 feet to 20,000 feet. By means of the photograph secured a reproduction called a photocartigraph is made to the desired scale by utilizing a special drawing apparatus operated by a draftsman and thus a complete survey of a required area is completed in approximately one-tenth the time required if the same area were gone over by a theodolite and level. Following the paper a discussion took place in which the following members took part: J. R. Cockburn, M.E.I.C., C. B. Hamilton, Jr., M.E.I.C., J. W. Falkner, A.M.E.I.C., J. J. Traill, M.E.I.C., and A. E. Davison.

Mr. Wm. Snaith was the second speaker of the evening. He took as his subject "Industrial Engineering." The speaker went on to discuss the subject and to define the same. He spoke of the relationship of the industrial engineer to the plant management, the bonus system, the study of labour and material, production control, cost system and the part played by the industrial engineer in all these complications. C. B. Hamilton, Jr., M.E.I.C., and J. W. Falkner, A.M.E.I.C., took part in a discussion.

A hearty vote of thanks to both speakers was made by C. S. L. Hertzberg, M.E.I.C., which was seconded by Mr. Hamilton.

On the evening of Thursday, November 27th, 1930, a regular meeting of the Toronto Branch of The Engineering Institute of Canada was held with C. S. L. Hertzberg, M.E.I.C., in the chair. After the minutes of the previous meeting were read and confirmed, the chairman introduced W. F. McFaul, M.E.I.C., city engineer of Hamilton who spoke at some length on "Recent and Projected Improvements to the Waterworks System of the City of Hamilton."

The speaker introduced his subject by citing the expenditures and general layout of the system at the time he took charge in 1913 as manager. In 1923, Mr. McFaul was appointed city engineer and manager of the waterworks system and in this year made many recommendations in a report which involved the expenditure of roughly $2,358,000. Of this amount the ratepayers by by-laws in 1926 and 1928 approved of some $576,000 being spent in the construction of the intake, conduits, screen chambers, an extension to the Beach pumping station and equipment extension of the Ferguson avenue pumping station and connecting main.

In order to relieve unemployment, additions are being made at the present time to various mains and also the construction of a reservoir. In addition to these works his department is preparing plans for a mechanical filtration plant. By means of numerous slides Mr. McFaul explained the many features of the new 48-inch and 60-inch intake pipe and the installation of the same.

Those taking part in the discussion were A. U. Sanderson, A.M.E.I.C., O. M. Falls, A.M.E.I.C., and E. M. Proctor, M.E.I.C. A hearty vote of thanks was tendered to the speaker by Mr. Sanderson.

EMPLOYMENT SERVICE BUREAU

This Service is operated for the benefit of members of the Engineering Profession and 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

All notices intended for publication must be received not later than the Tuesday of the week preceding the date of the issue in which they are to be inserted.

Situations Vacant

MECHANICAL ENGINEER, university graduate preferred, with at least four years experience in the running, organization and operation of a manufacturing plant, including electric power, high and low pressure steam equipment, heating plant, and motor truck maintenance. A permanent position and good connection with an international company. Apply to Box No. 649-V.

PROMOTION ENGINEER. Graduate engineer to do educational and promotional work with architects and contractors. Must be bi-lingual. Apply to Box No. 650-V.

SALES ENGINEER, University graduate, speaking both French and English fluently, for Montreal firm, preferably not over 35 years of age. Must be a producer and able to get best results from salesmen. Permanent position and salary in keeping with results obtained. Apply to Box No. 651-V.

MECHANICAL ENGINEERING GRADUATE, for steam control and instrument maintenance work for newsprint mill. One familiar with the preparation and analysis of steam reports and the making of necessary efficiency tests. Location, Newfoundland. Apply to Box No. 653-V.

MECHANICAL ENGINEER. Thoroughly qualified mechanical engineer for salesman by large manufacturing plant in Western Canada. When applying give full details, experience, age and salary required. Apply to Box No. 656-V.

MECHANICAL ENGINEER, with some experience in plant maintenance and layout, age from 25 to 30, location Ontario. Apply to Box No. 657-V.

RECENT GRADUATE in mechanical, electrical or civil engineering for development work with an industrial company in Montreal. Young man with one or two years experience required. Apply to Box No. 658-V.

MECHANICAL ENGINEER, with two or three years experience on mechanical draughting, preferably with some paper mill experience. Apply to Box No. 661-V.

THE NATIONAL RESEARCH COUNCIL OF CANADA

The National Research Council of Canada, will shortly proceed to make the following appointments to the staff of the National Research Laboratories:—

1. A physicist or engineer to carry out researches and standardization in the field of wireless telegraphy and telephony.

2. A physicist to carry out researches in the field of optics.

3. A physicist to carry out research and testing on electric meters.

The salaries will depend on the qualifications and experience of the persons appointed. Applications received from former applicants will be reviewed, and new applications are invited for the consideration of the Selection Committee.

Applications should include statements of age, race, nationality, education, technical experience, references. Address applications to:—The Secretary-Treasurer, National Research Council, Ottawa, Canada.

Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., married, desires employment with manufacturer of industrial products, selling to industrial and other markets. His experience includes engineering and building construction, administration and operation of utilities, municipal works, etc. Record of integrity; moderate salary; location immaterial. Apply to Box No. 14-W.

ELECTRICAL ENGINEER seeks connection with Montreal engineer or architect for part time work involving the design and specification for industrial and public buildings. Experienced and capable of complete responsibility. Apply to Box No. 40-W.

CIVIL AND MECHANICAL ENGINEER; aggressive, practical engineer, with background of experience in design, construction, maintenance and operation of pulp and paper mills. Especially qualified to reduce mill costs. Apply to Box No. 53-W.

ELECTRICAL ENGINEER, B.Sc., age 30. Experienced in power distribution and electrical communication, including design of carrier current systems. Apply to Box No. 110-W.

ELECTRICAL ENGINEER, graduate '27, fifteen months students' test course: fifteen months switchboard layout and substation design. Before graduation experience consisted of machine shop practice and electrical construction. Apply to Box No. 132-W.

COLLEGE GRADUATE, age 34, with over ten years experience in power developments and pulp and paper mill construction and maintenance, largely in direct charge of design or construction; desires new connection as chief or assistant engineer or construction superintendent. Apply to Box No. 167-W.

CIVIL ENGINEER, B.Sc., (McGill), M.E.I.C., P.E.Q. and B.C., with broad experience in hydro-electric power investigations, studies and exploration of forest lands, including design and construction driving and storage dams, wharves, flumes, piers and booms and loading plants, as well as general engineering and contracting, is open for engagement. Location immaterial. Now engaged but available on short notice as projects are nearing completion. Speak French fluently, physically fit, active and energetic, and can get results. References can be furnished if required. Apply to Box No. 177-W.

Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., B.A.Sc. and C.E. University of Toronto, with twenty years experience, is open for engagement. Three years railroad construction, one year lake drainage and dam construction, nine years municipal engineering, including pavement and bridges, two years town management, one year paving contracting, and one year resident engineer of highway pavement construction. At present in Maritime Provinces. Apply to Box No. 216-W.

DESIGNING DRAUGHTSMAN, experienee in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing and hoists. Also some experience in ventilating and heating work and calculators. Accustomed to strucural design and details. Good references. Present location Montreal. For interview apply to Box No. 329-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., R.P.E. Ont., with twenty-four years experience embracing dams, wharves, grain elevators, foundations, pile driving, highways, municipal engineering, water power surveys, road locations, inspections and estimating is open for engagement as engineer or superintendent in construction, operation or maintenance. Location immaterial. Apply to Box No. 358-W.

ENGINEER, age 31, married. Experienee includes two years mechanical, two years railway, six years structural and instrumentman and structural engineer on erection, desires position in Toronto. Apply to Box No. 377-W.

CIVIL ENGINEER, A.M.E.I.C., university graduate, O.L.S., married, twenty years experience city surveys, calculations for curved surveys, design, layout and supervision, sidewalks, pavements, sewers and water systems. Acted in capacity of chief engineer for large engineering and surveying firm for five years. Best of references. Available on short notice. Apply to Box No. 413-W.

ELECTRICAL AND MECHANICAL ENGINEER, S.E.I.C., educated Oundle and Manchester, age 24. Student course, Brit.-Westinghouse. Three years design, production, advertising, sales and control of sales force on mechanical and electrical goods. One year outside plant engineering leading public utility company. Desires work in sales, production or engineering capacity. Available immediately. Location immaterial. Apply to Box No. 415-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E. (Ont.), graduate. Eighteen years experience in survey and construction, railway, hydro-electric and buildings. Experience comprises both office and outside work. Desires responsible position. Would consider position with commercial or manufacturing firm. Available immediately. Apply to Box No. 425-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate of Nova Scotia Tech. with experience as plane table topographer, instrumentman and draughtsman and particularly interested in hydro-electric power development and reinforced concrete design, desires position. Willing to go to foreign fields. Available at a few weeks notice. Apply to Box to 431-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (McGill Univ. '27), age 26. Fifteen months outside plant engineering with large public utility. Twenty months sales engineering experience with electrical manufacturing

The Deterioration of Structures in Seawater

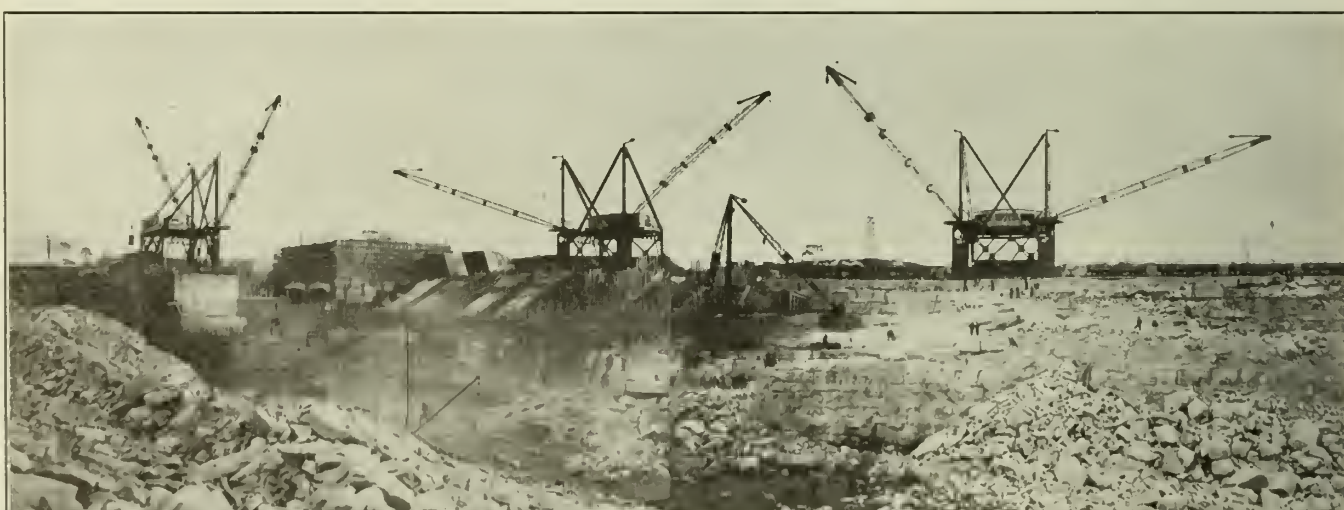
Since 1916 a committee of the Institution of Civil Engineers has been investigating the deterioration of structures of timber, metal, and concrete in seawater. Its first report was published in 1920, and its eleventh (interim) report has just appeared. Whether by coincidence or not, the present report, which now is published without the assistance of the grants that were given by the Department of Scientific and Industrial Research until March, 1928, appears under some headings to be more drastically summarized than its predecessors. In respect, for instance, of the last set of the numerous iron and steel specimens exposed for five years, which consisted of eighteen soft-grade chromium-steel bars, treated in various ways and exposed at Plymouth, Dr. J. Newton Friend, who has carried out this work for the committee, gives no figures of the results he has obtained. Among other results, he reports that, judged by loss of weight and depth of pitting, the resistance of the steel to corrosion by sea action does not appear to be increased by cleaning, whether by pickling or polishing, or by heat treatment. Both in the alternate wet-and-dry and in the complete immersion tests, the heat-treated and cleaned specimens suffered in general more severely than the bars exposed with the skin on. It was found, further, that better results were obtained by quenching followed by tempering than by annealing.

The usual periodical examination has been made, after about eight years' exposure, of the iron and steel bars exposed at Auckland, Halifax, Colombo and Plymouth, showing varying progress of corrosion, but no final dismantling for intimate observation was due to be made in the period under notice.

A progress report for the year was made on the first series of painted steel plates exposed to aerial corrosion at Southampton over five years previously. Of the nineteen types of protection, including galvanizing, none has been absolutely unattacked, but a great many are in very good condition, and deterioration had not proceeded far enough to justify dismantling.

A series of 240 plates, prepared also by Dr. Friend, have been exposed at Southampton and at Weston-Super-Mare respectively for seventeen months and twenty-eight and a-half months. These have been protected by a variety of tars—in some instances with the addition of slaked lime and of paraffin wax. The coating of some plates was applied at 80 or 50 degrees C., and on others the tar was applied at about 200 degrees C. to cold plates, and in one instance to hot plates of the same temperature. Two series of specimens were also treated with white lead in addition to tar, separated from it by several coatings of shellac varnish. In one instance the plates were coated as rolled with the millscale adherent, but in all the remainder they were sand-blasted. The continuously-immersed plates at Weston-Super-Mare broke adrfit and were lost.

At Southampton the completely-immersed plates invariably suffered greater loss through corrosion than those exposed at half-tide level. At both ports the addition of slaked lime to the horizontal-retort tar gave a distinctly better result, both in appearance and in resistance to corrosion, than the pure tar, but the addition to the vertical-retort tar had practically no effect, and, indeed, gave rather worse results than were obtained with the unneutralized tar. The addition of 5 per cent of paraffin wax, on the other hand, made an appreciable improvement in the protective qualities of the vertical-retort tar. Generally the horizontal-retort tar proved to be very much superior to the vertical-retort tar, the latter of which in the series at 80 degrees C. lost three to six times as much in weight as that of the horizontal-retort tar, and when applied at 200 degrees C. lost six to ten times as much. While in general tar applied at 200 degrees C. gave better results than tar applied at 80 degrees C., the application of hot tar to plates at the same temperature was not in general very successful. It is suggested that the plates should only be warm enough to ensure their complete dryness, and that probably about 100 degrees C. is suitable for the tar in most conditions. On the whole, tarring by painting over the millscale was found unsatisfactory. Painting with white lead on top of the tar, with coats of shellac varnish interposed, was very successful.—*Engineering.*



Site of Power-House, Beauharnois Power Corporation, Beauharnois, Que.

Preliminary Notice

of Applications for Admission and for Transfer

December 19th, 1930

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, 1931.

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

BARNECUT—REGINALD, of Calgary, Alta., Born at Plymouth, England, Jan. 6th, 1896; Educ., B.Sc., (C.E.), Univ. of Alta., 1923; 1919-22, field dftsman and leveller, D. I. Reclam. Service, Calgary; 1923-24, inspr., C.P.R., Winnipeg; 1924-28, struct'l. dftsman., Worden-Alley Co., Milwaukee, Wis.; 1928-29, struct'l. checker, Dominion Bridge Company, Winnipeg, and at present, struct'l. checker for same company, at Calgary, Alta.

References: R. S. L. Wilson, C. A. Robb, H. B. Lebourveau, H. M. White, R. H. Goodchild, A. J. Dostert.

GREENING—EDWARD OWEN, of Quesnel, B.C., Born at Thames Ditton, Surrey, England, March 29th, 1888; Educ., 1904-07, South Eastern Agricultural College, Univ. of London (Diploma 1906). P.C.E. Assns. of Prof. Engrs. B.C. and Alta.; Capt. C.E. and R.A.F. Reserves; 1907-09, chainman, rodman, etc., Tyrrell & McKay, Hamilton, Ont.; 1908-10, chainman and instr'man., Nat. Transcon. Rly.; 1910-11, transitman, 1911-12, res. engr., 1912-13, locating engr., 1914. res. engr., same rly.; 1914, also res. engr. at Williamstown, Ont., for C.P.R.; 1914-19, overseas., C.E. and R.A.F., Lieut., and Capt.; 1927-28, rly. dftsman., field and office, Edmonton, Dunvegan & B.C. Rly.; 1928, field engr., Calgary Power Company; 1928-29, rly.reconnaissance, 1929, stereoscopic examination of air photographs, and 1929 to date, location engr. in charge of party, Pacific Great Eastern Rly. Lands Survey of Resources, Quesnel, B.C.

References: C. R. Crysdale, E. A. Wheatley, R. W. Brock, E. J. Bolger, G. Grant, A. E. Doucet, H. Idsardi, T. C. MacNabb.

KNUDSEN—SVERRE, of Montreal, Que., Born at Innvik, Nordfjord, Norway, Oct. 24th, 1903; Educ., Civil Engr., Norwegian Institute of Technology, 1927; 1917-27 (during vacations), location of highways in Nordfjord, etc.; 1927 (2 mos.), in charge of party, planning widening of highway, Stryn, Norway; 1927-28, investigation of water course, Vadheim, Norway, including surveying, location of dams, tunnels and canals, soundings, design of dams, and estimating bldg. costs; 1929 (2 mos.), tracing and dfting; July 1929 to date, dftsman and instr'man., for Mr. L. E. Schlemm, M.E.I.C., landscape engr., Montreal.

References: O. S. Platou, L. E. Schlemm, F. S. Keith, G. R. MacLeod, S. Svenningson, M. D. Barclay.

LONGSTAFF—JOHN CALVIN, Montreal West, Que., Born at Missoula, Mont., U.S.A., Sept. 1st, 1889; Educ., Diploma, Univ. of Toronto, 1910; 1911-14, dftsman., with McGregor & McIntyre, Ltd., Dominion Bridge Co., and Toronto Structural Steel Co. Ltd., Toronto; 1915-16, various non-engrg. jobs; 1917-19, with C.E.F.; 1920-22, with Technical Service, City of Montreal; 1922-23, dftsman, Dominion Bridge Company, Lachine; 1923-25, dftsman., with same company at Ottawa, and 1925 to date, designer with same company at Lachine.

References: F. Newell, F. P. Shearwood, D. C. Tennant, W. C. Thomson, A. Peden, C. S. G. Rogers.

MARTIN—FRANK JOHN ELLEN, of Saskatoon, Sask., Born at Brighton, England, Sept. 10th, 1904; Educ., B.Sc., (C.E.), Univ. of Sask., 1928; 1927, asst. city bldg. inspr., and checking struct'l. designs, city of Saskatoon, Sask.; 1926, and 1928 to date, struct'l. designer and field engr. in steel and reinforced concrete constrn., for Frank P. Martin, F.R.A.I.C., arch't. and engr., Saskatoon, Sask.

References: C. J. Mackenzie, E. H. Phillips, W. M. Stuart, W. G. Worcester, H. B. Brehaut, H. M. Weir.

PITTAWAY—GEORGE HENRY, of 6901 Monkland Avenue, Montreal, Que., Born at Barrow-in-Furness, England, July 6th, 1897; Educ., 1912-17, Barrow Technical College and Regent St. Polytechnic, London; A.M. (by exam.), Inst. Struct'l. Engrs., England; 1912-17, ap'ticeship as mech'l. engr., 1917-18, engrg. dftsman., Messrs. Vickers Limited; 1918-19, overseas. Pte., B.E.F.; 1919-20, 4th engr., Anchor Brocklebank Line; 1920-28, chief engrg. dftsman., and constrn'l. asst., to the Fulham Borough Council, London, England; Full charge of designing and carrying out with direct labour large extensions to elec. generating station, including bldgs., turbines and boilers with auxiliaries, reinforced concrete pump rooms and circulating water intakes from river pipelines, etc.; 1928 to date, asst. engr. to The Shell Company of Canada, Ltd., in charge of Quebec and Eastern Ontario. Constrn. of service stations and storage equipment.

References: W. G. Hunt, W. L. R. Stewart, J. F. Wickenden, T. E. Rousseau, D. S. Ellis, O. A. Barwick.

REDFERN—CHARLES RAIMOND, of 33 Campbell Avenue, Montreal West, Que., Born at Owen Sound, Ont., Feb. 29th, 1888; Educ., B.A.Sc., Univ. of Toronto, 1909; 1910-11, demonstrator, strength of materials, 1911-12, demonstrator, in dfting., Univ. of Toronto Lab'y.; 1912-29, with P. Lyall & Sons Constrn. Co. Ltd., as follows: 1912-13, engr. on constrn. work; 1914-17, supt. on constrn. work; 1918-19, Toronto manager; 1920-21, Western manager; 1922-23, Associate Ontario manager; 1924-27, Ontario manager; 1928-29, vice-president and general manager, and June to Sept. 1929, president; Sept. 1929 to date, general manager for liquidator of above company, acting in advisory capacity; Also President, Redfern Construction Co. Ltd., University Tower Bldg., Montreal, Que., carrying on business as general contractors.

References: A. J. Grant, C. H. Mitchell, J. B. Challies, R. G. Swan, H. M. Scott, J. R. W. Ambrose, W. D. Black, R. L. Dobbin.

ULMANN—HANS, of 694 Godin Avenue, Verdun, Que., Born at Zurich, Switzerland, Feb. 14th, 1902; Educ., Elect'l. Engr., Technical Institute of Zurich, 1925; July 1925 to Aug. 1926, engrg. dept. for layout and sale of elect'l. equipment for different industries, Brown Boveri & Co. Ltd., Baden, Switzerland; Dec. 1926 to May 1928, engrg. dept., International Paper Co., New York; Juue 1928 to Dec. 1929, design of paper-making machinery, and at present, research engr., development dept., Dominion Engineering Works, Ltd., Montreal.

References: F. P. Shearwood, D. C. Tennant, H. G. Welsford, H. S. Van Patter, H. A. Crombie.

WHITAKER—ALBERT WILLIAM, Jr., of Arvida, Que., Born at Philadelphia, Pa., April 4th, 1892; Educ., B.S. in Ch.E., 1913, and Master Degree of Chemical Engineer. 1930, Univ. of Pennsylvania; 1913-16, technical engr., Massena works, 1916-18, technical engr., Niagara works, 1918, plant supt., Niagara works, 1918-20, carbon plant supt., Masseua works, Aluminum Company of America; 1926-28, carbon plant supt., 1928 to Sept. 1930, alumina plant supt., and Oct. 1930 to date, works supt., Arvida works, Aluminum Company of Canada.

References: H. R. Wake, R. E. Parks, N. D. Paine, G. O. Vogan, F. H. Cothran, C. P. Dunn.

WIGMORE—ROY DOUGLAS HAZEN, of 241 Prince Street West, Saint John, N.B., Born at Saint John, N.B., March 9th, 1897; Educ., B.Sc., Acadia Univ., 1923; 1913-15, rodman, road engr's. office, Saint John, N.B.; 1915-19, overseas, C.E.F.; Summers: 1920, rodman, St. John Dry Dock & Shipbldg. Co. Ltd.; 1921, levelman, water and sewerage dept., City of St. John; 1922, junior instr'man., Welland Ship Canal; 1923, inspr. on constrn., Power Commn. of City of St. John; 1923-24, sampler, assayer, surveyor, and in charge of constrn., Canadian Associated Goldfields Ltd., Larder Lake, Ont.; 1925-30, with Castle-Trethewey Mines Ltd., as follows: 1925, asst. engr., Bestel, Ont., 1925-28, assayer, (Castle mines), 1929, examinations and reports on silver properties, surveying mining claims, 1930, foreman in charge of development. Capitol development shaft; At present, asst. district highway engr., Prov. Dept. of Public Works, Saint John, N.B.

References: A. D. Campbell, J. T. Turnbull, G. G. Murdoch, G. N. Hatfield, D. A. Duffy.

FOR TRANSFER FROM THE CLASS OF JUNIOR TO A HIGHER CLASS

BOULTON—BEVERLEY KNIGHT, of Beauharnois, Que., Born at Ottawa, Ont., Oct. 27th, 1903; Educ., B.Sc., McGill Univ., 1925; With Quebec Development Co., as follows: 1923 (May-Oct.), rodman and part time instr'man. on constrn. of Isle Maligne development; 1924 (May-Oct.), electr'n. and straw boss; 1925 (May-July), electr'n. on P.H. constrn.; Aug. 1925 to Jan. 1927, office engr., and from Nov. 1925 to June 1926, as engr. in charge of constrn. of 154 K.V. transmission system for Duke Price Power Co. Ltd.; 1927, engr. in charge of design and constrn. of 110 K.V. transmission system, and from June 1927 to Nov. 1929, elect'l. engr., with Duke Price Power Co. Ltd., Nov. 1929 to date, elect'l. engr., Beauharnois Construction Company, Beauharnois, Que. (*S. 1923, Jr. May 1930.*)

References: F. H. Cothran, D. F. Noyes, M. V. Sauer, J. A. Knight, P. G. Gauthier.

BURBANK—JEROME DOUGLAS, of Buffalo, N.Y., Born at Toronto, Ont., July 13th, 1897; Educ., B.A.Sc., Univ. of Toronto, 1925; Grad. U.S. Naval Radio School at Harvard Univ., 1919; 1925-26, student engr., Niagara St. Catharines & Toronto Rly., St. Catharines, Ont.; 1926-27, dftsman., Niagara Lockport & Ontario Power Co., Buffalo, N.Y., and with same company to date, as follows: 1927-28, asst. to chief dftsman.; 1928-29, acting engr. in charge of carrier current telephone system of Buffalo Niagara & Eastern Power Corpn. in engrg. dept. of N.L.O.P. Co.; May to Nov. 1929, engr. in charge of above; 1929-30, engrg. dept. of associated companies combined in Nov. 1929, hence with engrg. dept. of Buffalo Niagara & Eastern Corpn. from Nov. 1929 to date, also in charge of radio interference work from May 1930 to date, for Niagara Lockport & Ontario Power Company. (*S. 1921, Jr. 1926.*)

References: N. R. Gibson, C. H. Mitchell, J. R. Cockburn, C. R. Young, T. R. Loudon, W. S. Wilson.

CURRIE—VICTOR ROBERT, of Peterborough, Ont., Born at Lammermoor, Ont., June 21st, 1897; Educ., B.Sc., (Civil), Queen's Univ., 1923; Summers: 1920, labourer, county road constrn.; 1921-22, concrete inspr. and inspr. macadam road constrn. for Ont. Dept. Highways; 1923, transitman, land subdivision surveys in B.C.; 1923-24, asst. res. engr. on concrete dam constrn. and hydrometric surveys, Spanish River Pulp & Paper Mills, Ltd., Sault Ste Marie, Ont.; 1924-26, instr'man and dftsman., on trans. line, land and topographic surveys, and from 1926 to 1928, in charge of prelim. surveys for power developments on Savannah River, also in charge of wash-borings, core-drilling and gen. foundation investigations, for Dixie Construction Co., Birmingham, Ala.; 1928 to date, asst. engr., hydrometric work and gen. mtce., Trent Canal, Peterborough, Ont. (*S. 1922, Jr. 1925.*)

References: W. L. Malcolm, D. S. Ellis, A. L. Killaly, A. E. Caddy, W. A. Spence, F. M. Corneil.

HANNA—HAROLD BENJAMIN, of 313 Elias Avenue, Peterborough, Ont., Born at Prescott, Ont., Sept. 29th, 1897; Educ., B.Sc., Queen's Univ., 1924; Summer work: 1920, rly. mtce. and constrn., C.P.R., Prescott, Ont.; 1921, foreman, highway grading and constrn., Dept. Public Highways, Prescott; 1922, foreman, concrete culvert constrn., Dept. Public Highways, Stratford; 1923, foreman, city paving, Stratford, Ont.; 1924 (May-Nov.), field engr. on plant extensions at Kenogami, Price Bros. & Co. Ltd.; Dec. 1924 to Dec. 1925, field and office engr. for W. I. Bishop Ltd. on constrn. of Price Bros. Riverbend mill; 1926 (Jan.-Feb.), instr'man. in charge of field survey party for International Paper Co., at Cascades, Que.; 1926 (Mar.-Apr.), field engr. for W. I. Bishop Ltd., on plant extension for Belgo Canadian Paper Co., at Shawinigan Falls, Que.; May 1926 to Nov. 1927, constrn. supt. of new plant at Bromptonville and plant renovations at East Angus, Que., for Brompton Pulp & Paper Co.; Dec. 1927 to Dec. 1928, woods engr. at Garthby, Que. for Brompton Pulp & Paper Co.; Jan. 1929 to date, plant engr., Peterborough plant, Canadian General Electric Co. Ltd. (*S. 1922, Jr. 1926.*)

References: L. DeW. Magie, W. M. Cruthers, A. B. Gates, W. P. Wilgar, C. R. McCort, G. F. Layne, W. L. Malcolm.

MARLATT—CHARLES EWART, of Trail, B.C., Born at Fort William, Ont., Nov. 4th, 1896; Educ., B.Sc. (Civil), Queen's Univ., 1923; 1913-14, surveyor's asst., also assayer of coal and coke, Hosmer Mine Ltd.; 1916-19, overseas, C.E.F.; 1919 (5 mos.), asst. to flotation tester, research lab., Cons. Mining & Smelting Co. Ltd.; 1923, topog'r., highway survey, B.C. Govt.; 1924-26, field engr., No. 1 plant, West Kootenay Power & Light Co. Ltd., Bonnington; 1926-28, designing in engrg. office, and from 1928 to date, supt. of safety and fire insurance, Cons. Mining & Smelting Co. Ltd., Trail, B.C. (All work in connection with fire insurance, including valuation and appraisal of plant and equipment, fire protection and prevention, adjusting, etc.) (*S. 1922, Jr. 1925.*)

References: A. B. Ritchie, B. R. Warden, B. L. Thorne, W. P. Wilgar, D. S. Ellis.

MILLER—WILFRID LAVERNE, of Hamilton, Ont., Born at Lawrence Station, Ont., Oct. 8th, 1896; Educ., B.A.Sc., Univ. of Toronto, 1923; 1923-25, graduate ap'tice course, and 1925 to date, electrical design of various forms of distribution and power transformers, auto-transformers, constant current regulators, etc., Canadian Westinghouse Co. Ltd., Hamilton, Ont. (*S. 1921, Jr. 1926.*)

References: H. U. Hart, W. F. McLaren, D. W. Callander, E. M. Coles, J. R. Dunbar, J. C. Nash.

OLIVER—CUTHBERT JACK, of Rio de Janeiro, Brazil., Born at Brighton, Sussex, England, July 20th, 1894; Educ., B.Sc., (E.E.), McGill Univ., 1923; 1920-21 (summers), inspection and repair various apparatus, Toronto Hydro-Electric System; 1922 (summer), and Jan.-May 1924, power house layout and design; transmission line calculations, Messrs. Kerry & Chace, Toronto; Sept. 1923 to Jan. 1924, sub-station design, etc., Manitoba Power Co., Winnipeg; 1924-25, Can. National Electric Rlys.—Toronto Surburban Rly., supervision of overhead line mtce., tracks, bridges and bldgs., etc.; 1926-28, inspr. of elect'l. engrg. distribution system, and from Aug. 1928 to date, overhead distribution engr., The Rio de Janeiro Tramway Light & Power Co. Ltd., Rio de Janeiro, Brazil. Work includes standardization and design of all overhead material and equipment, investigations and projection of future feeders, both urban and rural, supervision of constrn., etc. (*S. 1919, Jr. 1924.*)

References: H. G. McVean, C. V. Christie, C. M. McKergow, G. R. Dalkin, G. A. Wallace.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

BERESKIN—ABRAM ISAAC, of Ottawa, Ont., Born at Propoisk, Russia, Apr. 29th, 1903; Educ., B.Sc. (C.E.), Univ. of Man., 1929. Expects to obtain D.L.S. in Feb. 1931; 1926-27-28 (summers), plane-tabler and topog'r., Topog'l. Survey; 1929-30 (summers), asst. to chief, topog'l. survey, and from Oct. 1929 to date, surveys engr., Topographical Survey, Ottawa, Ont. (*S. 1925.*)

References: J. N. Finlayson, G. H. Herriott, F. H. Peters, M. P. Bridgland, L. E. H. Brenot, E. M. Dennis, R. B. McKay.

BLACKETT—HAROLD WILFRID, of 121 Emerald St. So., Hamilton, Ont., Born at London, England, Aug. 21st, 1903; Educ., B.A., 1928; B.A.Sc., 1929, Univ. of B.C.; 1927 (summer), nipper at Copper Mountain, B.C., for Granby Cons. Mining & Smelting Co. Ltd.; July 1929 to date, engrg. ap'tice, Canadian Westinghouse Company, Ltd., Hamilton, Ont. (*S. 1928.*)

References: R. W. Brock, E. A. Wheatley, W. H. Powell, H. U. Hart, W. F. McLaren, E. M. Coles, J. R. Dunbar.

DALTON—WILLIAM REGINALD, of Burlington, Ont., Born at Nelson, Ont., Nov. 23rd, 1900; Educ., B.Sc., Queen's Univ., 1929; Before graduation, machine shop, foundry and layout work, and dfting., with English Electric Company, St. Catharines, Ont.; 1929 (May-Oct.), asst. to meter expert in charge of metering and distribution system for blast furnaces, coke oven gas, steam air and water combustion engrg., Steel Company of Canada, Hamilton, Ont.; Oct. 1929 to Oct. 1930, ap'tice in tool designing for production work in air brake dept., Canadian Westinghouse Company, Hamilton, Ont. Not employed at present. (*S. 1928.*)

References: L. M. Arkley, L. T. Rutledge, A. Macphail, A. Jackson, K. P. Johnston, C. Anderson, W. B. Ford, W. F. McLaren.

LUSBY—GERALD W., of 768 Hall Ave., Windsor, Ont., Born at Amherst, N.S., Aug. 21st, 1903; Educ., B.Sc. (Mech.), N.S. Tech. Coll., 1925; 1925-26, rodman on survey party in connection with paper mill constrn., Canadian International Paper Co., Three Rivers, Que.; 1926-27, with Fraser Brace Engrg. Co. on install'n. and compilation of piping costs and records in connection with paper mill constrn. at Gatineau, Que.; Oct. 1927 to date, mech'l. engr., engrg. dept., Ford Motor Co. of Canada, East Windsor, Ont. (*S. 1925.*)

References: F. R. Faulkner, R. P. Freeman, J. E. Porter, C. G. Walton, A. Sutherland, W. E. L. Hall, J. W. March.

PHIPPS—CHARLES FERDINAND, of Montreal, Que., Born at Winnipeg, Man., Aug. 31st, 1903; Educ., B.Sc. (Elec.), McGill Univ., 1924; Summer work: 1922, gen power house work, Jordan River power plant, Vancouver Island Power Co., B.C.; 1923, formwork constrn., La Gabelle power development, Shawinigan Engineering Co.; June 1924 to June 1926, graduate ap'ticeship course, and from June 1926 to date, asst. engr. of transmission line design, Shawinigan Water and Power Company, Montreal, Que. (*S. 1924.*)

References: S. Svenningson, J. L. T. Martin, F. S. Keith, C. R. Lindsey, J. Morse, C. V. Christie, E. Brown.

THICKE—JAMES ERNEST, of 129 Hillcrest Ave., Montreal West, Que., Born at New Liskeard, Ont., Aug. 8th, 1902; Educ., B.Sc., Queen's Univ., 1928; Aug. 1923 to Apr. 1924, chainman on engrg. party on steel tower transmission line constrn. for Northern Canada Power Co., Timmins, Ont.; 1925 (summer), transitman in charge of engrg. party on steel tower transmission line constrn. for the Abitibi Power & Paper Co., Iroquois Falls, Ont.; 1926 (summer), asst. to res. engr. and transitman in charge of party on rld. constrn., for same company; 1927 (summer), transitman in charge of survey party making a contour survey of the Abitibi River; May 1928 to 1930, General Electric Company, Schenectady, N.Y., student engr., testing apparatus, power transformers, induction motors, industrial control, mercury arc rectifiers, large size D.C. and A.C. machines; Feb. 1930 to date, engrg. dept., Aluminium Limited, Montreal, Que. (*S. 1926.*)

References: J. M. Gilchrist, W. B. Crombie, D. M. Jemmett, L. T. Rutledge, G. K. Waterhouse, A. Sunstrum.

WEBSTER—ROBERT CHILION PETER, of 2039 McGill College Ave., Montreal, Que., Born at Ottawa, Ont., Dec. 25th, 1900; Educ., R.M.C., B.Sc., McGill Univ., 1923; One year advanced engrg. course, General Electric Co., Schenectady, N.Y.; 1924-25, demonstrator, dept. of mech'l. engrg. McGill Univ.; 1925-26, testing dept., and 1926-27, research design, manager's office, General Electric Co., Schenectady, N.Y.; 1927 to date, investigation and research, Canada Power & Paper Corpn., Montreal, Que. (*S. 1922.*)

References: C. M. McKergow, J. F. Plow, F. S. B. Heward, S. W. Slater, H. E. Bates, T. R. McLagan, A. N. Budden.

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The Head Office Building of The Sun Life Assurance Company of Canada, Ltd., Montreal

A Foreword by the Architects*

To the series of papers describing the engineering features of the building

The Sun Life building as it stands today covers an area approximately two acres in extent, is 24 storeys high above ground with three basements below grade and has a cubic content amounting to 22,000,000 feet.

To appreciate fully the difficulties faced in designing the building it should be borne in mind that the original building, for which we started preparing sketches some twenty-three years ago, was planned with a height of only 8 storeys, with an area of rather less than one-third of the present site and with no thought of an extension northwards. The problem was to graft on to this comparatively small building, the size and scale of which necessarily governed the much greater final scheme, a structure capable of housing a population of ten thousand people. It is difficult at any time to find the solution of a problem of such magnitude and the restrictions imposed by these governing conditions added greatly to its complexity.

The Corinthian order formed the dominating feature of the original building and it was therefore necessary to continue its use in the extension. This has been done in the lower storeys which form the base of the complete building; colonnades of great Corinthian columns constitute the principal feature of the main facades.

The elements of classic architecture emphasize the horizontal rather than the vertical, and in this building, despite a total height of four hundred feet, it has been possible to preserve those dominating horizontal lines owing to the great breadth of the base from which it springs. The emphasis of the horizontal and the general proportions of the mass are intended to give the building a monumental character in keeping with the dignity of the great organization it houses. The accompanying illustrations show the original building as it was in 1925 and the new building as it will appear when completed.

*Messrs. Darling & Pearson, Toronto.

We have briefly outlined the aesthetic considerations governing the design of the building and these were naturally of the greatest importance to the architects, but there were many other factors to be taken into consideration. The various problems connected with structural design, heating, ventilation, drainage, water supply, fire protection, electrical supply and distribution, vertical transportation and interior intercommunication, all had a profound effect on the architectural design. Each of the engineers had to study the requirements of his particular problem and work out a solution satisfactory not only to himself but also to the other engineers and to the architects, who of course had to co-ordinate the work of all.

Some of the principal requirements which had to be borne in mind by the engineers and ourselves in the design of the building are as follow:—

(1) The complete building, including the old, had to be designed to accommodate a population of approximately 10,000 persons.

(2) Transportation had to be provided to take this large number of people to their various departments within a period not exceeding 45 minutes. To meet this requirement 32 high speed passenger elevators were necessary.

(3) Provision had to be made for serving lunch every day to 10,000 people within a period of two hours.

For this purpose cafeteria and dining room space had to be provided on the 6th floor, the 5th floor and the 2nd basement totalling 44,000 square feet, including 10 fully equipped cafeteria counters each 50 feet in length.

To serve these cafeterias and dining rooms 33,000 square feet had to be provided for kitchens, bakery, serving pantries, dishwashing rooms, dry and cold storage rooms and refrigerating plant.

This lunch room accommodation was required to be divided into three main heads, in each case the sexes being served separately.

(1) General staff cafeterias (6th floor).
(2) Chief clerks' and divisional heads' dining-rooms (5th floor).
(3) Building operating and cleaning staff cafeteria (2nd basement).

Two freight elevators have been provided at the northend of the building for kitchen service only.

(4) Accommodation had to be provided for handling the very considerable shipping and mailing requirements of the company. For this the main shipping department has been located in the 1st basement approached from Mansfield street by means of an easy ramp.

Former Head Office Building.

Two general freight elevators have been provided and located near the shipping department.

Two of the 32 passenger elevators are equipped to serve as postal cars for ordinary inter-departmental communication and for distribution and collection of mail. The main mailing room is in the 1st basement close to these postal cars and to the shipping room.

Provision has been made for a system of pneumatic tubes consisting of 26 stations with possible expansion. This will give rapid inter-departmental communication.

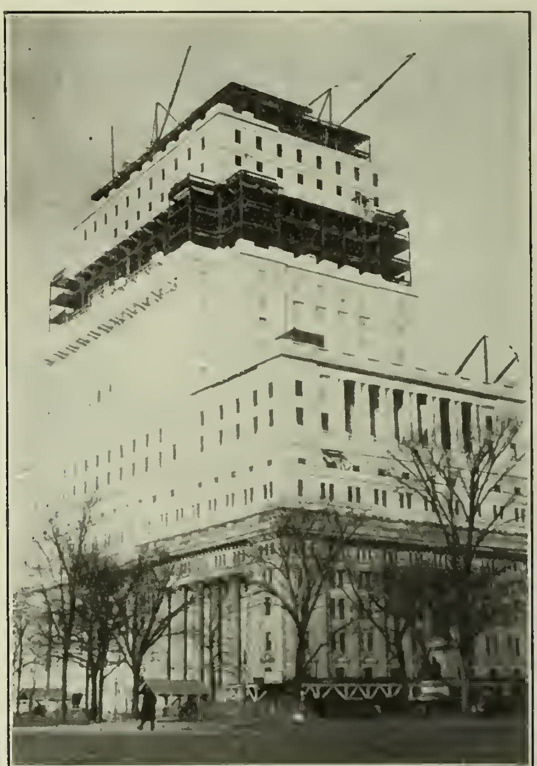
(5) Considerable space was required for the company's medical services, consisting of examination rooms, wards, treatment rooms, X-Ray and dental clinics.
(6) Provision had to be made for a large assembly hall capable of seating approximately 1,000 people, with a fully equipped stage, dressing room accommodation and a projection booth for moving pictures.

Space was also required where badminton, basketball and other games could be played by the staff after office hours. For this purpose a large playroom and several bowling alleys have been provided with fully equipped dressing room accommodation, totalling 17,000 square feet. The playroom is 126 feet by 58 feet and 26 feet 6 inches in height.

(7) Accommodation for the chief executive officers of the company has been provided on the 21st and 22nd floors, together with a board room and committee rooms. Dining rooms for the use of the chief executive officers have been arranged on these floors. They are served by adjacent kitchens entirely independent of the main kitchens on the 6th floor.
(8) Extensive filing accommodation was necessary—the active file room in the 1st basement is 52 feet by 150 feet (7,800 square feet) and the inactive file room in the 2nd basement is 50 feet by 208 feet (10,400 square feet).
(9) The boiler plant, it was early decided, was to be located apart from the building on the east side of Mansfield street at the corner of Cathcart street, but provision had to be made in the building itself for the very considerable mechanical plant necessary to operate it.
(10) The new work had to be arranged so that its execution could be carried on with minimum disturbance of the old building in which the staff were to continue at work during the building operations.

From the number of large units mentioned above and the diverse character of their requirements it is possible to visualize to some extent the highly involved plan layout which had to be worked into one comprehensive whole. When, in addition, it is remembered that the dominating character of the design was necessarily strict classic, requiring absolute symmetry and balance, it will be seen this was no ordinary problem of plan and design.

We hope and believe that the final solution of the problem will be satisfactory, and, if such should prove to be the case, we wish to make it clear that the success attending our labours will, in great measure, be due to the loyal and able co-operation of the engineers who have helped us to create the building, and whose work is described in the papers which follow, contributed by Messrs. F. A. Combe, M.E.I.C., on the boiler plant, A. H. Harkness, M.E.I.C., on the structural features, J. H. Mencke on the electrical equipment, A. T. Newman on the plumbing and fire protection, and E. A. Ryan, M.E.I.C., on the heating and ventilation.



Present Head Office Building.

In closing we wish to take this opportunity of expressing our very real appreciation of the thoughtful consideration and help given us by Mr. D. L. Macaulay, the Assistant Secretary of the Sun Life Assurance Company in charge of building operations, and by the Associate Architect, A. J. C. Paine, A.M.E.I.C., who has worked with us on this building ever since it was originally started in 1913.

The Structural Engineering of the Head Office Building of The Sun Life Assurance Company of Canada, Montreal.

A. H. Harkness, M.E.I.C.,
Harkness and Hertzberg, Toronto, Ont.

Paper presented at the Annual General and General Professional Meeting of The Engineering Institute of Canada, Montreal, Que., February 4th, 5th and 6th, 1931.

SUMMARY—The paper deals with the design and erection of the structural steel work for the new head office building of the Sun Life Assurance Company of Canada, in Montreal. Many interesting features of the work are due to the fact that the original office building, eight storeys in height, had to be incorporated in the new twenty-eight storey building, without interruption to the work of the offices contained therein.

The entire new building occupies a site 214 feet by 428 feet 6 inches, and rises to a height of nearly 400 feet above sidewalk level. The whole work involved the fabrication and erection of more than 18,000 tons of steel. The walls of the building are of granite backed with brick and the floors are of long-span concrete slab construction. Many of the columns in the original building had to be reinforced to take the increased loads, notwithstanding which the work was successfully carried out without interruption to building services.

Special methods of foundation work had to be employed, and a number of the original column bases had to be replaced. The erection of the steel for the new portion of the building presented no unusual problems, but the alterations in the old building involved a large amount of field work, and had to be carried out under difficult conditions.

The original portion of the head office building for the Sun Life Assurance Company is situated on the north side of Dorchester street between Metcalfe street on the west and Mansfield street on the east with a frontage on Metcalfe street of 144 feet 6 inches, on Dorchester street of 214 feet and on Mansfield street of 139 feet, the east end of the building being 5 feet 6 inches narrower than the west end. This building, 144 feet 6 inches by 214 feet, was 8 storeys high with a set back of about 5 feet at the fifth floor level. It was of steel frame skeleton construction, with the columns and footings designed for a 16-storey building. The floors were of tile arch construction with about 6-foot spans. This building was constructed under two different contracts, the westerly 144 feet being finished about 1913 and the easterly 72 feet during 1922. The location and size of the old building are shown on the general foundation plan, Fig. 1.

The new addition to the building extends north between Metcalfe and Mansfield streets, a distance of 284 feet, making the size of the entire building 214 feet by 428 feet 6 inches. Including three duct floors and the pent house, the building is 28 storeys high, rising to a height of 390 feet 11 inches above the ground floor, which is about 9 feet above the level of the sidewalk on Metcalfe street. Three basements, 16 feet, 14 feet and 14 feet respectively, make the lowest basement floor 33 feet below the level of the sidewalk. Up to the eighth floor the building covers the entire area of the lot except for an offset of about 5 feet at the fifth floor. The tower portion starts from the eighth floor and is 16 storeys higher with 3 storey wings up to the eleventh floor extending to the north and south. The main part of the tower is 171 feet by 240 feet up to the nineteenth floor, at and above which two other offsets occur. The outline of the plan of the tower is shown on the foundation plan, Fig. 1.

The walls of the building are of granite backed with brick. The granite facing is in 5-inch and 9-inch thicknesses bonded with 4 inches and 8 inches of brick, the brick backing carried about the steel columns for fireproofing. The walls are furred on the inside with tile furring blocks. The floors are of long span ribbed slab concrete construction, the usual span being about 16 feet. Beams under 18 inches deep are fireproofed with concrete. Those 18 inches deep and over, are fireproofed with terra cotta up to the bottom of the ribbed slabs which are carried on the fireproofing. Generally, the floors are finished with one and one half inches of concrete on three and one half inches of Haydite concrete fill to provide for the electric conduits.

The relation between the new and the old building is shown in the reproduction of the photograph of the west elevation, Fig. 2, the old building being that portion of the elevation on the lower right-hand corner, seven bays wide and 7 storeys high. The south two bays of the tower extend over the north two bays of the old building, so that the north three rows of columns in the old building carry from 22 to 26 storeys of floors and walls instead of the 16 for which they were designed. As a consequence most of the columns and footings of the north three rows required to be reinforced. This photograph shows the offsets in the north and south elevations occurring at the fifth, seventh, eleventh, fifteenth, nineteenth and twenty-second floors. None of these offsets occur at columns so that they all had to be carried on girders. The east and west elevations had corresponding offsets except at the eleventh floor for the tower portion. On these elevations the offsets to the walls of the tower occur at the seventh floor and are to lines of columns. Altogether, there are two hundred and twenty-three beams, girders or trusses in the building carrying columns.

The first contract for the addition to the building covered its construction up to the eighth floor. On account of the Sun Life Company occupying certain buildings on Metcalfe street on the west part of the lot which they could not vacate until new room was provided, the east half of the building was started first, and partly finished before the west half was started. The contract for the tower portion was subsequently let so that the construction of the building has proceeded almost continuously except for a short stoppage in the fabrication and erection of the steel. The steel work in the extension to the building amounts to approximately 16,000 tons and in the old building to 2,550 tons, making a total of 18,550 tons.

The columns in the outer walls for the lower portion of the building, which generally extend only to the seventh floor level, carry moderate loads, the maximum of which is 940,000 pounds. These columns were carried at the street level on concrete piers forming part of the basement walls. They rested on steel slabs figured at a bearing of 600 pounds to the square inch on the concrete. The columns were anchored to the concrete by anchor bolts which extended up through holes in the slabs to the column base. All interior columns rested on a bed of 1:1:2 concrete which was just thick enough over the rock to provide a level bearing at the correct elevation, the rock having been excavated to the nearest seam below. The loads on some of these columns amount to over 4,000,000 pounds. The slabs were designed for a bearing on the concrete of 1,200 pounds per square inch. The tops of the concrete pads were made level, and the bottoms of the steel slabs were planed and set on the concrete without grouting. The slabs were not anchored as they were large enough in area and heavy enough to hold the columns upright during erection, the columns being bolted to the slabs with studs tapped into the tops of the slabs.

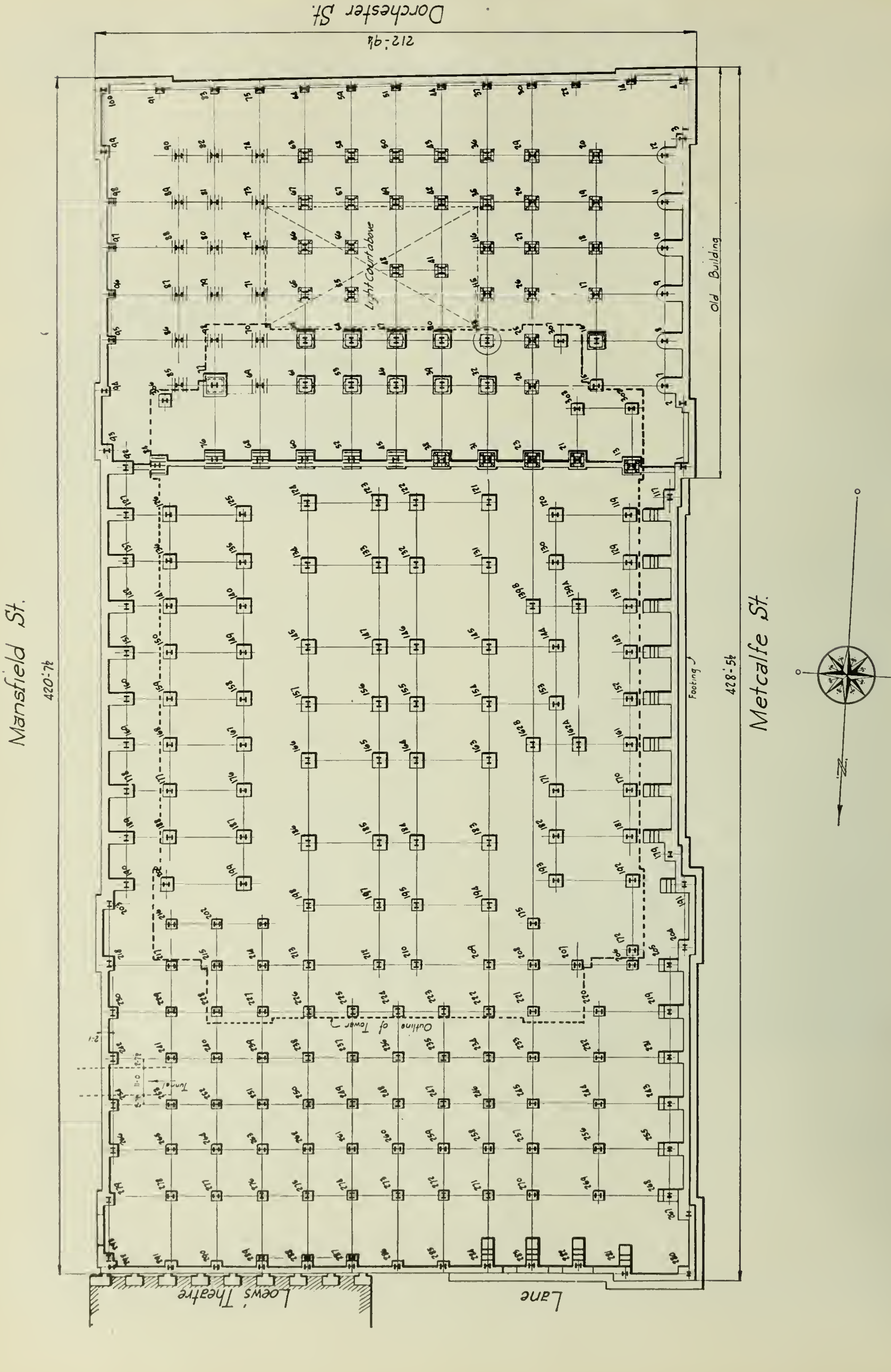


Fig. 1—Foundation Plan, old and new Buildings.

Fig. 2—West Elevation—Building under Construction.

The general excavation for the building extended to a depth of 34 feet below the sidewalk level on Metcalfe street. Approximately 30 feet of this was through a stiff dry clay and the balance through hard rock. For the east part of the building, which was started first, the entire area was excavated to depth and the basement walls and piers constructed as the excavation proceeded. The walls, which were not stable against the earth pressure, required to be shored and the shoring had to be maintained until the westerly portion of the building was constructed. This proved to be difficult and expensive with the full pressure from 35 feet of earth against the walls. To avoid the necessity of shoring the basement walls for the west half of the building they were designed as retaining walls, the piers for the steel and granite columns being given enough projection to provide stability against the earth pressure. (Fig. 3.) This photograph shows the projection of the piers with the offsets at the floor level to take the beams, and the grooves in the sides of the piers and the wall to take the concrete floors. The excavation for this part was done by digging a trench about 20 feet in width along the north and west sides of the lot, to the required depth,

Fig. 3—West Side—Basement Walls designed as Retaining Walls.

the earth being shored directly across the trench until after the retaining walls were constructed. The balance of the excavation for the west half was then finished by the use of steam shovels, a driveway being maintained along the east and south sides of the excavation adjacent to the new east portion already constructed and to the old building for hauling the material to the street.

The sidewalk is constructed of granite slabs from 6 to 7 feet in width, 8 inches in thickness and of a length equal to the width of the sidewalk, 12 to 14 feet. To carry the sidewalk free of the earth a continuous bracket was cast on the outside of the basement wall and a concrete wall was constructed under the outer edge of the sidewalk. Reinforced concrete beams under the joints in the walk spanning from this wall to the bracket on the basement wall were built to take the slabs and also the entrance steps to the building where these projected over the walk. (Fig. 4.)

In the old building there was a basement under the west three bays and a basement and sub-basement under the balance. The steel columns were carried on concrete

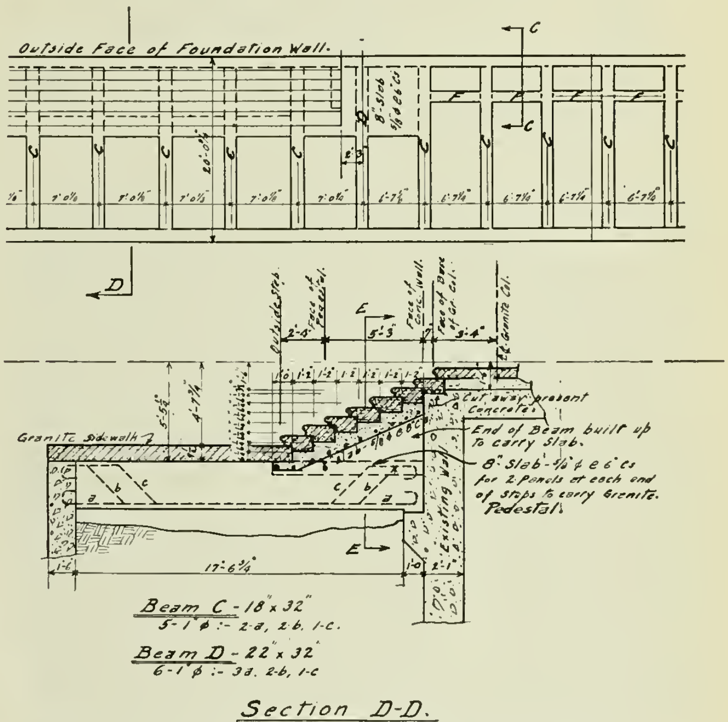


Fig. 4—Plan and Section of Sidewalk and Steps, Metcalfe street.

piers to rock, a distance of approximately 26 feet below the basement and 12 feet below the sub-basement floor. The footings for the columns for the west part constructed under the first contract were circular piers, the columns resting on square cast iron bases. For the east part constructed under the second contract, the piers were square and the columns stood on steel beam grillages. When the north piers of the old building were exposed by the excavation for the extension, it was found that there were thin layers of clay between the upper courses of rock under columns Nos. 52, 60, 68, 76 and 84. After the north wall of the old building was removed and while the columns were shored for reinforcing, the old piers were taken out and the rock underneath excavated to solid material. The steel columns were then extended downwards by the addition of a 12-foot length to each, the old grillage bases being re-used at the lower level. (Fig. 5.) The same condition was found to exist when the rock was exposed under the piers for the west half of this same row of columns

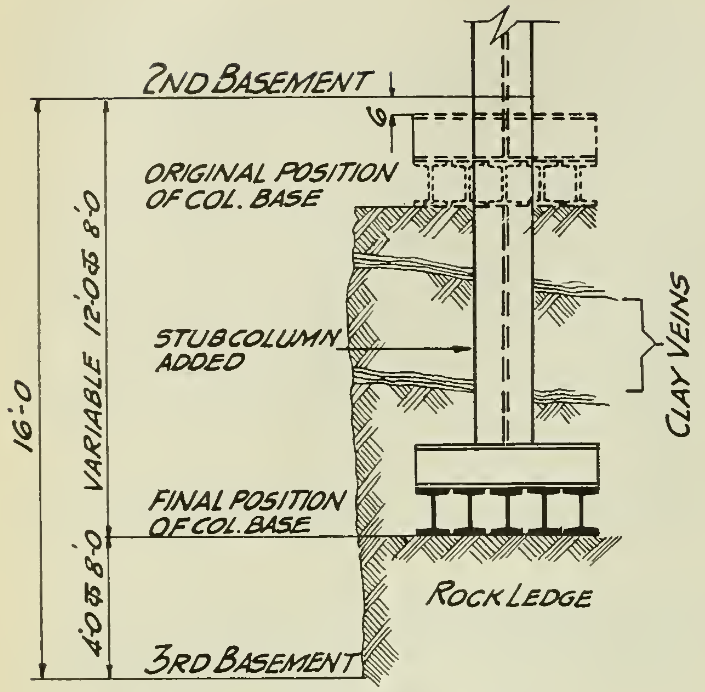


Fig. 5—Downward Extension of Column.

during the excavation for this part of the building. For these piers the columns were shored up, the old piers removed, the excavation carried to solid rock at about the level of the third basement floor and new square piers constructed up to the bottoms of the shored columns.

The old concrete piers for columns Nos. 16, 32, 39, 40, 46, 47, 54, 61 and 62 were 6 feet in diameter and were good for the increased loads on the columns, but the cast iron bases were deficient both in area and strength. These bases were removed, the top of the old pier cut down and replaced with a square concrete cap of 1:1:2 mix to take new steel slab bases. (Fig. 6.) For column No. 33, the final load on which amounts to 2,640,000 pounds, the old pier was increased in area by constructing an annular ring of concrete 2 feet thick about it. The top of the old pier was removed and the total area of the old pier and annular ring covered with a pad of concrete 3 feet thick to take the new steel slab. The footing for column No. 77, which was square, was treated in the same manner. (Fig. 7.)

Practically all the columns in the north three rows of the old building except those in the east and west walls required to be reinforced to take the increased loads from the new addition. These columns were all H-sections, some of which had cover plates. The first ones to be reinforced were columns Nos. 45, 52, 60, 68, 76 and 84 in the north row, which were exposed when the east half of the north wall of the old building was removed. These columns were reinforced by the addition of cover plates to the flanges. This required the cutting out of the old rivets and redriving rivets on the columns which already had cover plates and drilling the flanges of the others. The old spandrel beams carrying the wall were removed, and, after the reinforcing of the columns, replaced by the necessary floor framing. The rest of the columns were reinforced by adding angles or angles and plates to the web as shown in section B-B, Fig. 8. This required the field drilling and riveting of only two lines of holes through the web of a column, instead of four lines through the flanges as would be required for reinforcing with flange plates. The rivets were spaced at 12-inch centres except at connections

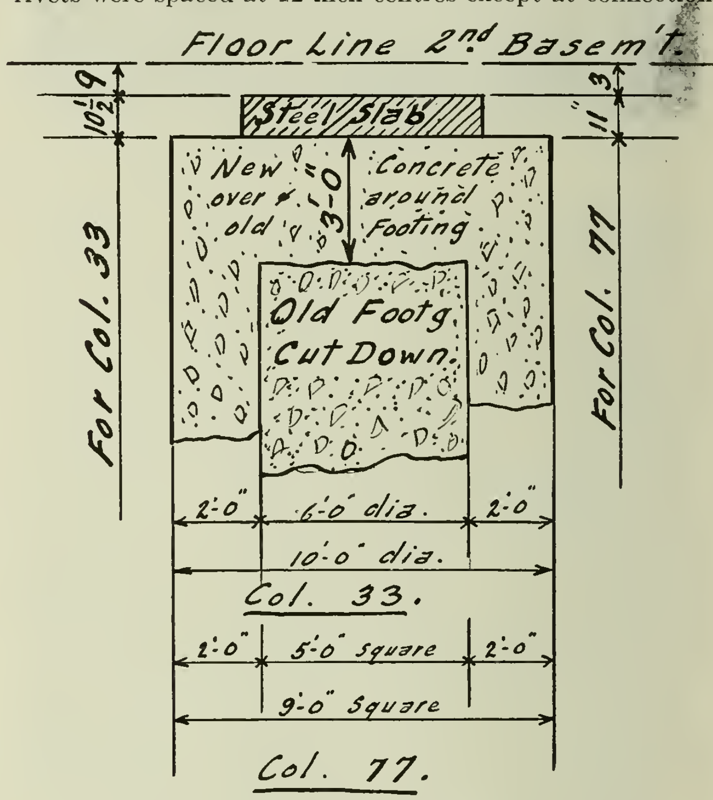


Fig. 7—Section showing addition on to Footings Nos. 33 and 77.

and splices. This method of reinforcing interfered less with the existing beam connections, especially on the columns at the old light court. Beams framing into the web were burned off to clear the projecting leg of the reinforcing angles and were carried on new bracket connections on the flanges of the columns.

At the same time that the eastern portion of the old building was constructed, the light court was shortened by taking a bay off the west end, moving the west wall of the light court one bay east and building in one panel of floors. This wall and the two intermediate columns were carried on a double girder spanning across the light court and framing into columns Nos. 33 and 35 with a span of 48 feet 9 inches. This loaded these columns nearly to the capacity for which they had been designed to provide for additional storeys. These columns were not reinforced at that time for any future additional load such as is now coming upon them, but provision was made for reinforcing for such load by adding reinforcing plates, marked 'A,' Fig. 8, to the flanges of the columns under the connections of

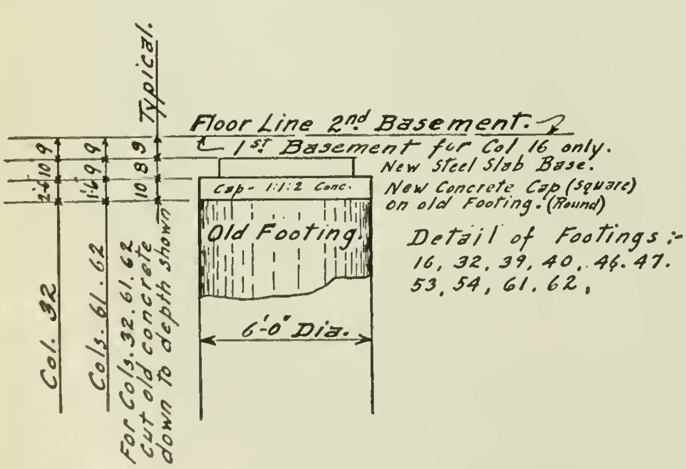


Fig. 6—Reinforcement of Footings in Original Building.

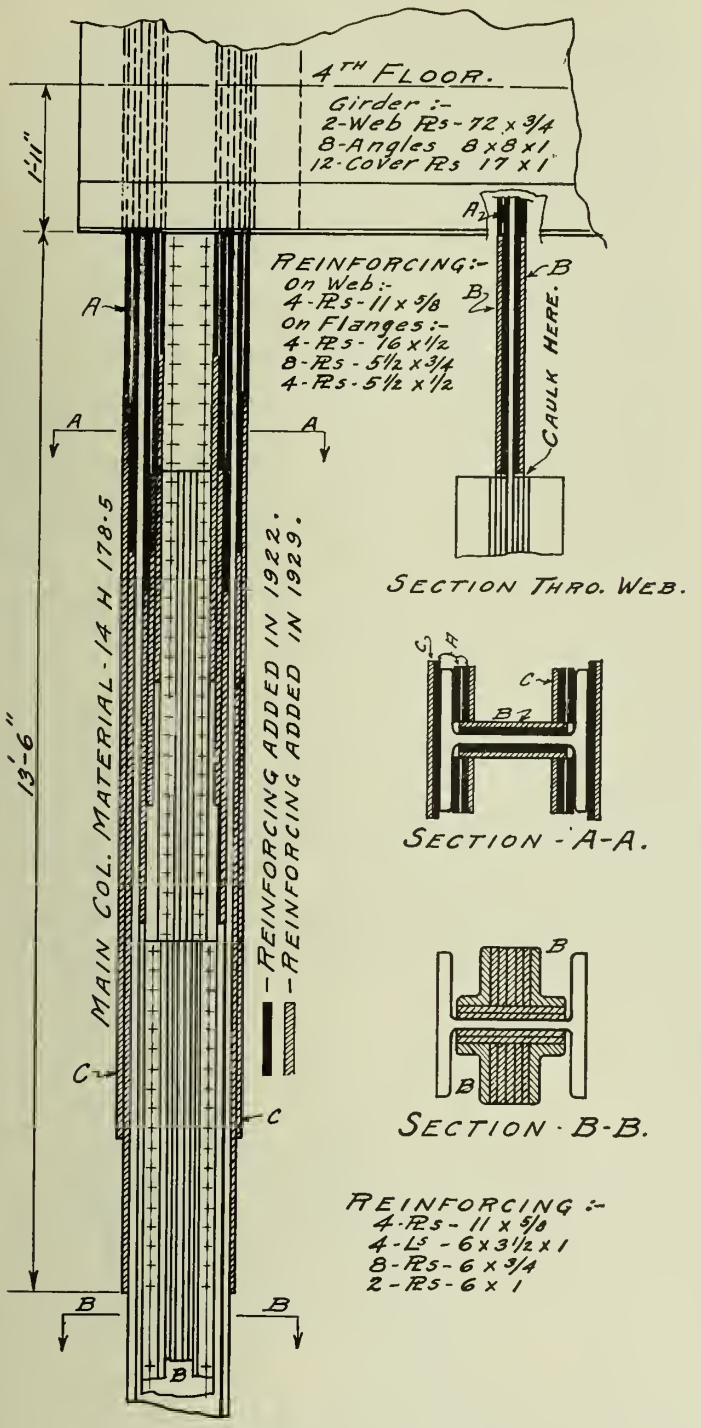


Fig. 8—Reinforcing of Column No. 33.

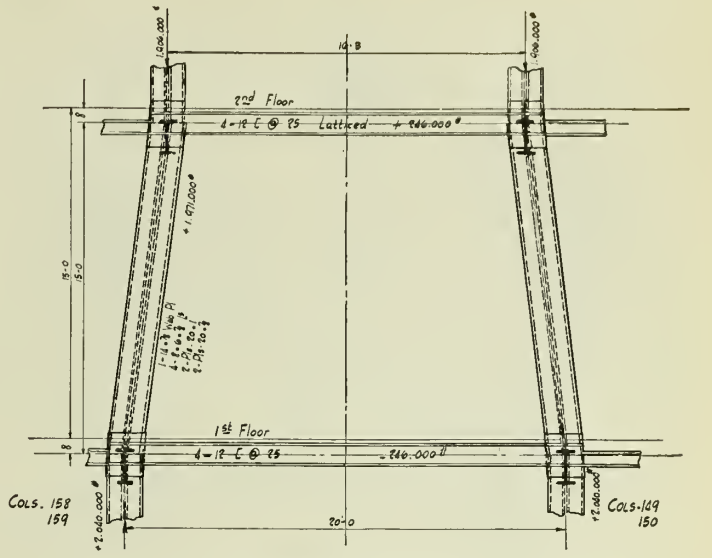


Fig. 9—Details of Sloping Columns Nos. 149 and 158, also Nos. 150 and 159.

the plate girders and to the webs. These plates were staggered in length and faced at the lower ends to bear on reinforcing plates to be added from below from the bottom of the column. The reinforcing used for column No. 33 for the additional load from the tower of the extension consisted of two plates 11 inches by 1¼ inches and four angles 6 inches by 3½ inches by 1 inch on the web with two plates 6 inches by 4 inches between the angles, marked 'B,' instead of plates on the flanges as originally intended. The plates on the webs were brought up to bear under the plates previously provided. New plates 'C' were added to the flanges below the plates 'A' and extended down to lap with the new angle and plate reinforcing a sufficient distance to allow enough rivets to transfer the load from the one reinforcing to the other. As it was impossible to measure and face the web reinforcing plates from below so that they would fit exactly under the plates already on the web, it was proposed to leave these plates about three-sixteenths of an inch short, and caulk the space between the ends of the plates with soft steel wire, then weld over the joint to hold the caulking in place. Before adopting this method a test joint was made in the shop, cut through and planed for inspection. It was found that the round wires had taken a rectangular shape, filling the space perfectly, and it was decided to use this method in the field. The plates, however, came to the field of such a length that they could just nicely be jacked into place making an exact fit so that the caulking was unnecessary.

While a column was being reinforced the stress in it was reduced to zero or near zero by shoring all load off it so that both the old column and the reinforcing would have the same final stress. Otherwise, if the area of the reinforcing were nearly equal to the area of the original column and the original column were loaded nearly to the allowed working stress, the stress in the original column would be 50 per cent. too great and in the reinforcing only 50 per cent. of the allowable stress.

The column spacing in the new building was largely determined by the spacing in the old portion, and as it was impossible to make the spacing in the tower conform to this, there were a great many column offsets. Most of these were made by carrying the upper offset columns on plate girders. There were, however, some exceptions

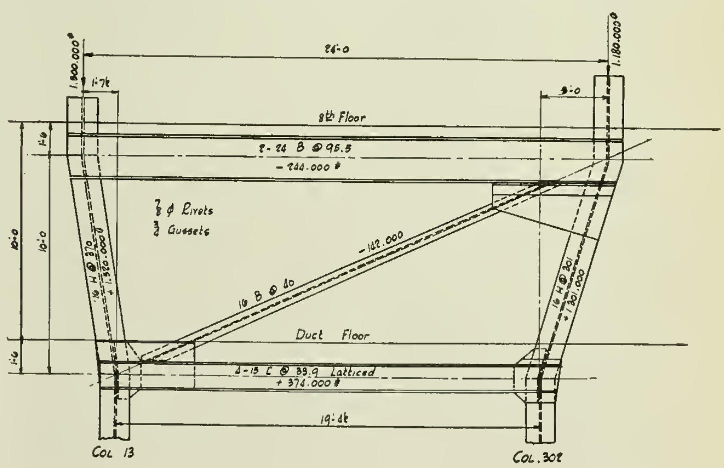


Fig. 10—Details of Sloping Columns Nos. 13 and 302.

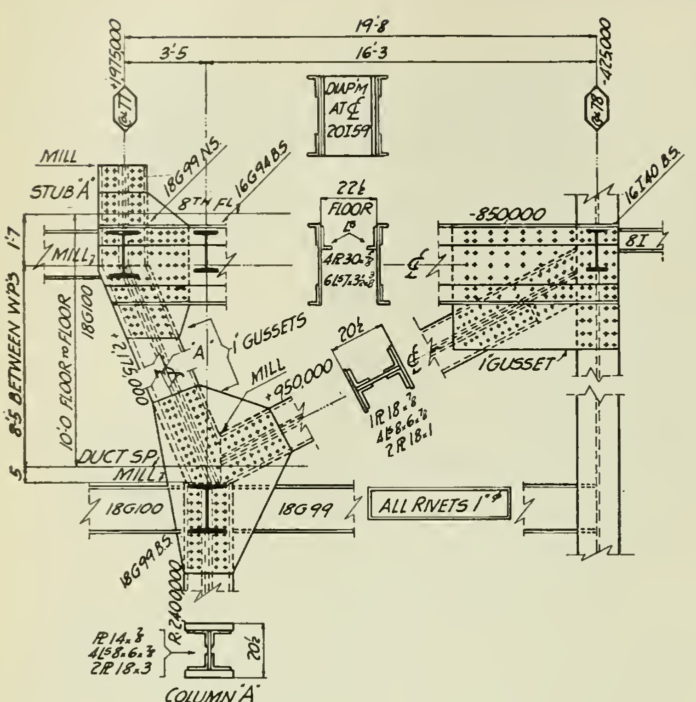


Fig. 11—Truss Between Columns 77 and 78—Duct to Eighth Floor.

to this. Columns Nos. 149 and 158 are spaced at 20 feet centres up to the first floor and 16 feet 3 inches above the second floor. As the loads were the same on the two columns and the construction symmetrical, they were sloped 1 foot 10½ inches towards each other through the first floor, the column splices being faced on the bevel. The sloping columns were tied together across the top and bottom to provide for the horizontal reactions due to the slope. (Fig. 9.) The rigidity of the construction of the building was assumed to be sufficient to provide for any horizontal reactions due to unbalanced loading of the columns. Columns Nos. 150 and 159 are similar.

In the case of columns Nos. 13 and 302 the unsymmetrical conditions, both in regard to loading and spacing, made it necessary to use a diagonal to provide for horizontal reactions. Both columns were carried through the storey height on the slope as shown in Fig. 10, the column splices being faced on the bevel.

Fig. 11 shows a truss construction for columns Nos. 77 and 78 where column No. 77 is cantilevered 3 feet 5 inches in the duct storey height of 10 feet. The direct reactions of the columns are taken by the faced ends, the gusset plates being designed to develop about 40 per cent of the stress. This truss was assembled and riveted up in the shop, the splice for column No. 77 at the eighth floor being provided for by a stub end.

In order to provide a large entrance hall from the Metcalfe street entrance, columns Nos. 144 and 152 of the typical framing were omitted from the ground and first floors. The framing for the second to seventh floors was hung from a double plate girder in the duct space under the eighth floor carried on columns Nos. 139 and 162 with a span of 48 feet 9 inches. The hangers were attached to the girders at the 16-foot 3-inch panel points by plates which form part of the webs and project below the bottom of the girder for riveted connections. These plates pass through slots burned in the cover plates on the lower flange of the girder. The hangers were made of H-column sections and were used as columns for the erection of the floor steel. They also made convenient sections to take the beam connections for the floor framing. Columns Nos. 144 and 156, extending up to the twenty-fourth floor, and each carrying a load of 1,470,000 pounds, stand on this double girder, at the panel points, making the total load at each of these points 2,200,000 pounds. Columns Nos. 139 and 162 which carry the girder stand on trusses at the second floor carried on columns Nos. 139A and 139B and columns Nos. 162A and 162B at the first floor. (Fig. 12.)

In some cases it was impossible to locate girders between existing columns to carry some of the upper columns for the tower over the old building. Four new columns, Nos. 302, 303 and 307 at the west end and No. 306 at the east end, were carried up through the old building from new footings constructed to rock. Column No. 307 stops at the eleventh floor where it takes one end of a girder carrying column No. 16 offset. Columns Nos. 302, 303 and 306 offset in the duct space under the eighth floor, column No. 302 by means of a truss as already shown in Fig. 10, column No. 303 by means of a cantilevered truss in a similar manner to No. 77 shown in Fig. 11 and column No. 306 by means of a cantilevered plate girder. Where the columns pass through floors the existing steel beams were burned off to provide clearance, and the ends carried on brackets on the columns which were erected by being dropped down from above.

The first offset in the old building occurs at the fifth floor, where the walls and wall columns for the fifth and sixth floors are set back about 5 feet from the face of the building. These walls and columns are carried on beams in the fifth floor. Owing to architectural alterations the loads on these beams were increased, making it necessary to reinforce them. Where old columns standing on top of the beams were replaced by new ones the beams were reinforced by adding cover plates to the top and bottom flanges after the old columns were removed. Where the old columns remained in place, making it impossible to

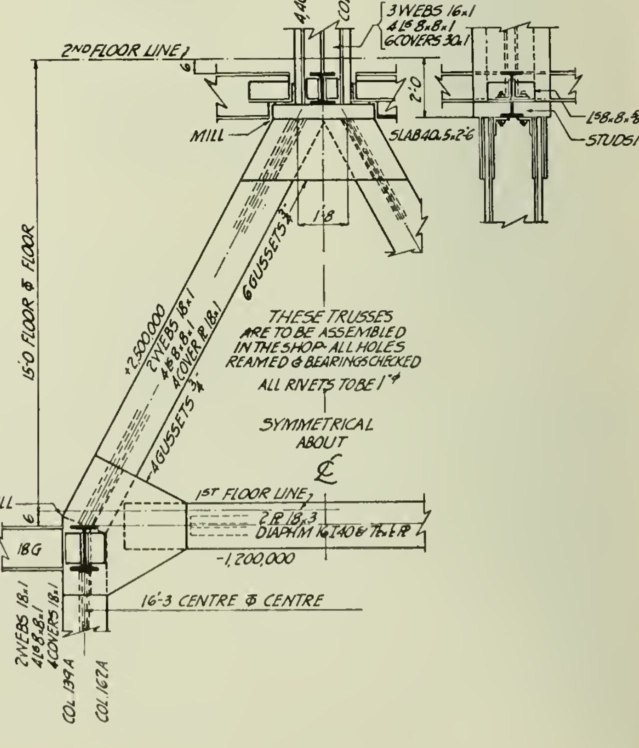


Fig. 12—Truss Carrying Columns 139 and 162.

add cover plates to the top flanges, the beams were reinforced by placing new beams underneath and jacking them into contact throughout their length so that both beams would have the same deflection and each one would get its calculated proportion of the load.

In the erection of the steel for the addition there were no new nor unusual problems. In order to cover the large area of the building, eight derricks were used to erect the steel and spaced so as to accomplish this purpose. The steel was brought to the job only as required for each derrick and immediately erected.

The alterations in the old building, which required the reinforcing of columns, the extension of certain columns downward to new footings, the replacing of old bases by new ones, the removal of steel for the old roof, seventh and part of sixth floors and the reinforcing of the beams over the fifth floor, made a great amount of field work necessary. This work all had to be done while the building was occupied by the staff of the Sun Life Company. For part of the time it was possible to get the use of all floors above the second for the two north bays. Columns which were being reinforced through rooms occupied by the staff were boxed in by sheeting covered with paper.

In order to relieve the column of load so that the stress in the column would be reduced to zero while the reinforcing was being added the floors were carried on vertical posts, one on each side of the floor beam close to the column, and short needles were put across between the posts under the beams. The load from the beams was then taken on the needles by driving wedges between the needles and the bottom of the beams. The shoring was generally carried up five or six storeys. Above this the unit stress in a column was small enough to be neglected. When the shoring was done on the north row of columns the masonry wall had been removed, so that the loads were comparatively small. This method of shoring held the columns while the reinforcing was being added and also while the new footings were being put in place.

It was necessary to replace eleven of the old cast iron bases by new steel slab bases. This operation was one of the most interesting on the building. The columns had to be lifted clear of the old footings, the old cast iron bases

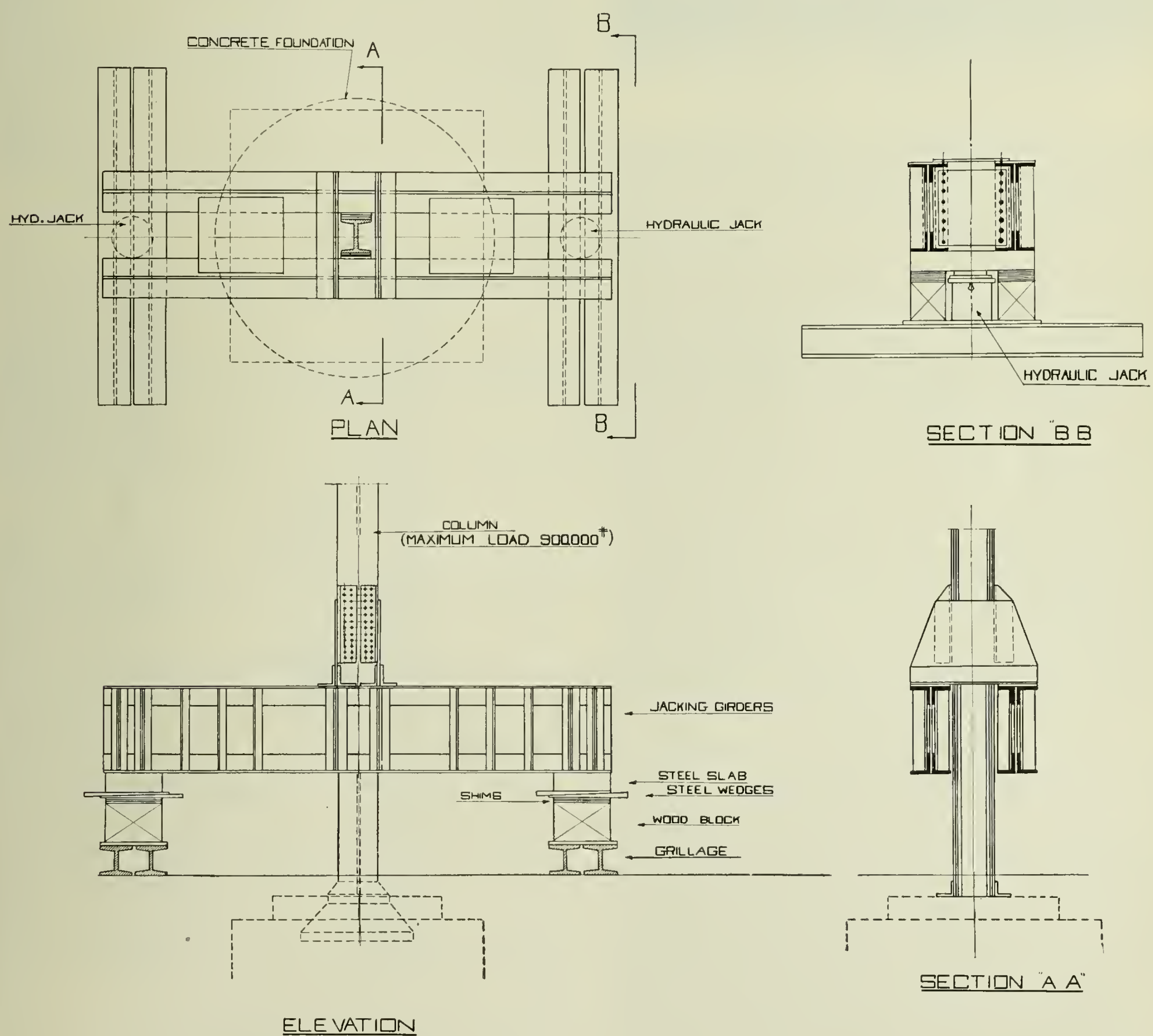


Fig. 13—Arrangement of Girders for lifting Existing Columns.

Fig. 14—Method of Anchoring Top Cornice.

removed, the new concrete footings prepared and the steel slab put in place. On the interior columns, while a portion of the load was removed during this work, such as partitions and the fireproofing on the columns, the loads remaining were still of some magnitude, the maximum being 900,000 pounds. In order to lift a column free from the base ninety-six holes were drilled through the flanges about 8 feet above the basement floor for the connection of heavy steel brackets, the holes in the brackets and the columns being drilled from the same steel templet. The brackets, Fig. 13, bolted to the flanges of the column, projected beyond the column to take the lifting girders. The brackets were made with connection angles on them, with the same spacing of holes as through the web so that they could be bolted to the column with the web plate of the bracket to the flange of the column, or at right angles to this direction with the angles to the flange of the column. This made it possible to connect the brackets to suit the most convenient direction in which to place the girders. The girders were 36 inches deep and 18 feet long, made of silicon steel and designed for a stress of 30,000 pounds per square inch. They were placed one on each side of the column under the brackets, and were carried at each end on a steel slab 24 inches wide, 4 feet 4 inches long and 8½ inches thick planed top and bottom. Each steel slab was carried on two heavy wooden blocks reinforced with heavy angles bolted to each corner. The blocks were spaced far enough apart to allow room for 285-ton hydraulic jacks between them. Steel shims and steel wedges were used on top of the wooden blocks and these were driven tight as the jacks took up their load. The blocks and jack were carried on a base of two 12-inch column sections about 12 feet long laid directly on the concrete basement floor. With the heaviest lift the load on the soil was about 8 tons per square foot. When the column was lifted by the jacks to free the old base, the girders were shimmed up by driving in the steel wedges on the wooden blocks, after which the base could be removed. The old cast iron base was then taken out, the new concrete top to the pier poured, and after setting, the new steel slab was put in place under the column. It was shimmed up tight to the bottom of the steel column and grouted in place, the grout being worked back under the base by drawing a chain back and forth from side to side until the grout showed up in a hole drilled through the base near the centre. After the grout had set, the column was let down on the new base. Most of this work was done in and about the boiler room, a good part of which space was filled with pumping and ventilating equipment, steam mains, water mains and electric conduits, all of which had to be kept in full operation during the progress of the work.

The main stone cornice of the building at the fifth floor level projects about 5 feet beyond the face of the wall. The top course of the cornice is 2 feet thick. The overhanging portion weighs approximately 2,000 pounds per lineal foot and required very secure anchorage. The method of providing this is shown in Fig. 14. The cornice is tied back by 1-inch diameter rounds, and the back is prevented from tipping up by plates bolted to the top flange of the 15-inch channel.

Messrs. Cook and Leitch, who were the general contractors on the building, and the Dominion Bridge Company, who had the contract for the fabrication and erection of the steel, were responsible for the carrying out of this work, and some of the problems presented to them in connection with the shoring of the columns seemed to defy solution. That in connection with the shoring of columns Nos. 33 and 35 was particularly difficult. The space about column No. 35 in the basement was completely filled with pipes, some of which had to be moved before the shores could be put in place. Most of the load came

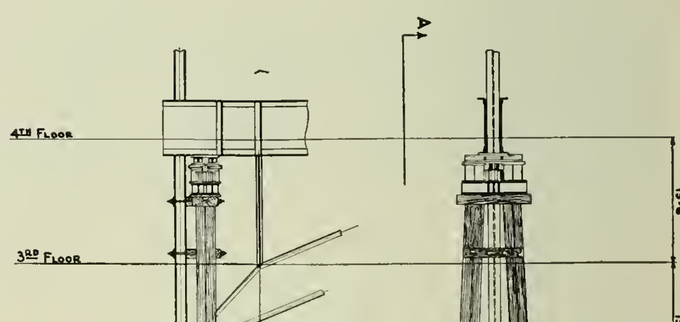


Fig. 15—Method of removing Load from Column 33 during Reinforcing Operations.

on these columns from the large girders on the fourth floor at the west end of the light court. This load was picked up by shoring from the basement floor with a bent under each end of the girder, a distance of approximately 75 feet to the bottom of the girder. Each bent of shoring consisted of two legs, one on each side of the column, each leg built up of four 12-inch by 12-inch timbers bolted together. The legs were tied together by cross braces and the bent anchored to the column as shown in Fig. 15. The end of the girder was then lifted by means of a hydraulic jack on top of the bent, after which the reinforcing was put on the column as previously described.

It is interesting to note the development in the mill, shop and erection practice, as exemplified in this building, between the time when the first portion was designed about 1912 and the present. In 1912 the maximum size of beam obtainable was a 24-inch I-beam at 100 pounds per foot with a section modulus of 198.4. When the design of the final extension was started the maximum size obtainable was a 30-inch girder section at 200 pounds per foot with a section modulus of 617.8. Before the design was completed 36-inch girder sections at 300 pounds per foot with a section modulus of 1103.6 were being rolled. Many of the heaviest weights of beams and girders have been used in this building to carry offset columns which otherwise would have required plate girders. There has been a change in the size and weight of rolled column sections obtainable from a 14-inch H at 287.5 pounds to a 16-inch H at 427 pounds. The change in the design of the cross-section of beams and columns and the addition of new and intermediate weights has resulted in great economy in the design and fabrication of steel. In the first part of the old building cast iron bases were used for the columns, in the second part steel beam grillages and in the new extension rolled steel slabs, the use of each type being the general practice at the time it was used. The use of heavy sections has made it necessary for the shops to resort to drilling to a greatly increased extent and the facilities for this work have been very much improved, so that now there is but small difference between the cost of drilling and punching. The use of electric welding is becoming fairly general both in shop and field and the time may be anticipated when all field work will be welded to avoid the noise nuisance.

In regard to erection much greater attention is being paid to the organization of the work. The fabricated material is carefully assorted in the piling yard so that each tier for each derrick can be shipped in one lot and reach the site just in time to be put in place as arranged according to the erection schedule. The use of stiff leg derricks for the erection of the first portion of the building has given way to the use of guy derricks for the subsequent work.

Mechanical Equipment in the Head Office Building of the Sun Life Assurance Company of Canada, Montreal

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Paper presented before the Annual General and General Professional Meeting of The Engineering Institute of Canada, at Montreal, February 4th, 5th and 6th, 1931.

SUMMARY.—The heating, ventilation and refrigeration equipment of the Head Office building of the Sun Life Assurance Company, Montreal, has been laid out with reference to the services needed in this large 27-storey building used for institutional and office purposes. Forced circulation hot water is employed for heating, with three distinct circulating systems, one for each of the three zones of the building. The building is mechanically ventilated throughout with washed and conditioned air, and in many parts an interesting system of "punkah" inlets has been used, with means for obtaining automatically a periodical variation in the intensity of the air-movement in the office spaces. In this way, through relatively small nozzles, capable of directional control by the room occupants, secondary currents are induced in the air of the room, resulting in thorough mixture. In order to diminish the operating expense for a ventilating system of this magnitude, re-circulation of treated air, and heat interchange between the outgoing warm air and incoming cool air are employed.

There is an extensive ammonia refrigerating plant, principally for the service of the kitchens and cafeterias, the ammonia lines being kept within the confines of the plant proper and the brine circulation being under thermostatic control. Provision is made for complete control and supervision of the mechanical and electrical plants from a central office, with the aid of distant-indicating thermometers, electrical alarms, and remote control switches.

The architectural characteristics, structural features, sanitation and electrical details of this notable structure are being dealt with in other papers at this meeting. The following notes will treat of the mechanical equipment connected with its heating, ventilation, and refrigeration. The building occupies a lot 435 by 220 feet and contains 3 storeys under ground and 24 storeys above ground, together with three full storey duct spaces. Mechanically it may be considered as divided horizontally by the duct spaces into three zones, referred to hereinafter as the low level, intermediate level and high level zones. All of the services in the building have been based on a population of ten thousand persons. As regards the heating and ventilation, the arrangements are unique in many respects, for the building is heated throughout by means of hot water, it is mechanically ventilated throughout, and the systems of air distribution are along lines dictated by the most recent research in this field both in Europe and America. By means of a system of heat recovery the outgoing vitiated air exchanges a portion of its heat with incoming fresh air, and the requirements of a climate peculiar to the locality are provided for in cleansed humidified air by the installation of a special type of air-washer-humidifier. The economical supervised operation of the various systems is assured by the measuring, indicating and control instruments installed for the numerous services which are included in the building.

Finally, the principles underlying the design of the necessary equipment and the restrictions governing the choice of apparatus as to its origin and manufacture are worthy of mention. A sound policy of balancing first cost with operating costs has been followed throughout, and the stamp of "made in Canada" or "within the Empire" marks the structure in many details.

Heating

In the light of the development today of zone and directional control of heat in large buildings, as also vapour heating at sub-atmospheric pressures to meet outdoor conditions of wind direction, temperature changes, the effects of the sun, etc., it is at once evident that the decision of the company to adopt hot water heating under forced circulation in its original structure was a far sighted one. A very thorough investigation into the matter from the several angles of first cost, operating costs, control, results obtained with other systems, and the particular requirements in a building of this kind for the purpose intended resulted in the conclusion to follow the same principle for the greatly enlarged edifice.

The heating is accomplished by three distinct systems—one in each of the zones. Each system is divided into two

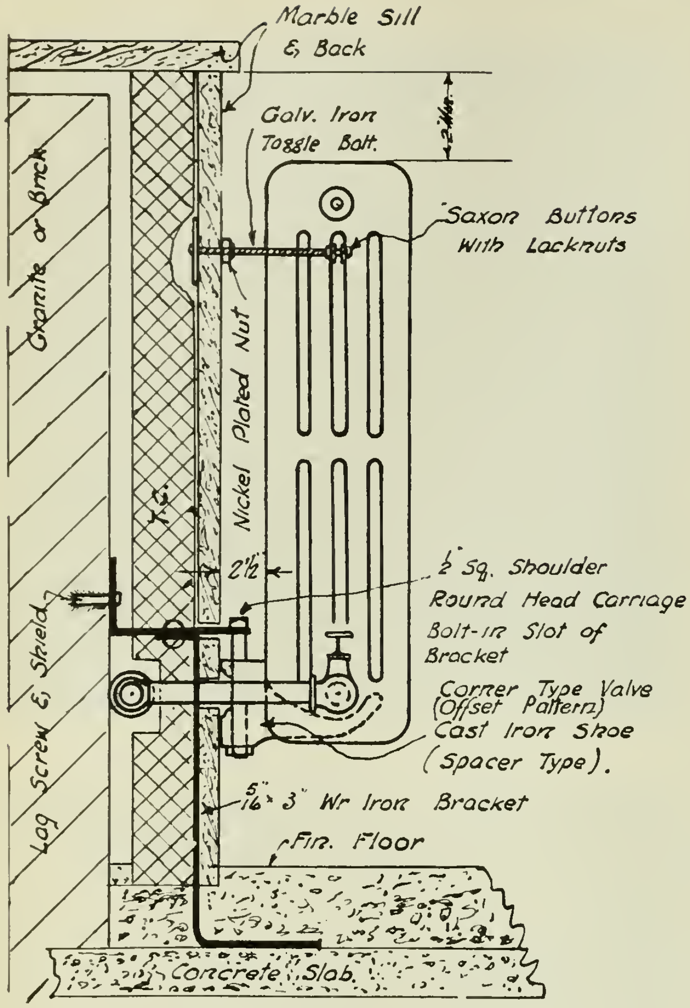

Fig. 1—Typical Detail of Radiator Supports, etc. Lower Zone.

circuits with its own complement of steam heated convertor, pump, control, supply and return main. The distribution is on the overhead main, downfeed principle with supply and return risers. The circuits are so arranged that different water temperatures may be maintained on the wind and lee sides as necessary to meet prevailing outdoor conditions. Hand and remote control of steam to the convertors has been provided. Automatic control of room temperatures is also afforded through a thermostatic system of heat regulation.

In the design of the heating system for the building, because of its proportions, consideration necessarily had to be given to "chimney effect." To this end the floors are cut off one from the other by means of doors at each communicating point, such as stairways, elevator shafts, etc. In determining the heat losses a graduated scale of temperature difference was applied for different levels, and the assumptions for air infiltration through doors and windows were varied according to their elevation. The heating of the entrances on the ground floor gave rise to extensive study because of the many factors involved. Special consideration had to be given to excessive air infiltration at this low elevation as also to the large entry of outside air in certain very short periods of time corresponding to the entry and exit of the large staff. At the same time the architectural treatment imposed restrictions on the arrangements possible of adoption.

In general, the radiation is of the cast iron column type, exposed, except in specially treated rooms where it is concealed. To meet the pressures of water obtaining at certain elevations, the radiators are of extra heavy construction and were subjected to test pressures correspondingly higher than is customary on standard radiation. Thought was given to the use of concealed radiation throughout the building—a practice that has been followed in the case of certain recent prominent buildings, but this was deemed unnecessary because of the low temperatures generally maintained in a hot water system, and the well-known objection to concealment in so far as cleanliness and cost is concerned. In the lower zone the radiators are of the legless pattern, and supported on brackets bolted into the masonry, of special design. (See Fig. 1.) In the upper zones this arrangement was not followed, and the radiators are of the floor standard type with legs of special height to afford easy cleaning. In all cases, how-

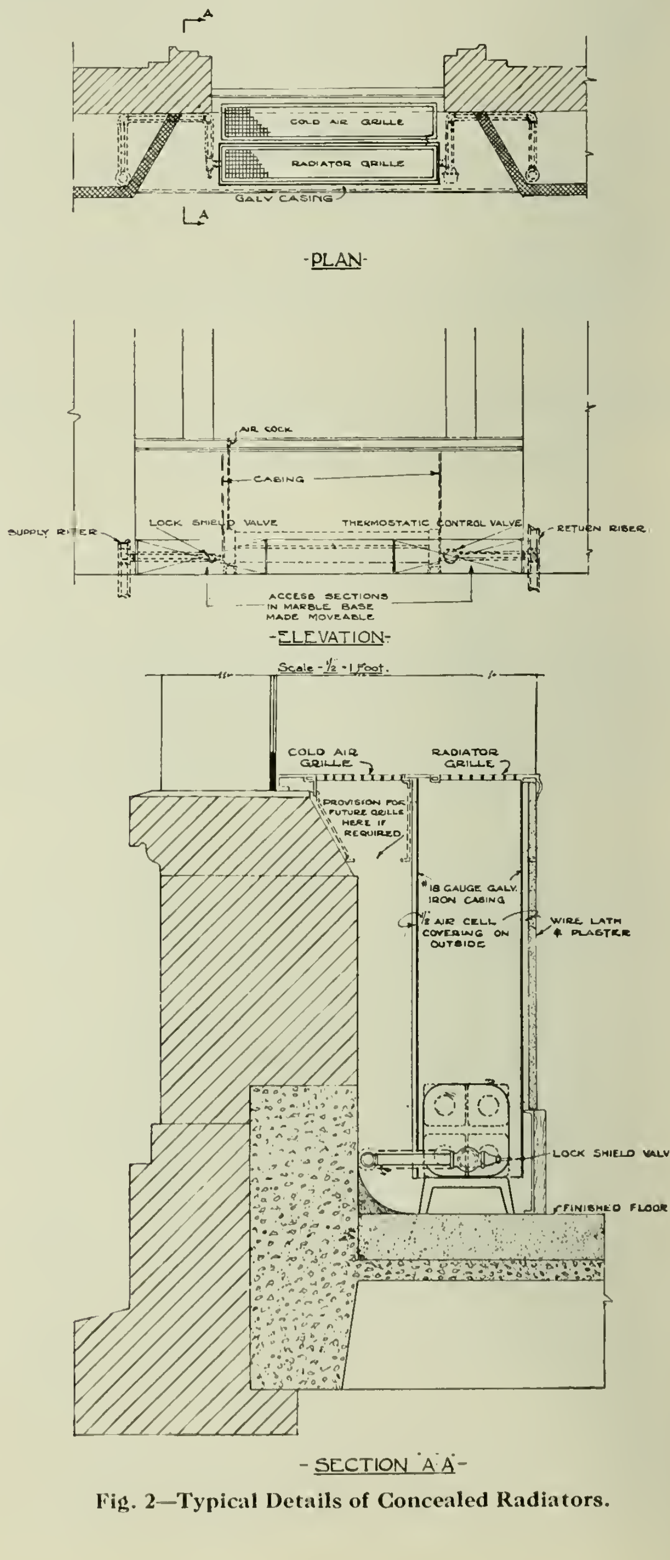

Fig. 2—Typical Details of Concealed Radiators.

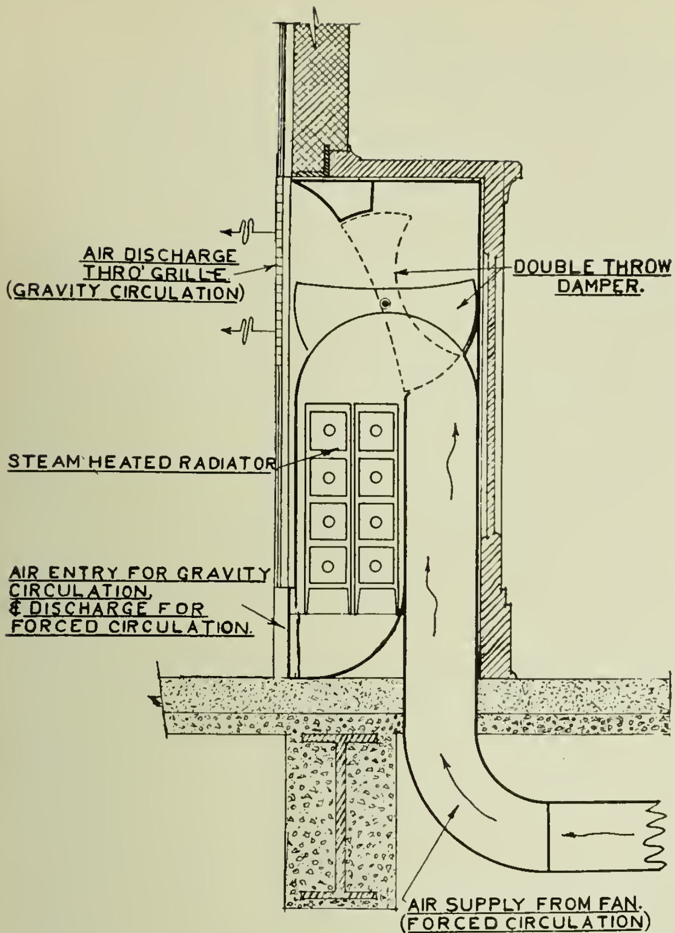

Fig. 3—Typical Detail of Heating Units. Main Entrance Halls.

ever, the radiator connections are brought through from the wall, and not through the floor—as is commonly done.

To meet the conditions arising out of large high windows at certain points, a special design of radiator compartment and baffling was evolved. This employed the combination of cold and hot air compartments with provision to avoid the deflection of cold air currents off the large glass surfaces towards employees occupying positions nearby, as shown in Fig. 2.

The main entrances are provided with individual systems of hot air heating, utilizing re-circulation principles as far as possible. The air is mechanically propelled over concealed steam radiators in enclosures of special design, as shown in Fig. 3. When desired, these radiators may be operated on gravity air circulation.

In order to ensure against sedimentation in the piping systems, which are for the greater part concealed, advantage was taken of the presence of a soft water system in the steam plant. The "make-up" to the heating systems is derived from this source.

Another provision which was made to facilitate rapid emptying of the piping systems is the arrangement of circulating pumps so that they may be used for "pump-out" purposes.

Ventilation

The necessity of comfortable healthy air conditions was appreciated from the beginning by the executives of the company. As a result of years of experience with large staffs they considered it imperative to reduce to a minimum the occasions of "absenteeism" due to necessarily sedentary work indoors. It is believed that this company has given as much, if not more, consideration to this factor than any other institution in the world. The services of its medical officers, engineers and operating staff have been combined in efforts to investigate, determine and maintain the very best working conditions possible. Much experimental work as regards ventilation has been carried out in the original building, careful records have been kept and as a result rules have been laid down for those responsible for the ventilation systems.

Because of the high degree of occupancy, the large interior working spaces distant from outside communication, etc., there was but one available means of fulfilling the requirements,—i.e., mechanical ventilation. The local and very varied climatic conditions make proper humidity control essential, and hence the air circulated throughout is washed and humidified. Owing to the nature of the work performed by the employees, the fixed seating arrangements, etc., the air distribution and circulation had to be arranged in a manner that would avoid noise or draughts. Because of the relation to adjacent buildings or those likely to be erected in the future, great care had to be exercised in the location of intakes and discharges to avoid introducing air already contaminated by smoke or odours and to prevent possible differences with neighbours owing to the emission of vitiated air from certain departments, such as machinery rooms, kitchens, cafeterias, etc. All of these factors had their influence on the architectural and structural features, and necessitated intensive study and scheming.

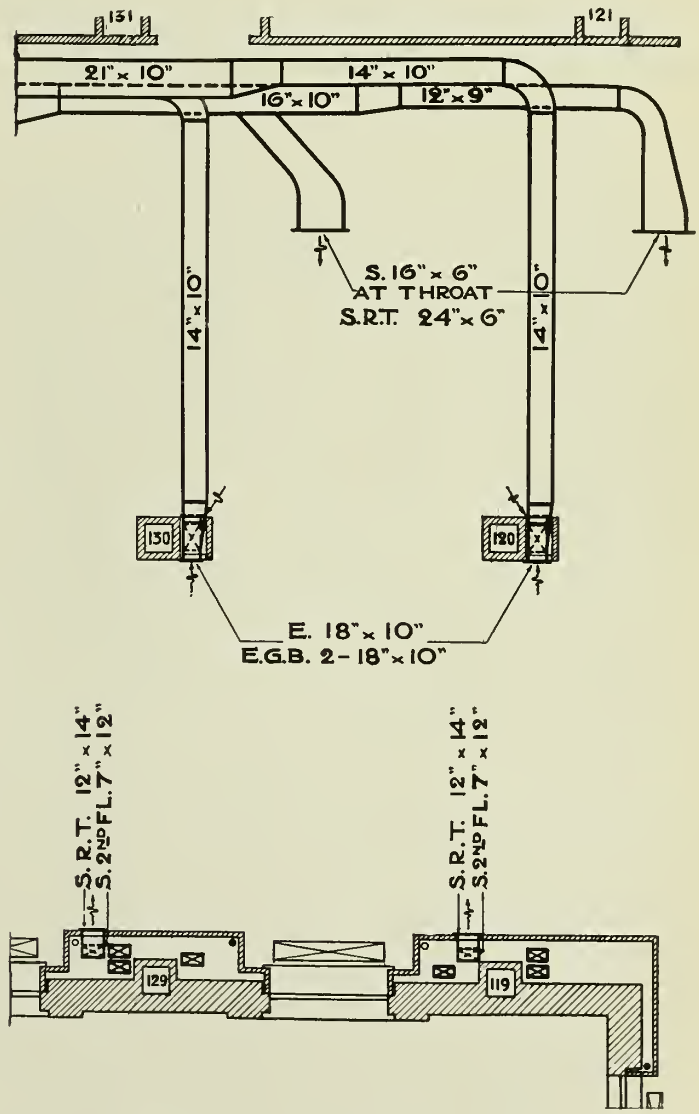

Fig. 4—Part Plan of Typical Floor. Lower Zone.

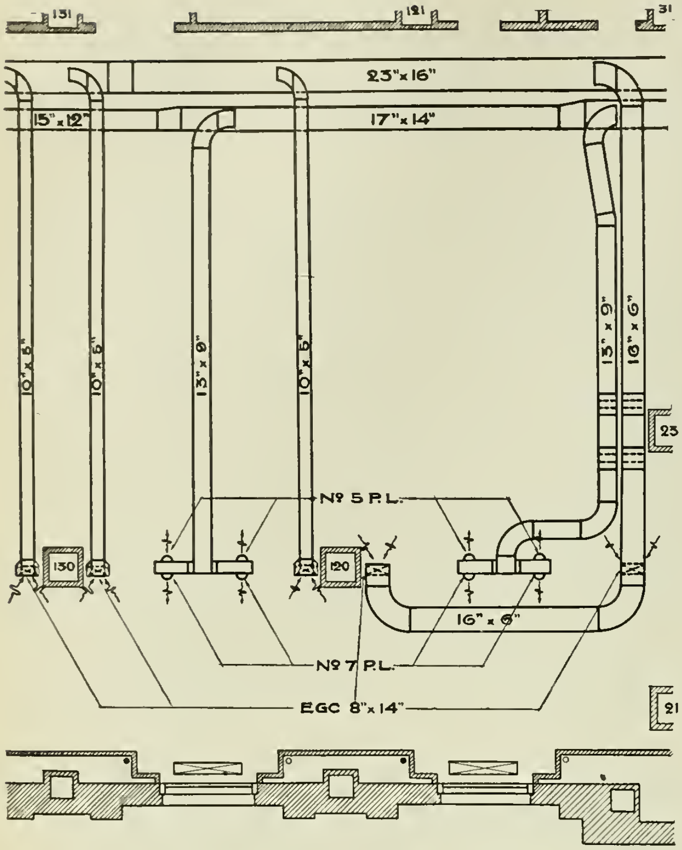

Fig. 5—Part Plan of Typical Floor. Upper Zones.

For years past the need has been recognized of securing better air distribution in ventilated areas. Numerous criticisms have been launched against the systems commonly in vogue, in many instances not without a certain measure of reason. On account of the increasing densities of population in given areas in buildings, engineers have been obliged to increase the hitherto recognized volumes of supply—and this without annoyance from draughts. This requirement resulted in the supply of large volumes at low entrance velocities, and because of restrictions usually imposed by room treatments and design, dissatisfaction or mediocre results ensued, owing to the occurrence of stagnant areas or stratification. Recent research has demonstrated that air motion and turbulence are of greater, or at least of as great, importance as actual change of air.

If asked what constitutes an agreeable condition out of doors in temperate weather the reply of most people will be—a temperature of about 70 degrees with a breeze—not constant, but of *varying* intensity. The breeze may reach a moderate degree of strength, but provided it rises and falls in intensity, it is pleasant. This thought suggested the desirability of varying the static air condition in the occupied areas of the new building, and after various possible methods of obtaining this result were studied, it was concluded that periodic variation of the speeds of the ventilating system fans was the logical solution. This has been accomplished by means of what is termed an "undulating mechanism"—specially developed for the purpose, and, it is believed, used here for the first time. In this mechanism the rheostats of the various fan motors are mounted on a common spindle rotated at slow speed by a small motor, thus varying the fan speeds as the respective brushes make contact with the resistor steps.

In the lower zone of the building the supply and exhaust openings for ventilation have been installed in the well-known way, following standard practice, to meet as far as possible pre-determined departmental and general layouts.

A part plan of a few bays on one of the typical floors of the lower zone is given in Fig. 4. Owing to the depth of the bays at this elevation it is considered necessary to supply air at two points in each bay. Supply and exhaust trunks are carried in a furred down portion of the ceiling kept within the limits of an assumed corridor line. On the office side of this line supply inlets are installed. The exhaust branches are carried over to an intermediate line of columns, with drops extending down to grilles located about 18 inches above the floor, one on either face of the column. Supply inlets also occur along the inner face of the outside walls, at an elevation of about 7 to 8 feet above the floor. This layout affords a very flexible arrangement for extension in the event of subdivisions being made to accommodate departmental heads. Probably there will be very little subdividing of these areas by permanent partitions, as they will be occupied as large departments, and hence the general distribution and circulation of air will be good. It would tend, however, to stratification along defined lines, were static conditions maintained constant. By varying the volumes admitted and the intensity, as is done by the successive rise and fall of fan speeds, and taking advantage of the well-known gravity effects of air motion it is anticipated that stratification will not take place and that the complete areas will be adequately swept. The objections usually raised against annoying air currents of constant intensity along fixed lines are also removed in this way. It must further be remembered that in large departments such as these the locations of desks are fixed, and draughts that will impinge upon individuals along a certain line occasion great trouble. Special care in this respect is required because of the grouping of male and female employees: modern fashions in clothing of the two sexes do not by any means simplify the problem.

When the company decided to proceed with and complete the intermediate and high level zones of the building, further thought and study was given to the subject of air distribution. Several schemes were investigated, following which a decision was reached to adopt a method which has been practised for several years past, with excellent results, in the ventilation of steamships. It is fundamentally the opposite of what has been the conventional practice of delivering large quantities of air into a room at low velocities. Through nozzles of relatively small aperture, capable of directional control at the will of room occupants, air is delivered at high velocities. Secondary currents are thus induced in the air of the room

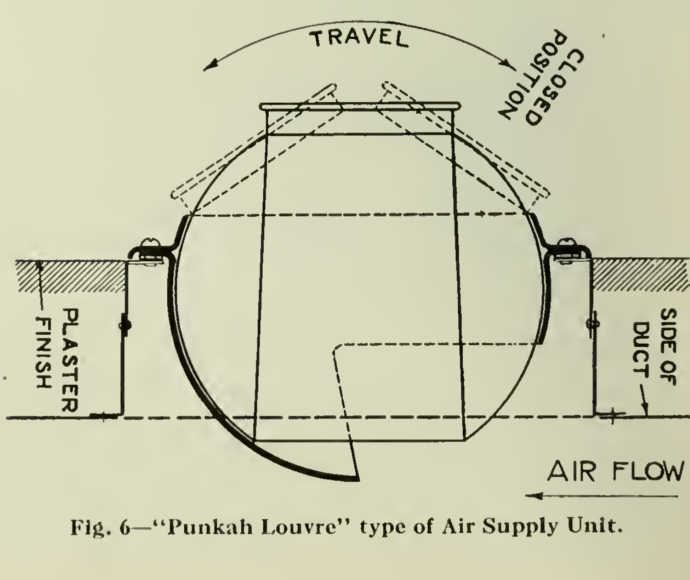

Fig. 6—"Punkah Louvre" type of Air Supply Unit.

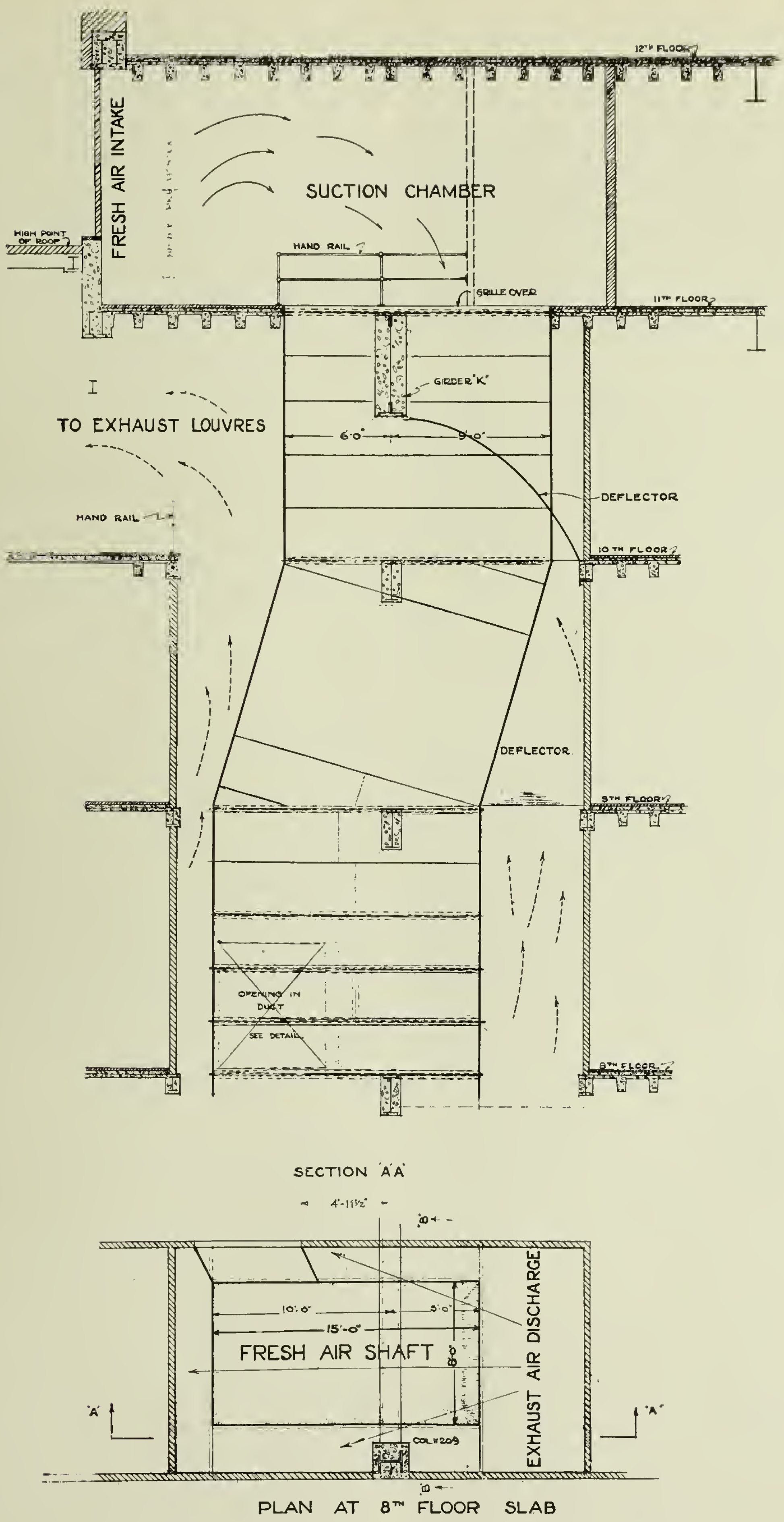

Fig. 7—Section and Plan of Heat Interchanger. Top of Airshaft.

and turbulence ensues, causing a thorough mixture—and without draughts.

A part plan of the layout of a few bays on one fo the typical floors of the upper zones given in Fig. 5 illustrates the arrangement adopted. The exhaust outlets, it will be noted, are along the same line as the supply inlets. A beam is formed in plaster, extending from column to column, which encloses the branch ducts and small plenum chambers. The exhaust grilles are in the soffits of these beams, and the supply outlets on the sides. The distribution will therefore be of the return type, the air sweeping across the ceiling or down at any angle or in any direction desired. Counter currents will also be set up by the convectional effects of the radiators on the outside wall side, and by the inevitable infiltration through windows, and it is anticipated that a thorough admixture will be the result.

A very flexible layout is also afforded permitting of extension or re-arrangement at small cost to permit of sub-dividing should it be necessary. This is very important in the present instance, as the upper part of this building will not be occupied, until required, by the company. For the time being it will be rented and the intention is to furnish space which is either ventilated or not as desired by tenants. Provision is made in the installation of dampers so that sections or units of trunk mains may be served with air as the requirements warrant.

A louvre of the punkah type as used on the supply systems is illustrated in Fig. 6. The outlet consists of a hollow ball capable of rotation in the enclosing socket so that air through the nozzle may be delivered in any direction within a relatively large range. The socket is so constructed that entire cut-off occurs in one position, and partial cut-off at points approaching this.

It is believed that the foregoing method of distribution, together with the undulating control constitute a distinct advance in mechanical ventilation.

Air supply fan rooms are located in the 3rd basement, and on the 9th, 10th and 25th floors to serve the respective zones. In each of these rooms the necessary tempering and heating coils and humidifiers are provided. The last mentioned are of a special design, combining air purification and humidifying characteristics. Atmospheric air first passes through a set of scrubber plates, after which it goes into the spray chamber and then through the eliminator plates to the fan room proper. In each of the fan rooms are the several fan units serving the respective systems. The air throughout these processes is maintained under close control automatically as to temperature and humidity, so that the air condition in the building is kept at all times within fixed limits.

The ventilating systems have been sub-divided into a number of units to provide for the operation of sections of the building independently and for departments such as kitchens, cafeterias, lounge rooms, assembly hall, etc., during short periods, and building service departments throughout the full twenty-four hours. In the interests of economy in space and initial cost, while at the same time serving the requirements fully, a combination system employing but one set of fans, air washer, etc., has been installed for the cafeterias, lounge and assembly rooms. By a series of control levers the fans may be thrown into operation on these rooms separately or together.

Distinct from the basic principles of design of the systems in the occupied portions of the building are those applying in the cooling processes for the removal of heat and vapour from elevator machinery and pump rooms, transformer rooms, etc. In cases such as these the air is cleansed in suitable filters, but not humidified.

A conception of the proportions of the installation will be obtained from the knowledge that the combined capacity of supply and exhaust fans is 1,800,000 cubic feet per minute, in 80 units.

Because of the low average temperature and the extremes that frequently occur in Montreal, with the consequent high cost of heating air for ventilating purposes, economics were given careful study. In addition to the practice of recirculation, whereby a portion of the air in the building is returned to the supply chambers, treated and re-distributed, a principle of heat interchange is followed in one of the large systems. The fresh air for the lower zone is taken in at the 11th floor level, and the vitiated air is discharged at the 10th floor level, in concentric shafts extending from these points to the respective fan rooms in the basement. The thin metal of the duct separates the two and thus heat is transferred from the out going air to the incoming air, thereby effecting a recovery of considerable amount.

A portion of this heat interchanger is shown in Fig. 7 to illustrate its general arrangement and principle.

Steam Services

Steam for the various requirements is generated in a power house separate from the main building and brought in through a tunnel on the Mansfield street side.

At the point of entry is a ring header from which the various distributing lines branch.

In general, high pressure steam at about 100 pounds per square inch is delivered to within close range of the points of usage, where reducing valves are installed to bring the pressure down to that required for the particular purpose.

A main pipe shaft extends through the building from bottom to top which contains main rising steam, hot water heating and domestic lines, cold water services and miscellaneous return lines, vents, etc.

The various steam services have been kept separate for metering purposes so that along main lines the consumption of the chief uses may be definitely determined.

The piping throughout the building both for steam and water has been welded, excepting in the smaller sizes. This has many advantages, the chief of which is the absence of trouble from leaky flanges, threads, fittings, etc. The importance of this is best appreciated when consideration is given to the vast amount of work that is concealed or in places difficult of access. Careful attention was paid to provision for expansion and contraction in the installation of expansion joints and bends. This is particularly necessary in welded construction as there are not the customary threaded connections which otherwise help in caring for this factor.

Refrigeration

A refrigeration plant, located in the third basement, employing ammonia as a refrigerant and brine distribution serves the various storage and refrigerator boxes and cooled drinking water systems. Ice is also manufactured on a small scale for kitchen, laboratory and hospital purposes.

The brine distribution is divided into high and low level systems and sub-divided again into high and low temperature ones, with corresponding coolers and pumps.

Ammonia lines do not extend beyond the confines of the plant proper.

The main compressors are electrically driven by synchronous motors, and the auxiliary compressor by a direct current motor, as is also one of each pair of brine pumps, so that in the event of failure of outside power, advantage may be taken of stand-by power from a storage battery and turbo-generator auxiliary service.

Drinking water for the lower zone is cooled in a cooling tank in the seventh floor duct space and distributed through a ring main with drops to the various units on the different floors.

Brine circulation in the refrigerator boxes is under thermostatic control, so that temperatures may be maintained to suit the nature and requirements of the materials stored. This is considered of great value, not only because of economy in operation of the plant, but also in avoiding waste or deterioration of foodstuffs.

Control Room

The control and supervision of the operation of the mechanical and electrical plants are centred in a control room off the engineer's office in the 2nd basement.

The indicating, measuring and recording instruments are mounted on panels encircling the room and the shift engineer's desk is directly in front. Surmounting these panels are the alarm and "in service" indicators.

The wet- and dry-bulb temperatures of air at different points in the building and the temperature of air, water, brine, etc., delivered to the various systems will be taken at periodic intervals through distance indicating instruments of the pyrometer type by the man on duty. Water temperatures in the hot water heating systems may be varied to meet changed conditions outdoors by means of air switches on the instrument board controlling the steam supply to the various convertors.

Attention is directed to high or low water, excess temperatures or pressures, electrical loads, etc., in connection with sumps, storage and expansion tanks, domestic services, air and refrigeration plants, electric generating and distributing plants by means of an alarm system combined with a series of lamp indicators, whereby the trouble in the affected service and its location is readily detected.

The operation of fans and motor driven pumps is under master control for starting and stopping through remote-control switches having lamp indicators and mounted on one of the panels in this room. Owing to the large number of such units widely distributed over the building, the significance of this feature will be appreciated in saving time when services are interrupted, and also in operating the plant so as to limit the maximum power demand. By studying conditions and staggering certain pumping operations, etc., it will be possible to keep expenditures for power within the most economical limits.

"In service" indicators in the form of lamps back of frosted glass panels bearing the name of the apparatus served show which unit of the more important groups such as boilers, pumps, compressors, etc., is in use.

A feature of the indicator lamp system is the provision made for detecting burnt out lamps and troubles in the control system which would otherwise create false impressions. It consists of a master control switch and wiring whereby all of the indicator lamps may be energized at one time and inspected.

Another item of interest in this room is the "view box" type drawings-cabinet in which are kept transparent records of piping and valve diagrams of the various systems. These diagrams are of standard size and contain complete information as to locations and numbers corresponding with the installation referred to; they may be quickly mounted in a frame holding an illuminated frosted glass panel, through which they are viewed and studied.

Engineering Staff Office

The chief engineer's office and executive department occupy a strategic position in the 2nd basement, adjacent to the control room. From this vantage point, within easy reach of a through service elevator, the many contingencies that arise in operating the building may be expeditiously met. A complete system of house and outside telephones communicates with the various elevator machine rooms, boiler plant, refrigerator plant, pump and heater rooms, etc., and a competent staff will be maintained at this point to carry out emergency repairs or adjustments.

This department also constitutes the centre for fire protection, in that it is the point at which indication of outbreaks of this nature will be registered from the alarm stations throughout the building. From here also the direction of the various trained squads is effected.

The log sheets, records of plant operating results, costs, etc., which will be kept in this department will be complete and up to date. Such records, which are too frequently overlooked, are essential in the successful and economical management of a great building.

In conclusion, the author tenders his most grateful acknowledgement to the Assistant Secretary of the company, officer in charge of building construction, Mr. D. L. Macaulay, for his friendly aid and for suggesting and assisting in the development of the new methods of distribution and control adopted in the ventilating of this building; and to the architects, Messrs. Darling & Pearson, and the associate architect, A. J. C. Paine, A.M.E.I.C., for their hearty collaboration in solving the numerous problems that have been encountered.

The Electrical Equipment for the Head Office Building of the Sun Life Assurance Company of Canada, Montreal

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SUMMARY—In designing the electrical installation for an institutional building, provision must be made for changes from time to time in location and requirements as to lighting fixtures, office equipment, telephones, etc. With this end in view, systems of race-ways for electrical conductors have been employed instead of the more usual conduits and wiring to fixed points.

In a building of this type, the electric elevator must receive careful consideration, together with the electrical service needed for ventilation fans, pumps and other auxiliary machinery. Alternating current is supplied from the street mains and is used for most of the building services except the ventilating fans and certain other special purposes.

Three-phase current enters the building at 12,000 volts from underground mains and is transformed to appropriate voltages for lighting, three-phase power, and for the converting equipment. This consists of two synchronous motor generator sets and two 400-kw. power rectifiers.

An emergency storage battery insures against a complete failure of electrical supply and is so connected that in the event of a breakdown, current will be automatically supplied to the drainage pumps, one elevator, and the emergency lighting system. A 150-kw. steam-turbine driven generator set has been installed for the purpose of battery charging.

Inevitable changes in location and arrangement of the various departments are provided for by a special system of ceiling lighting and fixture outlets, and a duct system under the floors provides service for the changing of the location of desks and office machines in office spaces.

Flood lighting has been installed for the outside of the building, stage lighting for the auditorium, radio service in certain areas, and ample provision is made for outside and interdepartmental telephones. Other communication services such as telegraph, teletype, and electrical clocks are arranged on each floor and there is a very complete fire alarm system.

Elevator service is particularly difficult in a building of which the entire population is governed by a single routine. The main elevator equipment of this building includes nine elevators service all floors, nine elevators service to the 5th floor, twelve serving the 8th to 15th, and nine serving the 17th to 27th. In addition to this, there are several other elevators operated for special purposes in other parts of the building.

The primary consideration in planning the electrical equipment of a large institutional building is the space which should be provided to accommodate the various riser shafts, conduits and race-ways. Since the space conditions affect the thickness of floor fill, the type of floor arch and the arrangement of suspended ceilings, the general requirements must be known or assumed before the architectural plans are completed.

Exact requirements regarding the exact locations of the numerous small units of electrical equipment such as lighting fixtures, electrically driven office equipment, telephones and signals of various kinds cannot be determined. Even after the building has been completed there will be a constant change in locations and requirements of this sort. To meet this condition satisfactorily it is imperative that the wire race-ways of various types be so designed and arranged to provide the utmost flexibility. The planning of the electrical installation for this building has been based therefore on the establishment of systems of race-ways for electrical conductors instead of the installation of conduits and wires to fixed points to meet known requirements.

In addition to the electrical facilities the personnel must also be furnished with heat, fresh air and water. To this end various fans, pumps and controls must be furnished with electrical service as most of these are electrically driven. The requirements in this connection are determined within reasonable limits during the preliminary stage and therefore do not present a problem. It was decided that the ventilating fans were to be equipped with direct current motors to provide for a more accurate speed regulation. The electrical service furnished to the building being alternating current and the fan load being of considerable magnitude, the conversion of the alternating current service to direct current for this purpose presented an interesting problem. The various electrically driven pumps are furnished with wound rotor, 3-phase motors and with the elevators constitute the alternating current power load.

The electrical elevator load present and future is made up of thirty heavy duty, high speed elevators and eight smaller elevators of moderate capacity. With one exception all of these elevators are of the variable voltage type and therefore are operated by alternating current service. The only electrical problem in connection with the elevators was to determine the actual loads which would affect the transformer sizes, the feeder capacities and the power factor. The loads were determined by calculation with the co-operation of the elevator manufacturers by applying probabilities to determine the root mean square or heating value of the current. The results were carefully checked by comparison with other installations insofar as this was possible.

For the purpose of insuring continuity of service in so far as this is possible the electric service for the building is obtained from the underground mains of the Montreal, Light, Heat and Power Company, which supplies the building through duplicate three-phase, 12,000-volt, 60-cycle services. The services enter the building at Mansfield street below grade and drop to the service switchboard in the 3rd basement through concrete encased fibre conduit. The two service feeders are arranged so that either may be used to supply the main 12,000-volt switchboard through electrically interlocked oil circuit breakers with suitable pilot lights, etc. The main 12,000-volt switchboard is of the concrete cell type of construction designed after collaboration with the Board of Electrical Examiners of the province of Quebec. By means of remote controlled oil circuit breakers this switchboard (see Fig. 1) controls the current to three groups of transformers, namely the three 12,000- to 115/230-volt, 500 kv.a. transformers for lighting service, three 12,000- to 230-volt, 500 kv.a. transformers for three-phase power service and three 12,000- to 2,300-volt, 500 kv.a. transformers to furnish current for the original building and the d.c. converting equipment. (Fig. 2.)

The three lighting and three power transformers have been located in a transformer room adjacent to the 12,000-volt switchboard, each transformer being placed in a separate concrete cell and supported over a pit, the primaries being fed through fused disconnects. The connections from the lighting transformer bank to the main lighting switchboard and similarly from the power transformer bank to the main power switchboard consist of groups of 2½-inch extra heavy copper tubing hung from the ceiling on insulators.

The main lighting and power switchboards are of the open face type, comprising slate slabs, mounted on angle frame work and providing a lever-type disconnect switch or air circuit breaker on the face of the board for each feeder

Fig. 1—Control Panel and B-16 Oil Circuit Breaker.

and with the feeder fuses or test links arranged on fuse slabs mounted on the rear of the boards. All feeder connections consist of copper bus bars extending to an ample size pull box over each switchboard which forms the terminating point of the feeder conduits and permits the feeders to be carried on racks to the location of the bus bar lugs.

The lighting switchboard is subdivided into three sections, one for each phase, each section being fed through an air circuit breaker and a double throw disconnect switch so arranged that the load of each phase can be transferred to the adjacent phase in the event of failure of one of the lighting transformers. (See Fig. 3.)

The power switchboard together with its transformer bus connections is arranged so that the power transformer bank can readily be operated in open delta in the event of failure of one of the power transformers.

The transformer and switchboard rooms in the 3rd basement have been located as near as practicable to the centre of load. From the light and power switchboard pull boxes, feeders extend across the ceiling of the 3rd basement to each of the four riser shafts, thence upward to the lighting panels and power sub switchboards on the floors above. The horizontal runs of feeder conduits are supported by means of somewhat unusual steel plate hangers wherein the plate is drilled to receive each individual conduit. The riser shafts are of ample size to contain the lighting panel as well as the telephone, signal and miscellaneous distribution boxes feeding the adjacent floor area of each floor. The riser conduits pass through two slots formed in the riser shaft at each floor by special steel framing. The riser conduits are supported at each floor by means of the usual bolted strap hangers resting upon the special steel framing. The cables generally have varnished cambric insulation and are supported approximately every 40 feet by means of special wedge type cable supports located in cable support boxes.

The lighting panel boards are of the three to two wire, open faced type, with a single pole knife switch and fuse for each circuit and with a specially designed neutral bus bar arranged at the top of the panel to which the grounded conductor of each branch circuit is direct connected. The steel panel board boxes are arranged with a hinged door to lock, opening over the entire panel board box including the gutter space but with a small door set in the large door to open over the branch switches and fuses. Each lighting panel is furnished with a main disconnect switch but no main fuses.

The alternating current power feeders extend from the main switchboard to various sub switchboards which in turn feed the individual motors. (Fig. 4.) The relatively low voltage of 230 volts was chosen for the alternating current power supply instead of 440 or 550 volts because of the added complications and increased cost which would result from the necessary segregation of the power feeders from the lighting feeders throughout the entire building. An additional reason is that the kitchen power load included approximately two hundred kilowatts of baking and roasting ovens for which 230-volt service would be required. It was therefore found that the possible saving in feeder sizes or conductor losses was not sufficient to outweight the advantage of the simplicity and safety resulting from the use of the lower voltage.

Two synchronous motor-generator sets originally produced the direct current service for the original building, which occupies the south end of the site. These machines were then fed from a 2,300-volt, three-phase, service entering the original building from Dorchester street, the same service also feeding two banks of transformers, for lighting and power, respectively. Thus there was on the 2nd basement of the original building a complete primary service switchboard, transformer vault, a main switchboard and a direct current generating plant. It was found that it would be inconvenient and costly to dispense with this equipment and it was therefore decided that the original building be left in its existing state and that it be sub-fed from the new Mansfield street 12,000-volt service. It was also found that the bulk of the direct current load was located fairly close to the existing building, and therefore that the existing motor-generator sets could be satisfactorily operated in their existing locations.

The direct current load, however, was so far beyond the capacity of the existing plant that it was decided to retain the motor-generator sets for standby and power factor correction service only, and to install two 400-kw. power rectifiers in the adjacent area. The service for the original building, including the direct current converting equipment, is now obtained from the 12,000- to 2,300-volt transformers located at the main service entrance by means of duplicate 2,300-volt feeders extending through a subway system beneath the floor of the lowest basements to the original building service switchboard. This service switchboard therefore now feeds the light and power transformers serving the original building, the two synchronous motor-generator

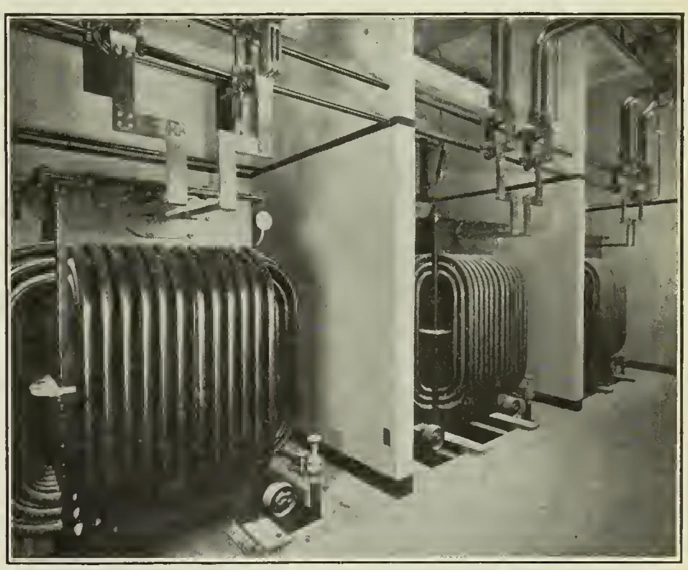

Fig. 2—Three 500 Kv.a. Power Transformer Banks 13,000 to 220 volts.

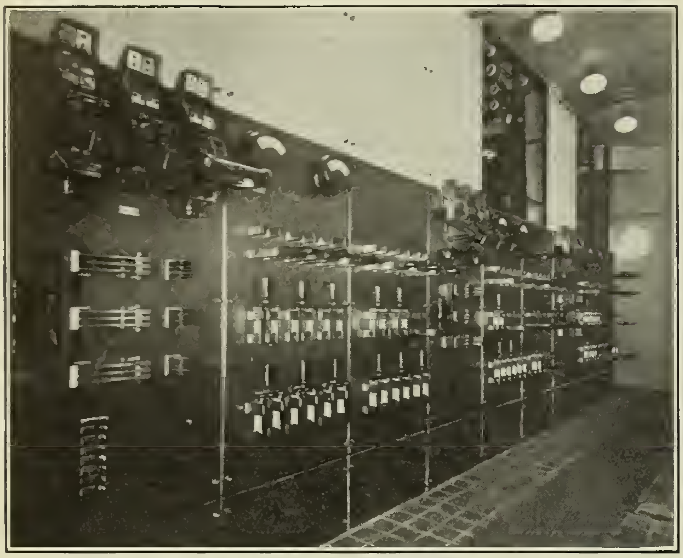

Fig. 3—Main Lighting Switchboard.

sets for power factor correction and standby and two Brown Boveri power rectifiers.

The direct current service for the building is fed and controlled by means of a direct current switchboard located in the rectifier room. The motor generator sets are to be adjusted to operate in parallel with one of the power rectifiers in the event of failure of the other. Additional power factor correction facilities have been provided in the form of two synchronous motor-driven refrigeration compressors.

The building is safeguarded against a complete shutdown of electrical service by means of an emergency storage battery, having a capacity of 600 amperes for one hour at 115/230 volts and so connected through automatic circuit breakers that direct current power will be furnished automatically to certain essential pumping equipment which will serve to prevent a flooding of the basement. The battery will in addition furnish current to one high rise elevator and to stair, exit and skeleton lighting.

A 150 kw. steam-turbine driven generator set has been installed for the purpose of battery charging, as well as to continue the supply of emergency service if the emergency should exist for a period exceeding one hour. During the charging cycle the battery will be split into two sections so that each half may be charged in multiple, thereby permitting this duty to be performed by a 115/230-volt, three-wire generator. The generator and battery connections are so arranged that the battery may be floated in parallel with the generator thereby practically doubling the emergency service supply when required.

While the possibilities of a complete breakdown of electrical service are considered somewhat remote, yet it was felt that a building housing ten thousand people should be safeguarded in every possible way.

It was found that the simplest and most effective method of applying the emergency source of power for lighting purposes was to have this power arranged to serve automatically a special system of exit lights, stair lights and emergency lights. These outlets are fed by separate feeders and panel boards so arranged that the exit and stair lights can be kept burning constantly so that means of exit and the stairways which would carry the occupants to the street are always illuminated. A system of night lights is arranged on separate feeders so designed that the outlets in the daylight areas can be turned off in the daytime by remote control from the engineer's office without affecting the similar outlets in the portions remote from daylight, which will burn constantly. This so-called night light system not only provides skeleton illumination from the general source of supply for the benefit of the watchmen and maintenance staff after hours but will in addition be automatically served by the emergency storage battery in the event of power failure. The night light outlets are strategically located in elevator and circulating corridors, toilets and locker rooms. The departmental areas are served at night by means of outlets placed at long intervals to light the way of the watchmen on their tours of inspection.

In view of the probability of constant growth and therefore the change in location and arrangement of the various departmental areas it became necessary to provide a flexible system of ceiling lighting fixture outlets which would permit relocation of the lighting units with a minimum of cutting and expense. The system adopted comprises a skeleton conduit arrangement wherein rigid conduits form a grid and connect with a permanently fixed pull box with a flush cover set diagonally off one column of each bay. From this pull box flexible conduits are extended above the hung ceiling to the fixture outlets in the bay. Changes in location of the lighting fixtures can therefore be readily made by cutting a hole in the hung ceiling at the location desired, and either fishing a new piece of flexible conduit from the pull box to the new location or by merely swinging the existing outlet to the new location if the length of the existing flexible conduit will permit. By this method changes in the location of ceiling fixtures can be accomplished without cutting a slot in the ceiling. The rigid conduit grid system has been designed to permit changes in the local switch control of the lighting fixtures by merely rearranging the conductors in the conduit.

The problem of providing service to the changing locations of desks throughout the departmental areas has been met by the installation of a fibre under-floor duct system. (See Fig. 5.) This system comprises half round sections of the usual 4-inch fibre conduit thereby producing a duct or race-way 4 inches wide, by 2 inches high, of semi-circular cross section. The ducts are arranged to extend parallel with the outer walls of the building and each run comprises two ducts placed side by side as close as practicable to each other. One duct of each run is utilized for telephone and signal wires and the other for lighting or office machine circuits. These duct runs have been carefully spaced to provide the utmost flexibility of desk location with the minimum expenditure of material. The spacing between duct runs varies from 6 feet to 9 feet, governed by the contour of the walls and the spacing of the building columns.

Although one of the ducts of the double duct, under floor duct system has been described as a race-way for lighting circuits, it is not expected that local or desk lights will be required for ordinary office work. The ceiling light fixtures have been designed and arranged to obviate the

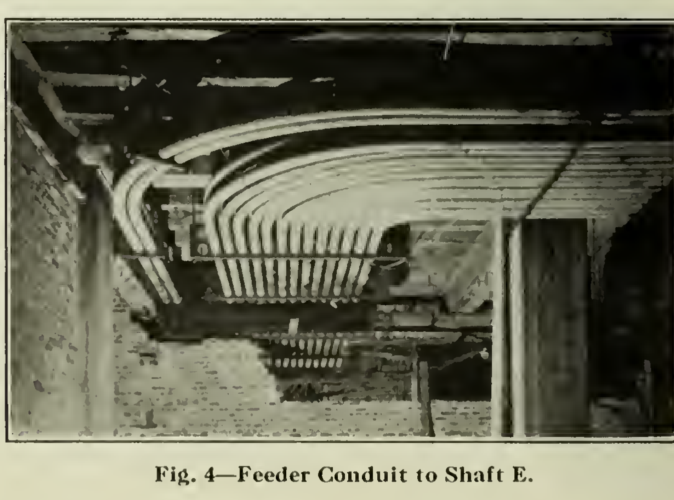

Fig. 4—Feeder Conduit to Shaft E.

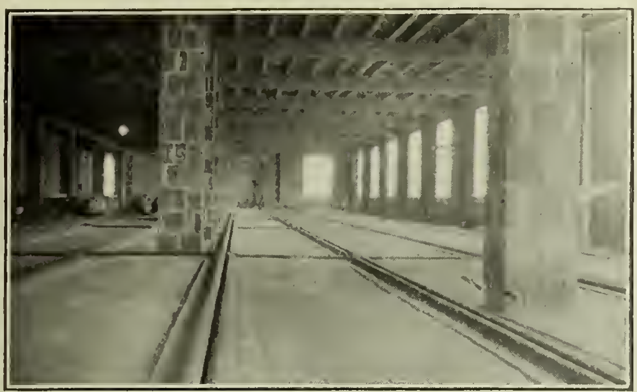

Fig. 5—Typical Under-floor Duct Layout.

use of desk fixtures. The lighting circuit duct will be generally used to furnish electrical service to the numerous business machines which have of late become an important adjunct to modern business methods. The modern office is gradually resembling a machine shop rather than a counting house. Some of these business machines, however, require current characteristics which cannot be served by the ordinary lighting circuit fed from the usual panel board. To meet this need vertical riser conduits extend from the basement and the various intermediate duct spaces to connect with junction boxes on the exterior walls and which form the termination of one end of the under floor duct header.

These exterior junction boxes, designated as auxiliary subjunction boxes, are provided with three distinct and separate sections; one devoted to 115-volt direct current service which is required by tabulating and similar statistical machines, one assigned to 115/230-volt, three-wire service for photostat and other heavy duty machines, and the third section which is connected to the riser shaft at each floor and which has been assigned variously to telegraph, ticker, teletype or telephone P.B.X. requirements. The vertical riser conduits feeding the first two sections obtain their service from a.c. and d.c. loop feeders which form a ring or loop on the duct space floors.

These a.c. and d.c. loop feeders are fed from feeders extending up the riser shaft, the single-phase a.c. service being obtained from the main lighting switchboard and the d.c. loop feeders being fed from a 115-volt storage battery, designated as the service battery, having a capacity of 80 amperes for ten hours. This battery has been so designed that the voltage will be extremely constant to meet the requirements of the direct current tabulating machines. The auxiliary riser conduits will remain empty and conductors for this auxiliary service are installed through these conduits only as required by the needs of each department. As these riser conduits are connected to loop feeders at both their upper and lower extremities, the possibility of congestion and lack of sufficient capacity has been avoided. The service battery in addition to serving the direct current business machines is used to furnish operating current to the remote controlled oil circuit breakers on the 12,000-volt switchboard as well as to the numerous remote controlled automatic panel board switches controlling the flood lighting of the building.

The building has been equipped with a system of feeders, panel board and outlets for lighting the building exterior at night. This exterior lighting, commonly known as "flood lighting," presented somewhat of a problem because it was felt by the architects that merely flooding the exterior of the building would result in the loss of the dominating features of the design. On the other hand, the architectural style prohibited the use of light which would in any way tend toward the modernistic. The problem has been met by the grouping of flood lights in such a way as to silhouette certain of the colonnades and by throwing light at such an angle as would tend to produce the shadows which would produce the results desired. All of the flood lighting groups of outlets are controlled from the engineer's office in the 2nd basement by the use of remote controlled automatic switches in the flood lighting panel boards located on the various floors.

The auditorium on the 7th floor of the building is to be equipped with modified stage lighting equipment comprising a stage switchboard complete with dimmers for the dimming of the various footlights, border strips, etc., as well as for automatically dimming the general lighting of the auditorium. In the rear of the auditorium is located a complete projector booth to accommodate modern motion picture projection and sound equipment for talking movies. The auditorium dimming equipment, as well as the stage curtains, will be under the direct control of the operator in the projection booth. In this booth there will also be

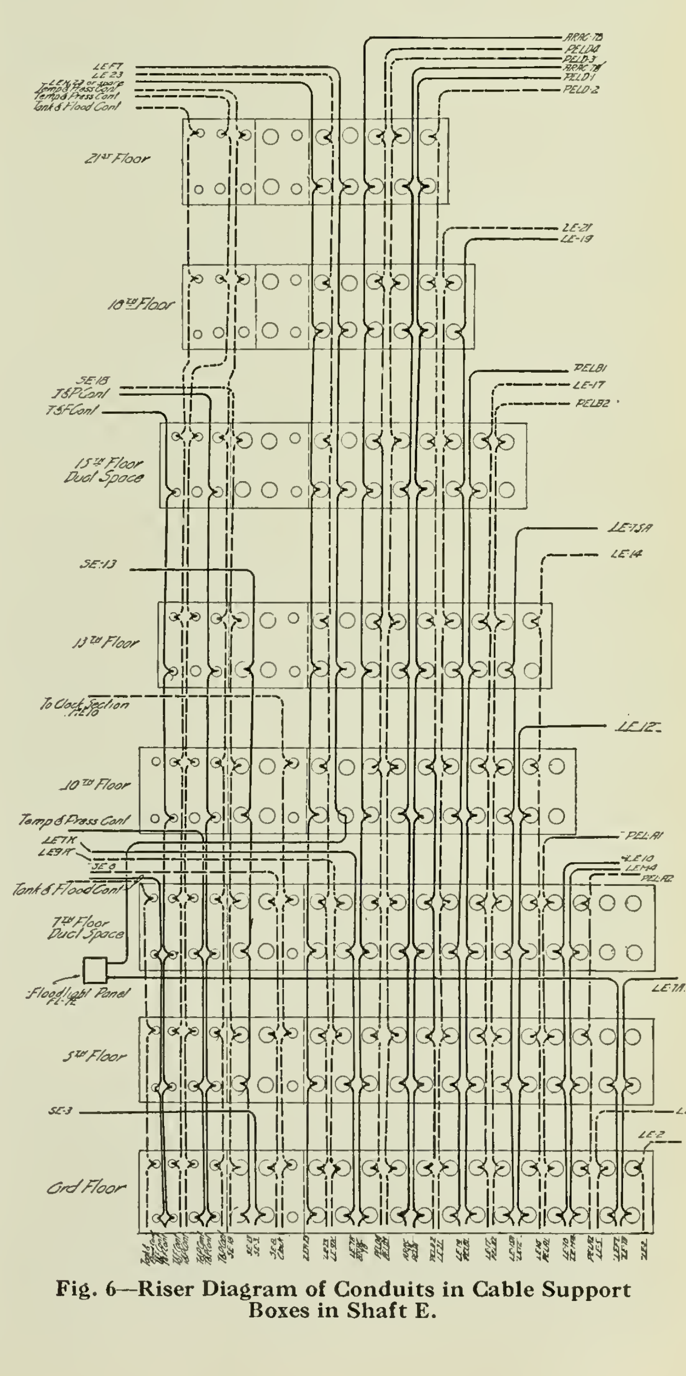

Fig. 6—Riser Diagram of Conduits in Cable Support Boxes in Shaft E.

located the central control board for the distribution of radio or disc record programmes over a two-channel audio distribution system connecting with loud speakers located in the play room on the 9th floor, the main dining room on the 6th floor, the chief clerks' dining rooms on the 5th floor and the officials' dining room on the 22nd floor.

This two-channel system will permit two programmes to be transmitted at the same time so that the choice of either will lie with the persons occupying the rooms in question. In addition this same system will be used upon occasion for the transmission or amplification of public addresses, which may be delivered in either the auditorium or the play room or in fact from the desk of the official delivering the address.

The lighting of the departmental areas is accomplished by the use of a totally enclosed type of lighting fixture, designed especially for the building. The glass enclosing globe is made of semi-daylight, tinted glass of contour determined by collaboration with the architects in an attempt to develop a unit scientifically correct and yet pleasing in form. These ceiling units have been installed on comparatively close centring because of the realization of the fact that uniform lighting as measured by a photometer does not necessarily produce satisfactory lighting conditions when the possibility that the individual will be so located that his body will cast a shadow over his work is considered. The design of the glass unit is such that the absorption of the glass in relation to the size of the unit produces a low brilliancy of light source with an efficient distribution curve. The intensity of light at the working plane in departmental areas will average 8-foot candles, with provision for increasing this intensity to 12- to 15-foot candles where required because of special conditions.

Similar totally enclosed units of smaller size are provided for the illumination of the toilets, locker rooms and general service areas. The main corridors and elevator lobbies throughout the building will be equipped with especially designed fixtures to suit the architectural requirements.

The centre of distribution for all signal services such as Bell telephone, telegraph, etc., is the signal rack room located in the 2nd basement. To this room are extended all of the conduits from the Bell telephone and the Electrical Commission of Montreal service entrances. From this rack room three systems of conduits distribute to each electrical riser shaft, namely, the Bell telephone system, the signal system and the miscellaneous system. The Bell telephone riser cables extending up the shafts are carried on messenger supporting cables and hung in open slots provided for the purpose. At each floor level an ample sized distribution box is provided in the riser shaft space with conduits extending across the ceiling of the floor below to the telephone section of a number of two-compartment subjunction boxes located generally on the wall of the service area and connecting directly with the under floor duct system. Similarly, conduits extend from a signal box in each shaft to the signal section of the subjunction boxes, the shaft signal boxes being interconnected vertically by riser conduits installed in the shaft. The miscellaneous services such as telegraph, teletype and electric clocks are accommodated in the riser shaft by means of a four-compartment distribution box on each floor, each compartment being vertically interconnected with the respective compartment of the boxes above and below. The distribution of wiring for telegraph and similar exterior services will be from the miscellaneous boxes through the signal boxes in the same shafts, thence through conduits provided to the signal sections of the subjunction boxes, to find their way eventually to the location desired through the underfloor duct system. The electric clock wiring is distributed from the shafts through conduits to wall and ceiling outlets spaced uniformly throughout the service areas.

A complete electric clock system has been provided comprising a master clock and programme instrument located in a suitable enclosed cabinet in the generator room in the 2nd basement. Double-faced ceiling type clocks are generally used throughout the departmental areas and chime tone programme bells located in flush containing boxes in these areas are operated by the programme instrument to summon the employees in groups to the dining room during the luncheon period.

A code ringing fire alarm system has been installed comprising approximately six individually coded fire alarm stations on each floor so arranged that the turning in of an

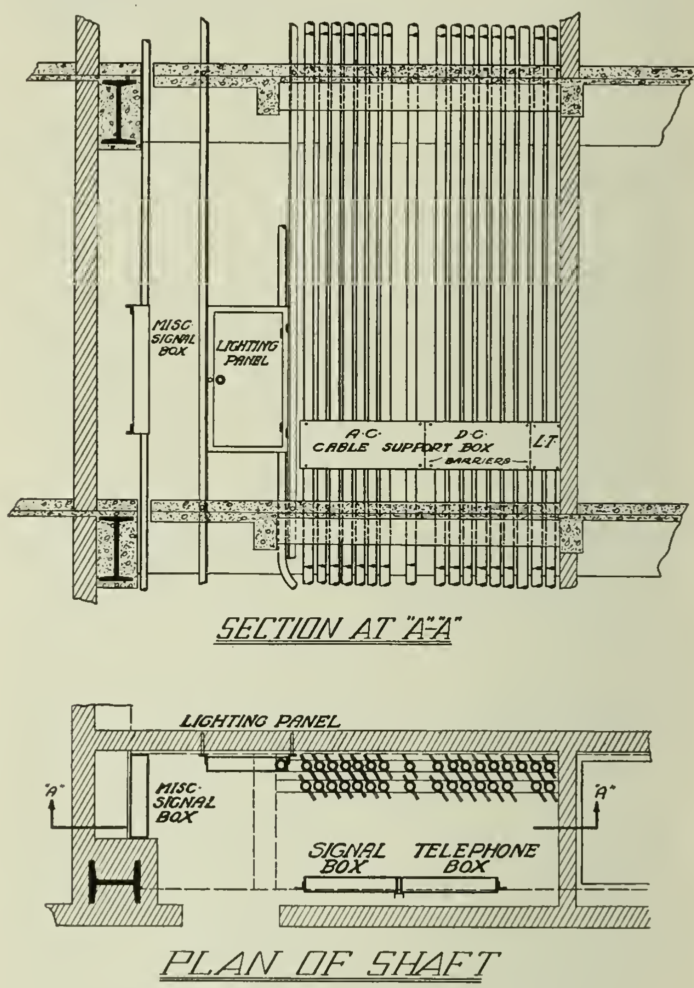

Fig. 7—Details of Typical Electric Riser Shaft.

alarm at one of the stations will cause the code of the station to be run by bells located in the areas generally occupied by the building maintenance staff. The code in addition will be indicated in the chief engineer's office, the boiler room and at the foot of the elevator shafts so that the elevator operators can immediately place their elevators to serve the fire fighting forces of the building. A record of each alarm will be automatically marked on the tape in a fire alarm recorder located in the central watch room.

The central watch room will be the centre of the building watch service as well as the after hour supervisory and inquiry bureau. In this room therefore are located the central control board upon which is indicated the watchmen's progress on their tour through the building in response to the signals despatched from the watchmen's tour stations located on each floor. Communication with the watchmen is arranged for by means of a signal light on each floor controlled from the watch room and located

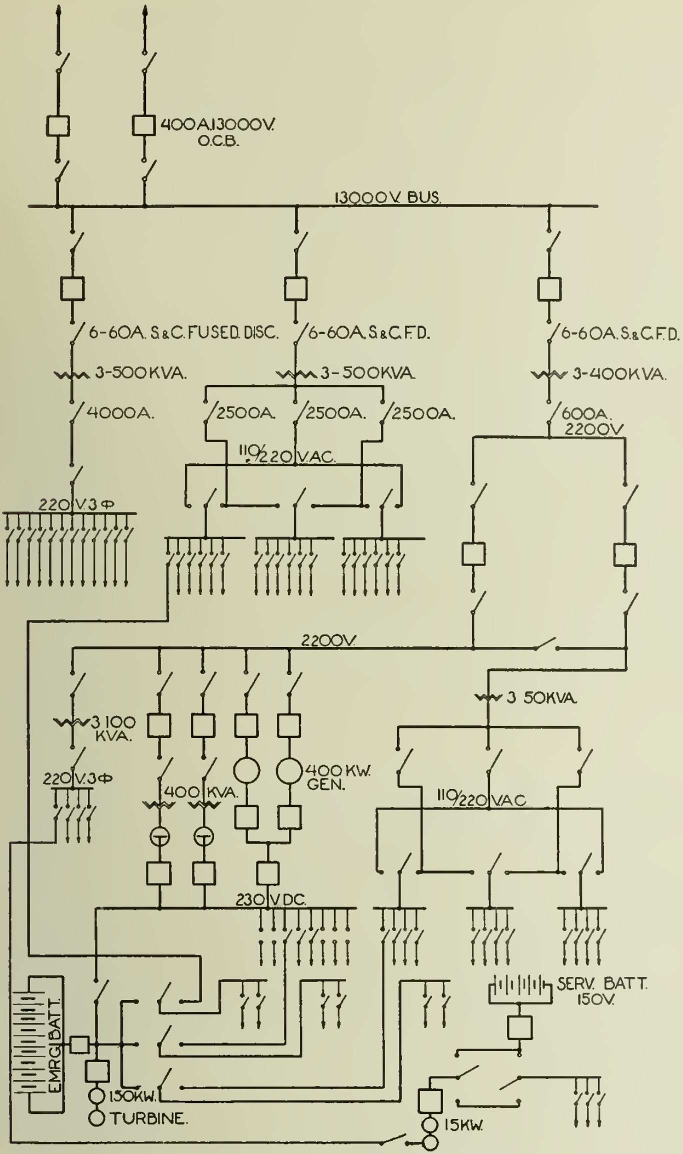

Fig. 8—Single Line Feeder Diagram.

adjacent to an interior telephone instrument. A tape record is made by a recorder of the time and location of each signal received from a watchman.

During the day the same interior telephone system is utilized by the chief engineer for communicating with the various building mechanics by means of signal lights located together with the watchmen's signal adjacent to the house telephone instrument. Each department or trade is assigned one of the seven distinctively coloured lights. Communication from the chief engineer to the various mechanical shops, boiler room, etc., is obtained by the use of the interior telephone system and service is also provided from the chief engineer to each elevator starter in charge of each elevator bank. In addition, each elevator starter may communicate with each elevator under his control or with the elevator machine room by means of a telephone instrument incorporated in the elevator control panel located in each elevator lobby on the ground floor.

Battery service at 24 volts is furnished for the fire alarm, electric clock and interior telephone systems from a signal service storage battery.

Elevators

Probably the most difficult problem that the elevator engineer is called upon to solve is the equipping of an institutional building, such as the Sun Life Assurance Company building, with adequate elevator equipment. The problem is made difficult because the entire population of such a building is governed by a single routine. The population furthermore is found to be more dense because of the large departmental areas with relatively few spaces devoted to private offices.

It will be found that approximately 30 per cent of a population of an institutional building must be transported in five minutes, whereas in an office building, occupied by numerous tenants, facilities for transporting from 15 to 20 per cent in five minutes will be sufficient. Furthermore, the density of population in an institutional building will usually be found to be one person to 80 square feet of net area; whereas in a rented building the density will not exceed 100 to 120 square feet per person.

This peak load of traffic, combined with the density of population produces a peculiar condition, in that if sufficient elevators are provided to meet the morning and evening loads, the space occupied by such an elevator installation will considerably increase the service area or non-productive portion of the building as compared with the useable or productive area. This would therefore result in increasing the cost of the building while at the same time seriously reducing the space which can be utilized for the purpose for which the building is erected.

The mere fact, however, that the occupants of an institutional building are all controlled by the dictates of one institution furnishes the solution. If the peak load is greater than a reasonable amount of elevator equipment can serve, it is quite natural to appeal to the heads of the institution to reduce the peak. The fact that the tramway systems of various cities have been faced by the same problem probably helped toward the conclusion that the hours of arrival and departure should be staggered.

The elevator equipment for this building has been designed on the basis that 50 per cent of the population of the building would commence and end their working day approximately one-half hour earlier than the balance. Even with this subdivision of peak load the elevators will be required to carry twelve to fifteen hundred people in five minutes when the building is fully occupied.

Having thus determined the traffic the next consideration is the size, capacity and number of elevators that will be required. Here again the requirements of an institutional building differ from the ordinary office building in that the large influx of passengers is best served by relatively large cars permitting a comparatively large number of persons to be carried at one time. The capacity of the machine instead of being based upon the usual 75 pounds per square foot of floor area of cab must be increased, because it has been found that the passengers in such a building have a tendency to crowd the cabs to their utmost capacity. The number of young persons that will fit into an elevator cab of ample proportions is sometimes amazing. Numerous tests have proven that the original rule which stated that a person occupies 2 square feet of floor area when standing in an elevator has been completely discarded in favour of a new rule of 1¼ square feet per person. This change in a fundamental rule may have been brought about by the popular fad of dieting for it has been found that each person under the new rule can be assumed to weight 125 pounds instead of the 150 pounds previously assumed. The net result of all of the above, however, is that the elevators for this building have been designed for a carrying capacity of 100 pounds per square foot of cab area. It was furthermore found that the most efficient size of cab would be one that would accommodate approximately twenty-five passengers, provided the cab could be made so that the width would be considerably greater than the depth to facilitate unloading at the various floors. With these conditions established the final arrangement of four banks or groups of 3,500-pound capacity elevators was adopted.

The low rise group known as bank "A," comprising nine elevators operating at 600 feet per minute, serves all floors to the 5th floor with provision for serving the 6th and 7th floors during the luncheon period, the latter floors being devoted almost entirely to this purpose.

Two intermediate groups of six elevators each, serve the 8th to the 12th floor and the 13th to the 16th floor, respectively. The bank "B" group will operate at a speed of 600 feet per minute and the bank "C" group has been designed to operate at a speed of 800 feet per minute, if and when the existing building regulations permit a speed in excess of 600 feet per minute to be used.

The high rise group, known as bank "D," comprising nine elevators, has been designed to operate at a speed of 800 feet per minute and will serve the 17th to the 22nd floor, inclusive, during periods of peak load, but is equipped with hatchway openings on all floors to enable this group to serve for intercommunication during off peak periods. It is expected that most of the elevators of groups "A," "B," and "C" can be shut down during periods of light traffic and that most of the load during such periods will be carried by this high rise group.

All of the elevators in the four groups above mentioned are of the full signal control, variable-voltage, type, wherein the functions of the operator have been reduced to the manipulation of buttons and the closing of the doors, which is accomplished by merely throwing the control lever.

The cab doors and hatchway doors are opened and closed by compressed air engines located above the door opening. The compressed air for this purpose is obtained from a separate compressor plant, located in the 3rd basement.

The elevator cabs are constructed from the architects' design. Each cab of the high rise banks is equipped with a position indicator located over the cab door, which indicates the progress of the cab by means of the successive illumination of glass numerals set in bronze plate. An intercommunicating telephone of the loud speaker type has been provided permitting each operator to communicate with the elevator starter without interrupting his duties. Emergency exit doors have been provided in the cab side which will permit the passengers to be removed to the adjacent elevator in the event of a shutdown.

The elevators are naturally equipped with every modern safety feature and furnished with means to permit the operator to eliminate the automatic features and assume full control of the movements of the car if necessary.

One elevator in the low rise and one in the high rise bank has been designed for freight service while at the same time permitting its use for passenger service when required. These two elevators are each of the same duty and capacity as those of the balance of the bank but each cab is furnished with a rear door opening into a circulating or service corridor to permit freight to be carried direct to the departmental areas without passing through the elevator halls. A special signal system has been provided for freight service only. The cabs of these elevators have been constructed with false tops which can be swung upward when desired to produce a height within the cab of 10 feet 6 inches to accommodate long members of furniture or other equipment.

The motor-generator set of the high rise freight elevator of the bank "D" group is of the dual drive type, having an alternating current motor and a direct current motor both driving the generator. In the event of power failure from the a.c. source, an automatic interlocked circuit breaker on the elevator control panel will immediately close with the result that the generator will be driven by the direct current motor by means of current obtained from the emergency storage battery. Upon the resumption of a.c. power the emergency source will be automatically disconnected and normal operation resumed. This feature will insure that one elevator at least can be operated in the event of a serious interruption of electrical service. It is not expected that this elevator will be of any great assistance in the carrying of passengers in times of emergency but it will permit the building maintenance staff to reach all floors quickly to make emergency repairs or to fight a fire.

Each starter has been furnished with complete indicating and control equipment in the form of ornamental bronze panels which will show him the location of each elevator, the direction of its travel and the floors calling for service. In addition to the usual control equipment one of these panels is equipped with a complete scheduling device which will automatically indicate the proper moment when each car should leave the ground floor on its upward trip and similarly when each car should start on its downward trip from the top terminal landing. The timing device is adjustable so that the headway or operating schedule of the elevators can be changed to meet the varying traffic and the number of elevators in operation.

In addition to the thirty elevators comprising the four main banks there is a group of two manually controlled elevators at the Mansfield street entrance of the original building, a group of two signal control elevators at the Metcalfe street entrance of the original building and an automatic push button elevator located to serve the security vault space and which runs to the 5th floor for the use of officials. The special needs of the cafeteria kitchen, which is located on the 6th floor at the north end of the building, will be served by two moderate duty freight elevators running from the 3rd basement to the 7th floor and thereby providing means of transportation between the cold storage rooms in the basement, the freight service entrance, the kitchen and the auditorium and all intervening floors.

A special automatic elevator will be installed for official use only, to operate between the administrative floors located at the top of the building. All of these auxiliary elevators are of nominal duty and speed to suit the purpose of each and are all equipped with means of telephone communication with the chief engineer's office.

In conclusion, it is perhaps needless to add that the results in this field are due to the efforts of many individuals. The writers wish to particularly express their gratitude to:

D. L. Macaulay, Assistant Secretary of the Sun Life Assurance Company of Canada and Executive Officer in charge of new building construction, for technical advice and assistance in connection with every phase of the electrical and elevator engineering, as well as for his sympathetic understanding of the many problems arising during the course of the work.

The architects for their guidance and for co-operation in providing for the requirements of the installation.

A. J. C. Paine, A.M.E.I.C., associate architect, for the numerous suggestions and the solution of the many problems of installation.

Kenneth T. Cregeen, Jr.E.I.C., engineer in charge of Building Maintenance, for his constant interest and helpful criticism.

The contractors for their intelligent co-operation and excellent work.

Steam Station for the Head Office Building of the Sun Life Assurance Company of Canada, Montreal, Que.

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Paper presented before the Annual General and General Professional Meeting of The Engineering Institute of Canada, at Montreal, February 4th, 5th and 6th, 1931.

SUMMARY.—This paper gives a general description of the new steam station to serve the head office building in Montreal of the Sun Life Assurance Company of Canada. The station is built below ground level across the street from the main office building with which it is connected by service and pipe tunnels, the intention being to construct a building over the plant which will be used as a service building to the head office. The main floor of the boiler room is 48 feet below street level with ash basement beneath, and approximately one-half of the excavation was made out of rock.

Among the features of special interest in the design of this station may be mentioned:—

(a) The attention given to provide a commodious and well laid out plant, the structural steelwork and braces against earth pressure being arranged for the support of the main pieces of equipment and intermediate floorings. Usually this is difficult to obtain as the engineer rarely has the opportunity to co-operate with the architect on building and structural plans when the steam plant forms the basement of an office building. Study has been given to the appearance by the use of quarry tile flooring, tile dado and tinted walls, and good lighting from large wall brackets around the entire operating floor.

(b) The plant has a capacity of approximately 4,000 boiler horse power. This is exceptionally large for the service of an office building and is due mainly to the very complete system of ventilation and air conditioning that is provided.

(c) As the load is governed in general by the outdoor temperature, the main steam generating units are specially designed for economical operation throughout a wide range of output. In addition to the special setting of the units, with provision for cutting in additional heating surface with auxiliary fans for the higher loads, heat is extracted from the outgoing flues and stack by the incoming air for combustion, so effecting a minimum of heat loss from the fuel burned.

(d) The coal handling system is arranged for fuel to be received either from street level by a covered truckway, or from the underground tracks of the Canadian National Railway's new station development when completed.

(e) A complete installation of instruments, meters and controls furnish full information for the guidance of the operators to maintain efficiency and to indicate and record conditions and results. Distant recording instruments in the chief engineer's office in the main building also furnish essential information and permit general directional control from that point.

(f) Provision is made for the installation of a garbage and refuse destructor furnace, with can cleansing and handling equipment, to burn general rubbish and the waste from the kitchens in the main building. The heat from this furnace will be utilized for the generation of steam in one of the boiler units, as an auxiliary to coal firing.

The steam station to serve the new head office building in Montreal of the Sun Life Assurance Company of Canada is situated below ground level at the corner of Mansfield and Cathcart streets, being connected to the main building by service and pipe tunnels crossing under Mansfield street. It is proposed eventually to erect an 18-storey building over the site of the station, and the structure is designed for the support of such a building which will also be served by the plant. At the present time the chimney, truckway over coal bunker, ash hopper and elevator head above grade are grouped in a brick tower housing which will later be incorporated in the overhead building. The remainder of the site is at present utilized as a covered garage space.

Figs. 1, 2 and 3 show the plan and general sections of the station. The plan dimensions are 117 feet long by 77 feet wide, the main boiler operating floor being 48 feet below street level, approximately one-half the depth having been excavated out of rock. A 12-foot basement below this floor extends over about one-half the area, with a large drainage sump below the basement floor from which all plant drainage is automatically pumped up 60 feet to the Mansfield street sewer.

The enclosing walls are of concrete, the earth pressure being taken care of by a steel bracing framework in conjunction with the main column members for the support of the future building. Provision against water accumulation between the rock face and the outside of the walls is made by vertical ducts draining to pipes or gutters leading to the main sump in the basement.

The spacing and arrangement of columns and structural steel-work is such as to provide a good layout for the boiler plant as well as for the future overhead building. The front ends of the boilers are carried from main cross beam struts, and other cross steels are set at convenient heights to suit the several operating floors and the equipment. The attention given to these features of design has resulted in a commodious well-arranged plant, an important factor for efficient operation.

One main stairway with combined passenger and light freight elevator provides access at the north corner of the station from the covered truck space to all floors, and a second stairway at the south corner leads to the pipe and service tunnels and communicates with the mezzanine floors overlooking the firing floor. Large pieces of equipment are handled through a sidewalk hatchway on Mansfield street with a shaft extending clear down to the boiler room floor. A toilet and locker room with showers is provided for the operating staff and store rooms are conveniently located for ready access.

The main floor is paved with heavy quarry tile of dark brownish red colour and a 54-inch tile dado of lighter colour is carried around the walls, the upper part of the concrete walls being painted. Good lighting is provided by large wall brackets mounted about 12 feet above the floor on each building column around all sides of the main floor.

Boilers

The steam requirements are principally for heating and ventilating and as such the load varies over a wide range depending upon the outdoor temperature. It was decided therefore to instal three main steam generating sets each designed to have an economic range of 10,000 to 40,000 pounds of steam per hour, and also one small boiler of 8,000 pounds steam per hour capacity which was removed from the old boiler-room of the original section of the main office building and re-erected.

Each of these main sets comprises a Babcock-Wilcox and Goldie-McCulloch cross-drum water-tube boiler placed in a specially arranged setting and having an effective heating surface of 4,500 square feet, a large percentage of which is exposed to radiant heat from the furnace, and a Foster-Wheeler economiser or water-heating section of 2,160 square feet heating surface.

The furnace equipment of each boiler consists of a compartment type balanced-draft chain-grate stoker, by the same makers, 9 feet wide by 14 feet long, arranged to operate either on natural or forced draft. Regulated secondary air is provided from the air cooling of the furnace side walls. The grate area and furnace volume allow for rates of burning and heat release which are within the limits of good practice for Nova Scotia coal, for the use of which fuel the plant was designed. This coal analyses approximately 56 per cent fixed carbon, 36 per cent volatile,

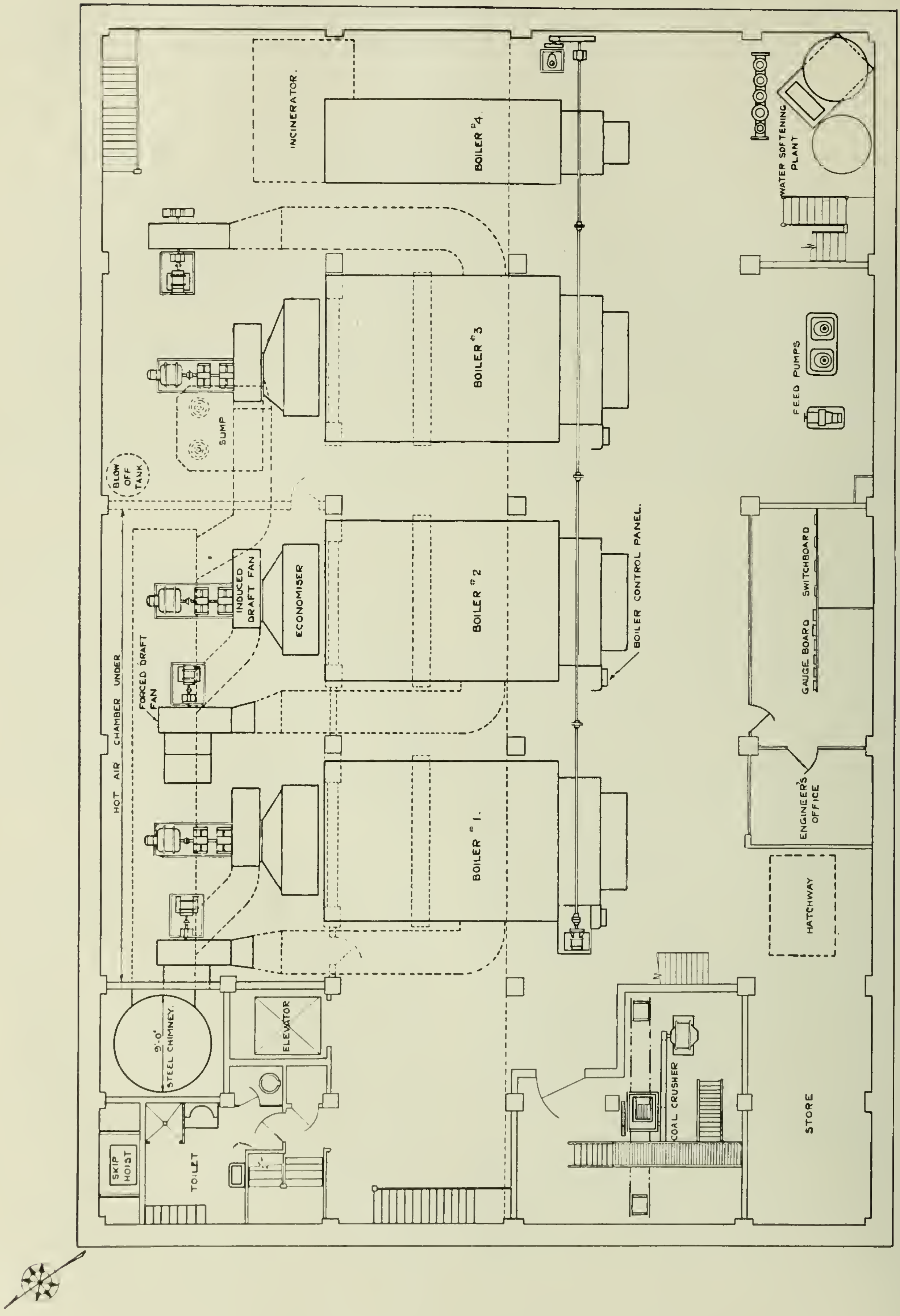

Fig. 1—Plan of Steam Station.

and 8 per cent ash, with 2½ to 3½ per cent sulphur; its calorific value is approximately 13,400 B.t.u. per pound, dry. The iron content is high, the fusing point of the ash being around 2,000 degrees F., and the general characteristics of the coal call for special features of stoker and furnace design to ensure efficient combustion with satisfactory operating and maintenance conditions.

Each steam-generating set has an independent forced draft fan and induced draft fan, connected to variable speed A.C. motors and controlled from an operating panel at the front of the stoker. On this panel are also mounted a Bailey boiler meter and multipoint draft gauge so that the operator can make complete observation and regulation from this point.

The boiler setting is arranged so that under light loads,—up to 15,000 pounds of steam per hour,—the boiler section only will be in service, the gases passing direct to the chimney by an overhead flue. Under such loads the stoker will operate under natural draft. For the higher loads the economizer section is cut into service and the forced draft and induced draft fans operated to maintain a balanced draft condition, the gases being discharged from the induced draft fans to another main flue in the basement leading to the base of the chimney.

Air is supplied to the extent required for ventilation and for light load under natural draft by a main supply fan drawing either from outdoors or from the service tunnel, as desired. When the boiler fans are in use air is drawn in from above street level through windows and louvred openings in the walls over the truckway, down the encasement around the steel chimney stack to a closed compartment in the basement to which the forced draft fan suctions connect. The discharge ducts from the induced draft fans and the main lower flue also pass through this basement compartment and are left uninsulated so that the air for combustion is warmed by heat extraction from the outgoing gas ducts.

The flooring under the rear passes of the boiler is set up 8 feet from the boiler room floor, giving free passage beneath and access all around the furnace walls. This makes for convenient operation and allows for any changes in furnace operation which may be desired or developed in the future, either in the form of pulverized fuel or oil burning. Soot from the rear passes of the boiler is discharged through water jet valves to the sump in basement whence it is pumped in water suspension by the special sump pumps to the street sewer.

Coal and Ash Handling

Coal is delivered in trucks from Mansfield street and after being weighed on a Gurney auto platform scale in the covered truckway is dumped through holes in the floor to the main storage bin below having a capacity of 400 tons. Below this storage is the coal handling floor where the coal is drawn through gates in the bin floor into 1-ton cars and delivered either directly into the stoker hoppers or through a coal crusher to a bucket elevator which raises it to a coal bunker over the firing floor. This overhead suspension bunker has a capacity of 300 tons of coal and is of Allen Sherman-Hoff make, formed of interlocking cast iron plates on steel suspension straps. This construction was considered a desirable one to withstand the destructive action of high sulphur coal. The bucket elevator travels at a speed of 45 feet per minute and is driven through a herringbone speed reducer and chain drive from a 7½ h.p. motor.

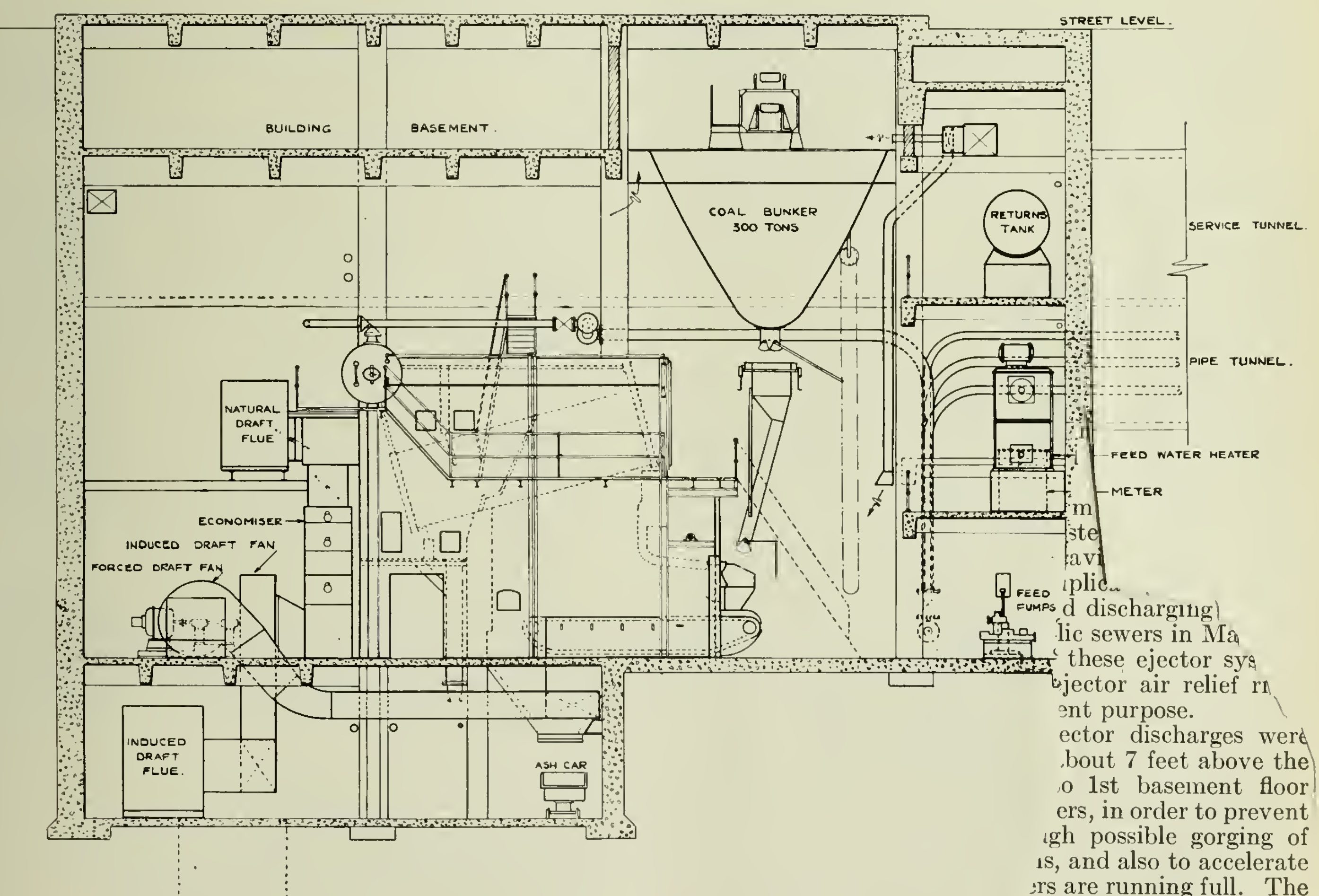

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Fig. 2—Cross Section of Steam Station.

The low level tracks of the Canadian National Railway Terminal development will be approximately 2 feet below the level of the boiler room floor and provision has been made so that coal may be received from railroad cars on track sidings by an extension of the upper runs of the conveyor through the south wall, while doors at the end of the firing floor will give direct access for loading or unloading equipment.

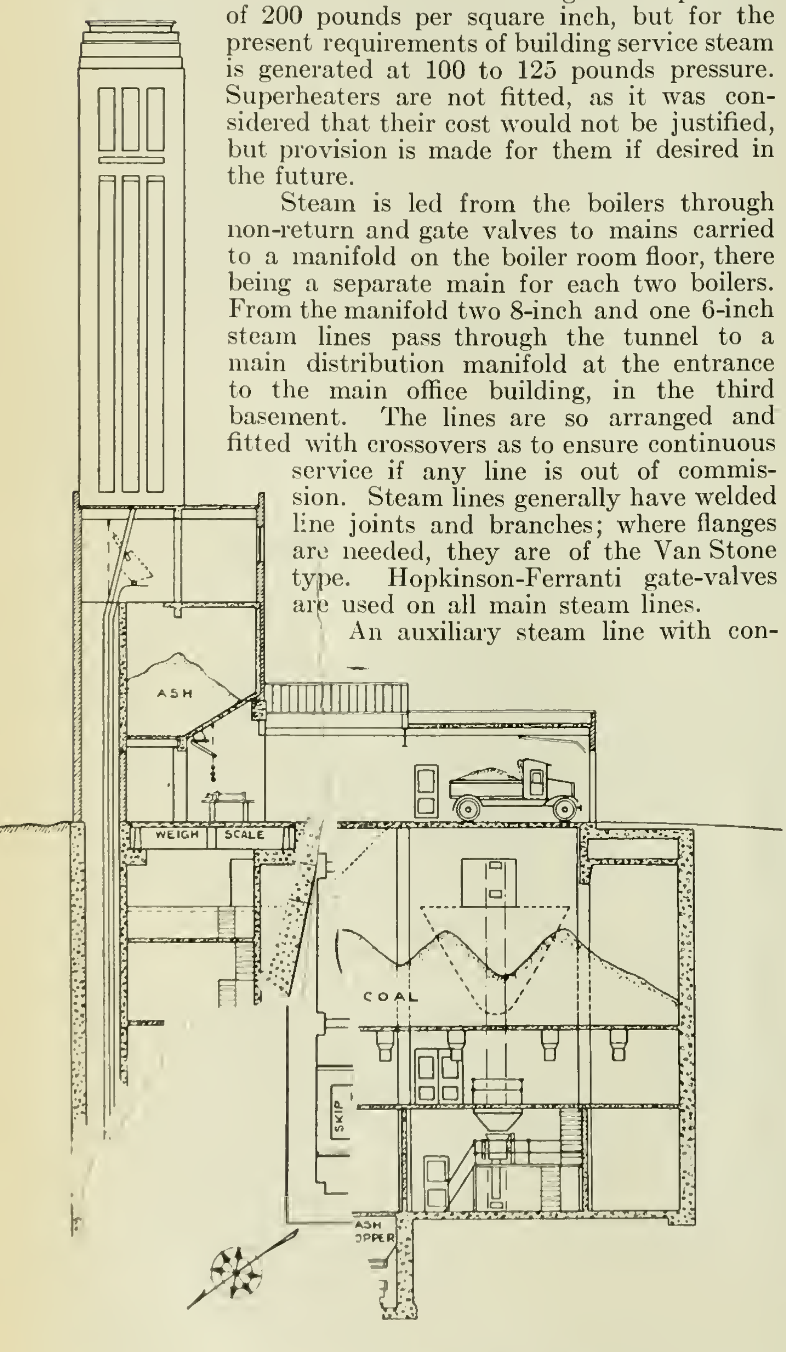
Ashes from the chain grate stokers fall into special tile-lined cast iron hoppers of the same make as the overhead coal bunker and are taken by hand cars in basement to a skip hoist. This hoist lifts the ashes 90 feet to a concrete ash hopper and returns to the basement pit automatically by the action of a single button push. The ash hopper has a capacity of 25 tons and discharges through a roller gate and chute to trucks in the covered way.

Steam and Water Systems

The boilers are built for a working steam pressure of 200 pounds per square inch, but for the present requirements of building service steam is generated at 100 to 125 pounds pressure. Superheaters are not fitted, as it was considered that their cost would not be justified, but provision is made for them if desired in the future.

Steam is led from the boilers through non-return and gate valves to mains carried to a manifold on the boiler room floor, there being a separate main for each two boilers. From the manifold two 8-inch and one 6-inch steam lines pass through the tunnel to a main distribution manifold at the entrance to the main office building, in the third basement. The lines are so arranged and fitted with crossovers as to ensure continuous service if any line is out of commission. Steam lines generally have welded line joints and branches; where flanges are needed, they are of the Van Stone type. Hopkinson-Ferranti gate-valves are used on all main steam lines.

An auxiliary steam line with connections from each main steam line and from each boiler drum supplies the feed pumps and other auxiliary equipment and station heating. As an emergency alternative the steam feed pumps can be fed direct from the main steam manifold.



Handling System.

The water treating and feeding apparatus is placed on two mezzanine floors and at the boiler-room floor alongside the firing aisle. The condensation returns from the building, both under gravity head from the upper zone and from pumps in the third basement, are brought through the tunnel to a 1,500-gallon storage tank on the upper mezzanine floor from which the water passes through a Cochrane de-aerating feed water heater and Bailey V-notch Weir meter on the intermediate mezzanine, and thence to the feed pumps at boiler room floor level. By the use of the full headroom of the boiler plant in this way for the feed water system, a good suction head is maintained on the feed pumps and a simple, accessible and easily visible arrangement effected.

Two Weir vertical feed pumps, removed from the old boiler room, and one Weir steam turbine feed pump of 250 gallons per minute capacity are installed and space is provided for an additional unit. Duplicate feed lines lead to the boilers, either direct or through the economizers, with regulators and pump governors to maintain a constant water level in the boiler drums. A Permutit zeolite water softener supplies soft water to the laundry and heating system in the main building as well as make-up, as required, for the boiler plant.

Instruments and Meters

Complete information for the guidance of the firemen, to indicate operating efficiency, and for record purposes is furnished by numerous meters and instruments. In addition to the water meter measuring the total feed to the plant, the output of each boiler is given by indicating, recording and integrating steam meters and a separate meter shows the steam used by the auxiliaries. Coal fed to each stoker is measured by a Lea coal meter.

As a check on the Bailey boiler efficiency meters, two Republic CO_2 recorders are installed, each one being connected so that gas samples may be read from either of two boilers. Four pen-recording thermometers are connected to each economizer showing the inlet and outlet temperatures of both gas and water, and other instruments are installed to record the temperature and pressure in the feed water heater and at other points so that the condition and efficiency of each piece of equipment may be determined.

Besides the readings given in the steam station, the total feed water will also be recorded on an instrument placed in the central instrument and control room in the main office building, so that the load on the plant can be noted and regulated from this point.

The station switchboard and general gauge board are situated in a glass-fronted instrument room facing the front of the boilers, and adjoining this room is the boiler room engineers' office. A large illuminated master steam gauge is placed on the building wall at the south end of the firing floor and the whole assembly of instruments and controls is in clear vision and convenient for operation from the firing floor.

Incinerator

At the present time garbage from the building cafeteria and kitchens is disposed of by contract, but it is proposed in the future to build a rubbish and garbage incinerator furnace in the basement of the steam station under the rear of the small boiler, the setting of which is arranged so that the heat from the incinerator may be utilized in this boiler. The proposed scheme for garbage disposal includes provision for readily handling the cans and cleansing them before return to the building.

VENTILATION

Previous mention has been made of the air supply for ventilation and for light loads under natural draft. This air is discharged through several ducts down to the firing floor and the warm air from the top of the boiler-room passes up through openings to the space over the suspended coal bunker. The space above the coal bunkers, which is also supplied with a small amount of high velocity air direct from the fresh-air fan to ensure circulation, is ventilated by an exhaust fan which discharges into the chimney enclosure, the air thus joining the circuit to the forced-draft fans supplying the boilers. By this system a general circulation of air is provided and accumulation of dust laden air over the coal bunkers is prevented.

The Plumbing System Designed for the Head Office Building of The Sun Life Assurance Company of Canada, Montreal

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Consulting Engineer, New York, N.Y.

Paper presented before the Annual General and General Professional Meeting of The Engineering Institute of Canada at Montreal, Que., February 4th, 5th and 6th, 1931.

SUMMARY—The paper describes the arrangements and design for the drainage, water supply, fire protection and other allied services in the new head office building of the Sun Life Assurance Company of Canada in Montreal, which will contain a population of ten thousand people. Provision had to be made for an extensive kitchen and cafeteria equipment in addition to the regular sanitary requirements of a large modern office building.

A considerable portion of the drainage has to be carried out by ejectors and pumps, special provision has been made for refrigerated drinking water and hot water supply, and there is a very complete fire protection and sprinkler system.

The fire mains and sprinklers can be supplied from fire engines, from high pressure street mains, from the building steam fire pumps, and from tanks on the 9th, 16th and 24th storeys. Special care has been taken as regards fire hazard from adjoining buildings.

All vent, soil, and relief risers are extended above the main roof level and means are provided to prevent damage to the piping from the fall of storm water carrying grit from the roof drains.

The water supply is drawn from two independent street mains and filtered, the piping being so arranged as to provide for the continuity of service to all of the three pressure zones of the building. There are three electrically operated house pumps with a steam standby pump.

An endeavour has been made to obtain the best in design, material, and workmanship throughout the installation.

The design of the Plumbing System for the Sun Life Assurance Company's head office building in Montreal may be divided into the following groups, each of which will be dealt with individually.

1. Drainage and venting of general fixtures (mezzanine to 24th storey) by gravity.
2. Drainage and venting of general fixtures (ground floor to 3rd basement) by ejectors.
3. Drainage of kitchen fixtures (separate) by gravity.
4. Drainage of laundry fixtures (separate) by ejectors.
5. Drainage of low level fixtures (3rd basement) by ejectors.
6. Drainage of low level floor drains and ground water by sump pumps.
7. Drainage of roof and other exposed surfaces (mezzanine to 24th storey) by gravity.
8. Drainage of other exposed surfaces (ground floor to 2nd basement) by ejectors.
9. Water supply and drainage for drinking fountains.
10. Cold water supply to fixtures.
11. Hot water supply to fixtures.
12. Fire protection supply and sprinklers.
13. Liquid soap supply.
14. Gas (fuel) supply and emergency lighting.
15. Mechanical plant.

These all had to be arranged so as to work in with the existing equipment of the original building on Dorchester street, which was of course much less extensive.

The following sections deal with the above sub-divisions in the order given.

1. Gravity drainage and venting of all plumbing fixtures (except those of kitchens, cafeteria and bakery) from mezzanine to 24th storey inclusive (Diagrams No. 1 and No. 3):

For this service a system of extra strong galvanized, genuine wrought iron piping, with companion main vent risers and branch fixture vents of the same material, was designed, discharging from fixtures to street sewers, entirely separate from the systems taking kitchen waste and storm drainage. In plan the plumbing fixtures were kept as close to risers and as much within a central service area as was physically possible.

Because of plan area (and excluding that part of the building already existing) the gravity sewage drain system, and also the roof drainage by gravity under item No. 6, was divided into four parts, so as to discharge through two separate house drains and house sewers in Metcalfe street, and through two others into the public sewer in Mansfield street. This gives the fixtures and main roof four points of relief, besides reducing the space required for adequate fall in the branch drains.

The house sewers, underground, in the street were designed of extra heavy cast iron soil pipe.

2. Ejector drainage of all plumbing fixtures (except kitchen) from ground floor to 3rd basement inclusive (Diagrams No. 2 and No. 3):

For this service a separate system of drain and vent piping, isolated from the gravity systems, was provided, but of the same material as the gravity drains. These drains discharge into two sets of duplicate Shone ejector pots, operated by compressed air, and discharging through two separate house drains to the public sewers in Mansfield street. The ejector fixture vents of these ejector systems must not be confounded with the ejector air relief risers which are necessarily serving a different purpose.

Inside of the building these ejector discharges were goosenecked or run up vertically to about 7 feet above the highest curb level, then dropped to 1st basement floor level and run thence to the street sewers, in order to prevent any flooding of the building through possible gorging of public sewers under storm conditions, and also to accelerate ejector discharges when public sewers are running full. The sump pump discharges (item No. 5) were similarly arranged. (Diagrams No. 1 and No. 3.)

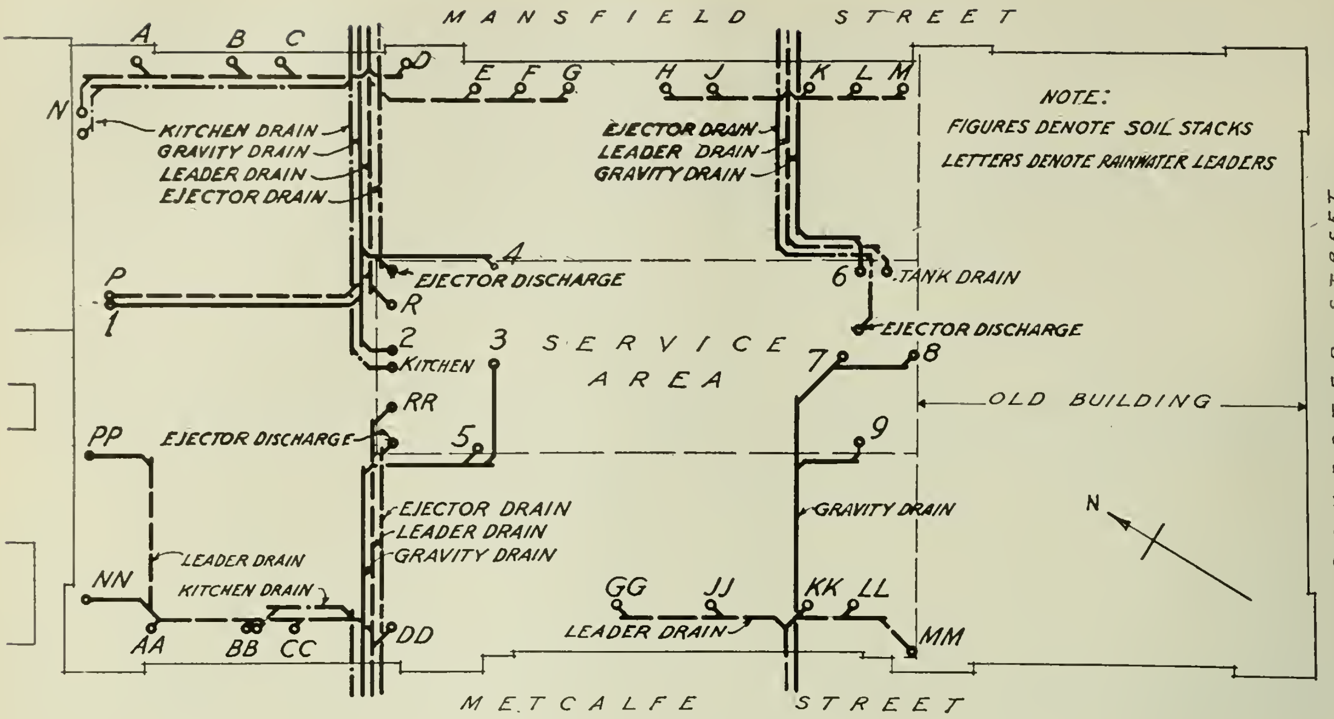


Fig. 1—First Basement Plan.

3. Gravity drainage of kitchen fixtures:

For this service, a separate system of drains was designed, discharging direct to the public sewers from the kitchen, cafeteria and bakery fixtures on the 7th and lower floors. This confines any trouble incident to this type of drainage to its own system of piping. Grease traps of the latest design, without water jackets, were specified to be set on the wastes of all sinks, dishwashers or other fixtures where greasy water is discharged.

The branch vents of these fixtures were designed to be connected with the main vent risers of the system described under item No. 1 where any such risers exist near kitchen fixtures, otherwise into the main vent riser of their own system, but not to the ejector system.

4. Ejector drainage of laundry fixtures (Diagrams No. 1 and No. 3):

From the laundry fixtures on the 3rd basement floor, a separate system of low level drains was designed to discharge to its own unit of two ejector pots delivering through goosenecked discharge mains to the ejector house drains. The branch vents of these fixtures were vented to the high level system of ejector fixture vents. The ejectors used for this purpose (formerly in use in the existing building) were reset in an ejector pit together with a second set of two reconditioned ejector pots for the low level fixtures (item No. 6) all actuated by compressed air.

5. Ejector drainage of low level fixtures (3rd basement) other than floor drains (Diagrams No. 2 and No. 3):

For this service, which includes all general, waste vented and water supplied plumbing fixtures in the 3rd basement, other than floor drains, funnel, trench and other drain boxes, the drainage system was designed to be of extra heavy cast iron soil pipe discharging into a reconditioned set of two ejector pots (mentioned in item No. 4) reset from the existing building in a new ejector pit, and discharging through goosenecks to and through the ejector house sewers to the public sewers.

6. Sump Pump drainage of low level floor drainage and ground water (Diagrams No. 2 and No. 3):

For the drainage of all floor drains, drip and waste funnel drains, the overflow from air moistening and like apparatus together with a few isolated sinks (all in the 3rd basement) plus the overflow from the old sump, another system of extra heavy cast iron soil pipe drains was designed to discharge into a sump pit under the northerly end of the central service area. This sump also receives the overflow from an adjacent interceptor pit which acts as a sedimentation pit for the ground water drainage of the site.

The discharge of the contents of the sump pit was designed to be handled by a set of two submerged vertical centrifugal sump pumps with direct connected electric motors together with a steam standby pump of the duplex piston type, with one emergency suction to the sump pit and one to the open ejector pit. The sump pumps all deliver through goosenecks to the ejector drains and thence to the Mansfield street sewer.

7. Gravity drainage of roofs, loggias and other surfaces exposed to weather (from mezzanine to 24th floor) (Diagrams No. 1 and No. 3):

This system discharges from boxes to the public sewers by gravity, through four separate house drains and house sewers; two to Metcalfe street and two to Mansfield street so as to permit emergency relief of roof drainage if any one drain should be stopped up, and also to prevent the reflection of temporary gorging of house drains on any other system. These rainwater drains join the house drains for sewage from the building foundation wall to the public sewer.

The piping used is extra strong galvanized guaranteed genuine wrought iron screw piping in the building, and extra heavy cast iron soil pipe where buried in street.

Each leader stack is trapped with a double handhole running trap at base. All branches are dropped one storey before joining the leader and all possible bends were eliminated on branches.

8. Drainage of surfaces exposed to weather from ground floor to 2nd basement:

This item is small and after the freight entrance driveway drainage has passed through an oil separator its discharge is delivered to the northerly unit of high level sewage ejectors for disposal to the public sewers.

9. Water supply and drainage for drinking fountains:

For drainage, a system of waste-risers for drinking fountains was designed to discharge with open ends into the large drip funnels. Each single riser was extended to and above the roofs with trapped branches to each fountain.

For supply, the cold drinking water mains connected to the cooling units were designed to distribute in overhead grid form to down supply mains which in turn connect to a return circulation main at their base and thence return without trapping through a single upward return circulation riser to the cooling unit.

Each fountain branch has an individual control valve, and where the pressure will exceed fifty pounds an approved pressure reducing valve is to be installed on the fixture side of the control of each branch supply.

10. Cold water supply to fixtures (Diagram No. 4):

Part of the cold water supply of this building, as is usual with all other high buildings, is supplied under street pressure, and part is pumped to tanks and thence under tank pressure to fixtures above safe street pressure supply level and to all hot water heaters under tank pressure.

Thus to accomplish a golden mean of static pressure on all fixture fittings, this building was divided into three zones, each supplied by house tanks set at such a height above the highest fixtures supplied by them as to give proper working pressure to those fixtures, while at the same time avoiding the use of pressure reducers on the branches to the lowest fixtures in that zone.

This arrangement is typical of the multi-zone building and is applied to the fire protection system as well. The thought can also be applied to the division of carriage of sewage into gravity and ejector systems.

They are, therefore, in the design of water supply for this building, a low level, an intermediate level and a high level zone. In the low level zone the street pressure supply is connected to the base of the cold down supply risers from the low level tank. These risers have dividing valves at the 2nd and 3rd storeys above the fixture branches for those storeys, so that the average street pressure can be made use of up to either level and thus reduce the pumping load. Control valves are placed at the base of each riser so that when desired street pressure can be shut off and the tank pressure supply used.

Water supply can be taken from two separate street mains (in addition to that supplying the original portion of the building) and this applies to fire supply from other high pressure mains as well. Each source of supply is valved and check valved at or near foundation wall and then cross connected to the other supply main. From this cross connecting header, after passing the water through filters, branch supplies are taken to the fixtures and mechanical equipment which require cold water at the average street pressure, and also to a large two-compartment suction tank which forms the normal source of supply to the house and fire pumps. There is also a by-pass to permit of direct supply to the suction of these pumps from the street pressure header if the tanks for any reason should be out of commission.

The electrically operated house pumps, one for each zone, and the steam stand-by pump good for all zones, are planned to draw normally from the suction tank and deliver to a two-compartment house tank and a separate fire tank at the top of each zone. From each tank as before mentioned the cold water is fed down to fixtures and hot water heaters in its zone.

The piping specified is extra strong galvanized guaranteed genuine wrought iron.

11. Hot water supply to fixtures (Diagram No. 4):

For the supply of domestic hot water to the general plumbing fixtures in each zone, a pair of horizontal cylindrical storage hot water heaters are set at the lowest level possible in each zone. Cold water is supplied through a separate down supply main from the house tank to these heaters.

From each pair of heaters the hot supply discharges, properly valved, are combined into one main hot supply riser up to the duct space over each zone, there distributing through a so-called gridiron main without trapping to return circulation supply risers feeding down, from which the supply branches to fixtures are taken. Each of these down supply risers has a check valve set on 45 degree angle where it connects with the branch to the main, and also control valves at top and bottom with a valved drainout at bottom. All such risers connect into return circulation mains and the water returns untrapped to the heaters by gravity.

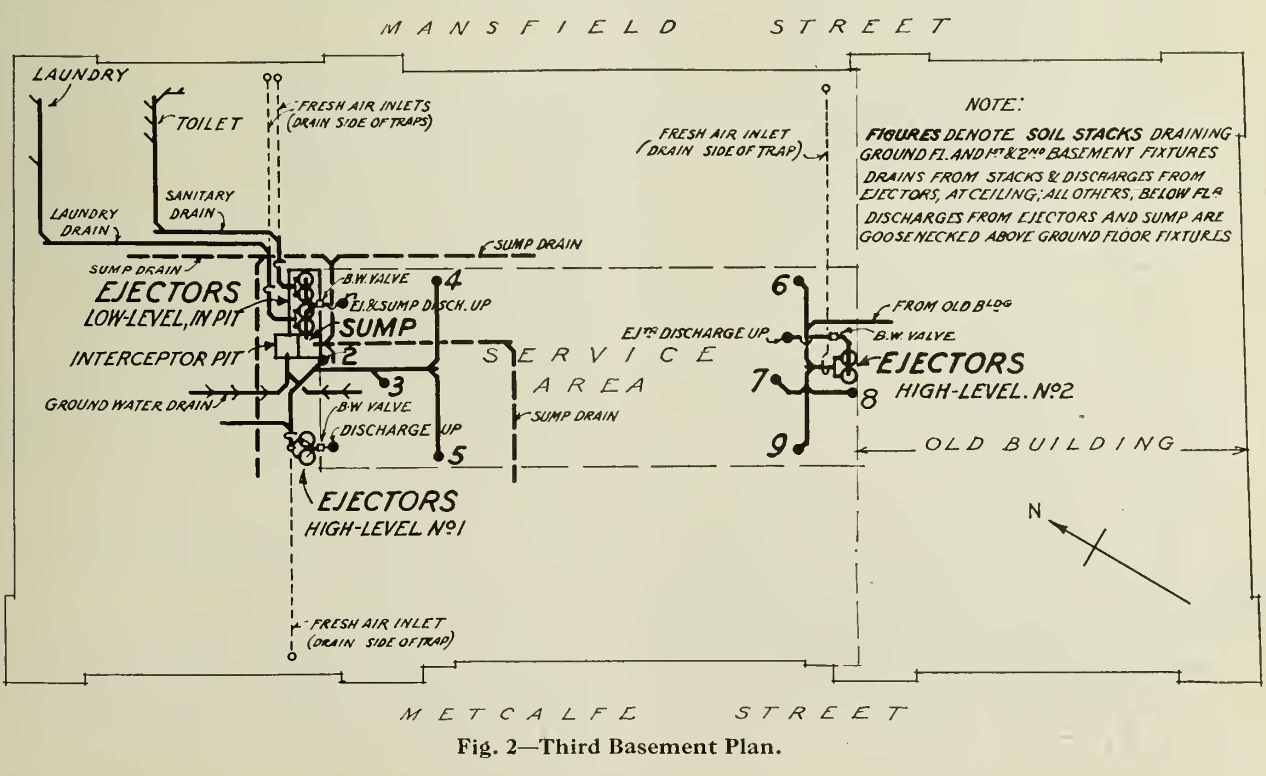


Fig. 2—Third Basement Plan.

In the lower zone are many fixtures for kitchen, cafeteria and bakery service and there is also a considerable amount of laundry equipment. To the general heaters there were therefore added one for kitchen use and one for laundry purposes, all of the same size but all so cross connected and valved that any desired number of units can be valved into any particular service which may at times be subject to heavy draft. It may finally work out that one will be used for laundry, two for kitchen, and one for general service, with hot water at different temperatures. In this zone hot water return circulation pumps, one for each service, are installed to provide efficient circulation in case of any interference with the designed gravity circulation.

In all heaters the water is heated by high pressure steam through copper coils in heater shells, the temperature being controlled by thermostats.

The material originally specified for the hot water heater shells was genuine wrought iron, but owing to difficulties experienced in obtaining this material in Canada of the sizes required, a heavy weight of steel was finally used.

All hot supply and return circulation piping is of 67 per cent copper content brass of extra strong wrought iron sizes and weights, with fittings of 75 per cent copper content.

All hot supply horizontal mains were designed with adequate expansion loops en route and there are loops at top and bottom of all risers. All fixture branches are taken off with six ell expansion loops to prevent rupture by expansion and contraction.

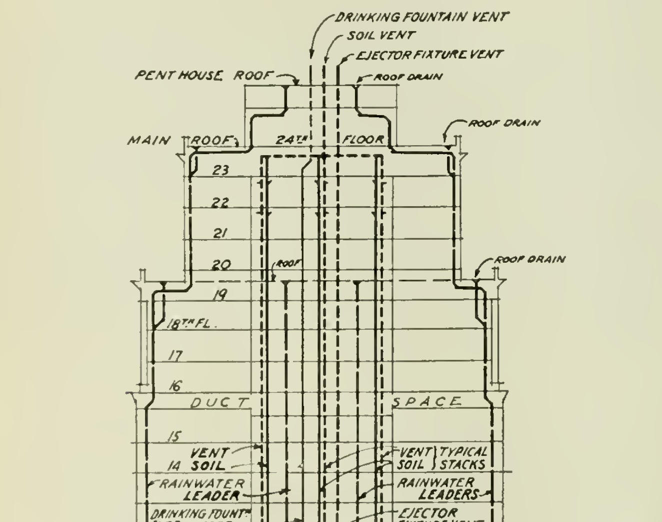


Fig. 3—Drainage Diagram.

On each heater is provided a safety relief valve, and also a free unvalved expansion riser carried up to the house tank of its zone and goosenecked up to an adequate height above the tank water level. From the high point of each hot water heater grid system a free air relief (expansion) riser is taken also goosenecked adequately above the water level in the house tank of that zone. The outlets of all these expansion and relief risers are discharged into drip pans under tanks and not into the tanks themselves, in order to obviate the possibility of scalding any person engaged in cleaning a tank. Drip pans are required under heaters.

12. Fire protection supply and sprinklers (Diagram No. 5):

The system of piping designed for this service consists of a continuous full size, loop fire main header in the 3rd basement, another in the 7th duct space storey and one in the 15th duct space storey. The headers in the third basement and seventh duct space connect to and supply five fire stand pipe risers in the original portion of the building, together with five fire stand pipes in each zone of the new portion. To the 15th storey header are connected four fire stand pipes, all in the new portion of the building, to serve the high level zone.

The header at the third basement ceiling receives its supply as follows:

First: From fire engines through siamese at street level, with check valve opening in on branches from siamese to header.

Second: From high pressure fire mains in Metcalfe and Mansfield streets, through high pressure branch supply mains also provided with check valves opening in. This pressure might serve in the two lower zones in some emergency when fire engines (or pumpers) could not serve through the fire siamese.

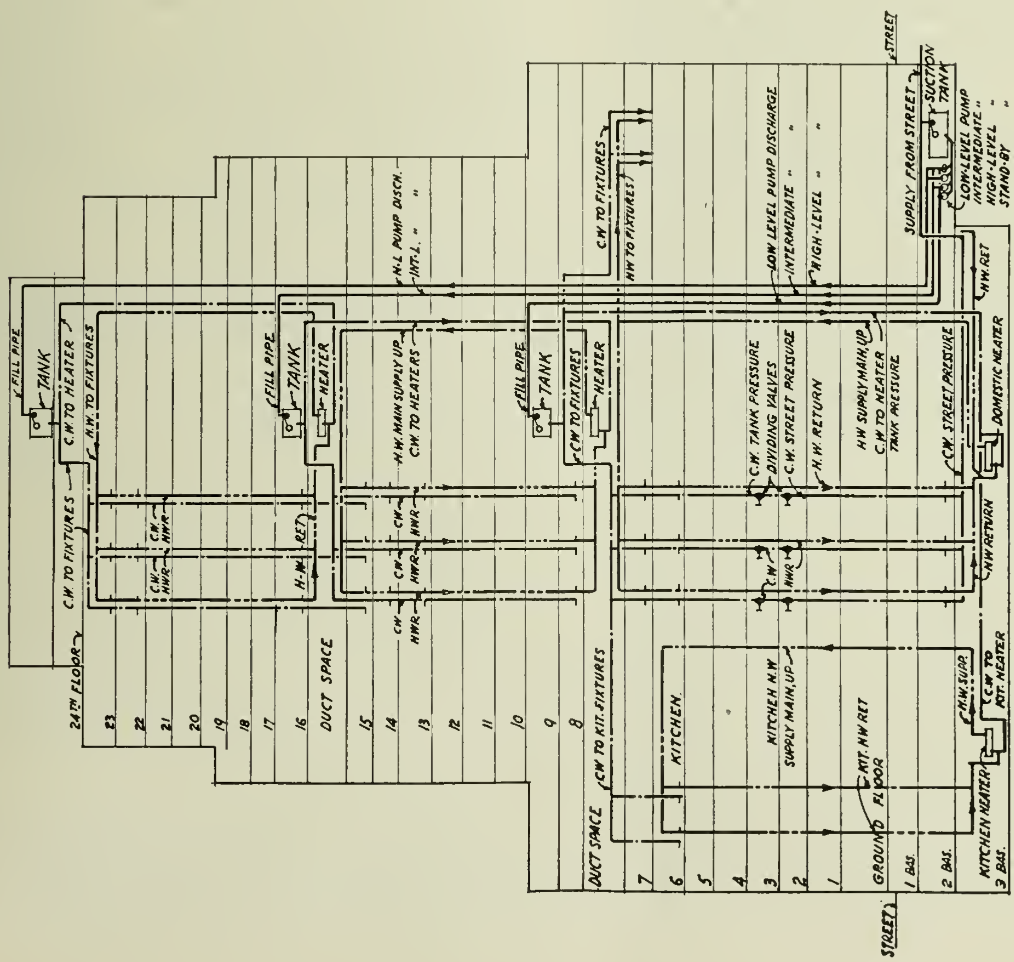
Third: From the building steam fire pumps, normally drawing their supply from the suction tank, which tank in turn is supplied from the low pressure water supply mains in Metcalfe and Mansfield streets; the fire pump discharge is also provided with a check valve. As before mentioned an emergency by-pass around the suction tank permits street pressure to be valved direct into suction headers. The two fire pumps can be used either in parallel or in series.

Fourth: From the fire tank in the 9th storey the down supply riser to fire stand pipe No. 1 has a check valve opening down, set in a horizontal position, with an O.S. & Y. controlling gate valve set on each side and sealed open, all located near tank. This tank main down connects into fire stand pipe No. 1 just below another check valve on that stand pipe, which arrangement permits pressure to be pumped up all the way to the main roof or the top of the high level zone, but does not permit the higher tank supply to be drained down to a lower zone than its own. This same principle is applied at connection of tank main down from the intermediate tank to fire stand pipe No. 1 which is the one stand pipe that rises from bottom to top of entire system. All other stand pipes begin in the lowest storey and end at the hose outlet of the upper storey of their zone; in plan they are all one immediately above the other.

We thus have tanks for fire service supply in the 9th storey for the low level zone, the 16th storey for the intermediate zone and the 24th storey (or upper pent house) for the high level zone.

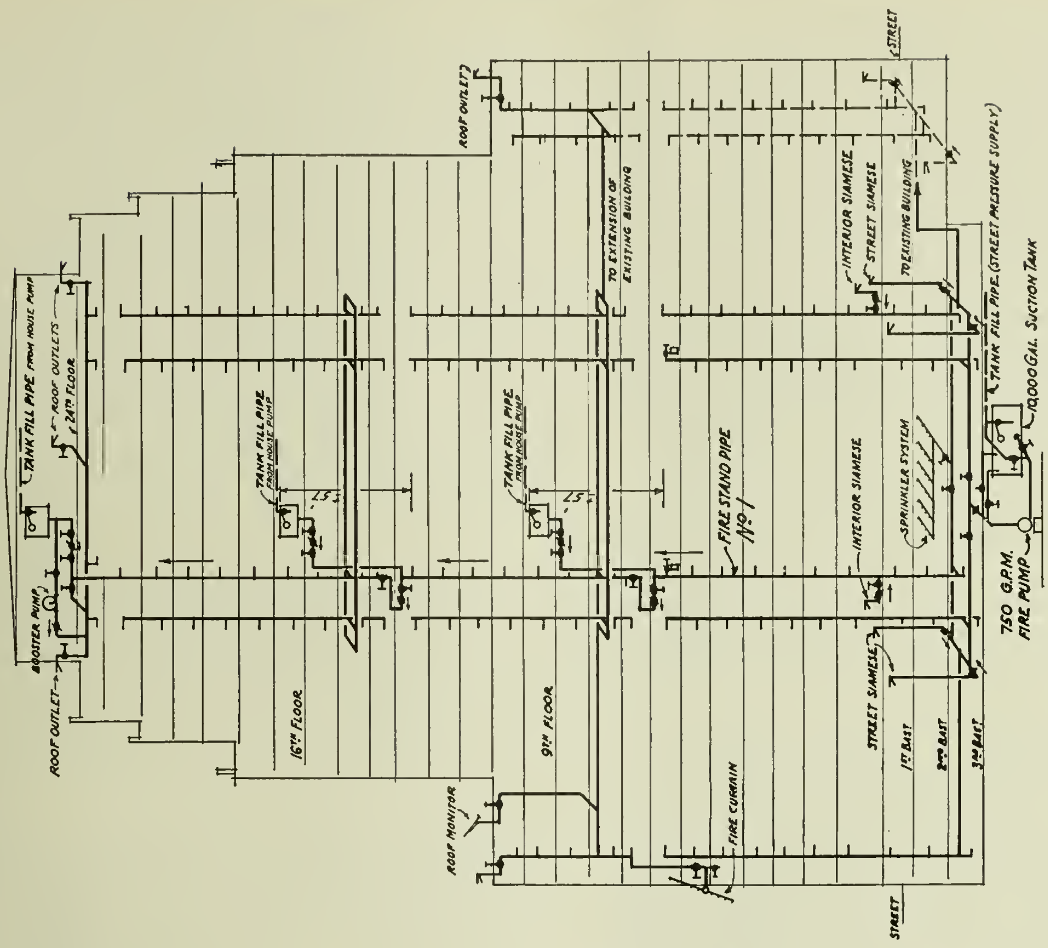
For architectural reasons the pent house roof level was kept down. This brought the high level zone fire tank to such a level in relation to the main roof and attic space hose outlets that an electrically driven booster pump was located in the pent house, to draw from the fire tank down-

SUN-LIFE BUILDING
MONTREAL



WATER SUPPLY DIAGRAM

Fig. 4.



FIRE PROTECTION SYSTEM DIAGRAM

Fig. 5.

DARLING & PEARSON ARCHITECTS
A.J.C. PAINE ASSOCIATE ARCHITECT
A.T. NEWMAN CONSULTING SAN. ENGINEER

main and deliver into the cross header for the outlets mentioned. This pump can be started from the control board in the engineer's room in the 2nd basement, thus permitting a quick rise in pressure at highest hose outlets, until the building fire pumps, or the city fire engines, get into operation.

Dividing valves are placed in each horizontal header so that any one fire stand pipe (in any zone) may be valved out of commission if piping should split or a hose valve burst.

On the 10th storey roofs at the north and south ends of the building, as well as on the main (24th storey) roof, two-way individually valved hose end outlets are provided and at the north end (where buildings either do or may exist quite close to the Sun Life building) there are two swivel-head fire monitors. These can be left in play even though the operators are driven away by heat and they also provide greater force because of their iron pipe connection which obviates the thrashing possible when hose held by hand is in use for such purposes. The water supply to all roof outlets including the monitors is controlled by long stem wheel handle gate valves with the wheel handles well above roof level and adjacent to the outlet served, while the valve itself is protected from freezing. Automatic ball drainouts are also called for, draining down from the outlet side of control valves.

On all the stand pipes, in each storey, there are provided one 1½-inch valved outlet with hose, hose-nozzle and rack, and also one 2½-inch valved outlet, without hose or rack, for the use of the fire department with their own hose. In the 1st, 2nd and 3rd basements the 1½-inch outlet valves are provided with pressure reducers set between valve and hose. These can be reset while in place so as to meet various pressures. Two similar pressure reducers of 2½-inch size are provided and kept at predetermined sites in each of the basements for use by the fire department should a basement outlet have to be put in service while the pumps were providing high service pressure for fire fighting purposes in any of the upper storeys.

The initial service to all fire hose or monitor outlets is obtained under static pressure from the fire house tanks, which tanks in turn are supplied by the house pumps.

From fire stand pipe riser No. 1 a branch emergency supply pipe will be extended to each group of fire and house tanks; namely one in the 9th storey, one in the 16th storey and one in the 24th storey. This affords another means of filling the house tanks and keeping them in service if the normal house pump supply risers to these tanks are rendered useless, which condition actually obtained in one large building some years ago, although heavy rubber lined hose was temporarily used from hose outlets to provide supply to tanks in that case. These permanent emergency branches are out of the way, but the valves at tanks must be sealed shut to prevent draining down the fire stand pipe system and thus defeating its purpose.

As to sprinklers, there are two cases. One valved branch runs from the 3rd basement fire main to sprinkler heads in certain rooms used for such purposes as paper baling etc., and another branch is led from the 16th storey tank fire stand pipe service to an exposed header of brass pipe with open spade nozzles located at the 5th storey level on the north wall of the building above the adjoining Loew's theatre and designed to give additional protection in case of a fire occurring in that theatre. The control valve on this branch is readily accessible inside the building and is sealed closed. It will be manually operated like the valves for the roof outlets, and has the same type of automatic ball drainout, so as to prevent damage from frost.

The valve to the sprinkler head line in basement is to be kept open on a wet system, all heads being factory tested to withstand a pressure exceeding that which would be needed for actual fire service.

Extra strong genuine guaranteed wrought iron pipe is used throughout this system except where brass pipe is noted.

13. Liquid soap supply:

The piping for this service is divided into two down systems in each zone, filling to sub-tanks and from them to faucets on fixtures. The head of each system is provided with valved double offset cross head connection with space and skids for two drums. Easily accessible valves control the supply from drums to sub-tanks.

Isolated fixtures and smaller fixture groups have group tanks rated as sub-tanks, manually filled.

The piping for this system of supply is black full card standard weight genuine wrought iron.

The soap faucets and exposed piping to wall are of non-corrosive mono metal, nickel plated and then chromium plated.

14. Gas supply, fuel and emergency lighting:

Fuel gas supply is connected to all kitchen, cafeteria or bakery fixtures requiring it, and there are also branches to forty emergency lighting outlets in the 3rd basement.

A master emergency shut-off valve for operation by the fire department from the sidewalk was specified but was finally omitted.

The gas piping is black standard weight genuine guaranteed wrought iron.

15. Mechanical plant:

Under this head are the following operative units:

(*a*) Water filter.
(*b*) House pumps................Electric
(*c*) House pump, stand by........Steam
(*d*) Fire pump...................Steam
(*e*) Booster pump (fire system)...Electric
(*f*) Sump pumps.................Electric
(*g*) Sump pump, stand by........Steam
(*h*) Sump and ejector pit ejector...Steam
(*i*) Hot water circulating pumps...Electric
(*j*) Ejectors......................Compressed air
(*k*) Air compressors...............Electric
(*l*) Plumbing fixtures.

Regarding these, the following notes may be of interest.

(*a*) Water filter:

This cast iron shell drifting sand filter has been in use in present building. It will be used until the building population and consumption require the installation of another for which space has been provided.

(*b*) House pumps (electric):

These are three in number (one for each zone) to fill the house tanks and are horizontal multi-stage centrifugal heavy duty pumps, automatically and manually operated by direct connected electric motors.

(*c*) House pump (steam, stand by):

This is a horizontal duplex direct-action piston pattern steam driven pump.

The valved and check valved discharge of this pump is so cross connected to the electric house pump discharge risers as to permit it to be used to supply any house tank at any zone level. This pump will provide an alternative supply in case the electric current is cut off, and will supplement the capacity of the electric pumps if necessary.

(*d*) Fire pump (steam):

This pump was originally specified to be an underwriters horizontal duplex direct action piston pattern steam-driven pump, but later two horizontal multistage centrifugal pumps driven by steam turbines were substituted. These are to be manually controlled in parallel for service on low or intermediate zones and in series for high level zone. They are to operate under an ultimate working pressure of 350 pounds.

Like the house pumps, they will usually draw from the suction tank, but will be connected with the emergency by-pass which, when required, will furnish street pressure supply direct to the pump suctions. The valved and check valved discharge of these pumps connects into the new fire main loop and thence through fire stand pipe No. 1 they will deliver effective fire streams from main roof or any lower outlet. On the pump side of check and control valve there is a valved test end delivering into the suction tank and an unvalved branch with safety relief valve also discharging separately into the suction tank.

(*e*) Booster pump (electric):

This horizontal centrifugal electrically-operated pump has but one source of supply, namely the high level fire tank, and discharges to the highest fire hose outlets direct. It is to be operated from the engineers control board in 2nd basement or at the pump.

(*f*) Sump pumps (electric):

There will be one heavy duty line duplex automatic electric bilge or sump pump unit, submerged in pit, consisting of two pumps direct connected to motors set well above flood level on 3rd basement floor. The pit has an air vent to the outer air and is furnished with a high water alarm. The valved and check valved discharges are delivered through goosenecks to house drains and thence to street sewers.

(*g*) Sump pump, standby (steam):

This is of the same type as the stand by house pump but fitted to handle sewage. Its suction is divided, one leg to draw from the tight sump pit and the other leg from the open ejector pit, each leg being fitted with foot valve, gate valve and priming line. The discharge is the same as for the electric sump pumps.

(*h*) Ejector (steam):

A medium size steam-operated ejector is provided to handle small amounts of drip, thus obviating the necessity of putting the large pump into operation under uneconomic conditions. It draws from the sump or from the ejector pit.

(*i*) Hot water circulating pumps (electric):

There are three of these, of the same horizontal centrifugal type as the cold water house pumps, except that they handle hot water and will be manually controlled. They are placed on valved by-passes from the return circulation main of the system which they are to serve, one for general, one for kitchen and one for laundry service.

(*j*) Ejectors (air operated):

Two reconditioned existing duplex heavy cast iron ejector pot units are reset in the ejector pit, one for general and one for laundry service. Two new duplex pot units are also provided and set on the 3rd basement floor, one at the north and one at the south end of the building; they will serve the general fixtures from 2nd basement to ground floor inclusive. Each pot has its inlet and outlet guarded with a check valve. The moving power is compressed air supplied by motor driven compressors and introduced through an air valve operated by a bell-shaped float so set that the pots alternate in their discharge. Each pot has a silencer, and an adequate size ejector air relief riser run up to and above the main roof.

(*k*) Air compressors:

The existing horizontal direct single action compressors with their belt connected motors, have been reconditioned, and placed at the south end of the 3rd basement, together with one new compressor, one old air receiving tank, and one new tank.

A combined compressed air discharge main will deliver air from the receiving tank to all sewage ejectors.

If compressed air is required later for dental units, small compressors serving one or two chairs will be installed near them.

(*l*) Plumbing fixtures:

These are of normal type, the majority of Canadian manufacture, some from Great Britain and a few of foreign make.

General

It would be well to emphasize the fact that to prevent any possibility of danger or nuisance from vent openings at a low level, all vent, soil and relief risers are extended to end above the main roof level.

All leaders are carefully offset every 8 to 10 storeys to prevent abrasive action at base from fall of storm water carrying grit from roof surfaces. Cushion legs were specified at base of leaders where last drop was ten storeys more or less, but were later omitted.

The flushing rim toilet room floor-drain wastes discharge into large copper funnels, each funnel having a 4-inch trapped and vented waste discharging through the low level drain system to the sump.

No main house traps with fresh air inlets or breathers are permitted by the city of Montreal by-laws, and therefore none have been installed.

No globe valves are used unless they come with some special fixture or apparatus already designed to function with such valves.

In conclusion, the author would remark that in the construction and equipment of this great building, said to be the largest in the British Empire, an endeavour has been made to obtain the best in design, workmanship and material that can be put into its creation, and he believes that no effort has been spared to attain that end.

Report of Council for the Year 1930

In presenting the annual reports for 1930 the Council would point out that although industrial conditions during the year have been somewhat adverse, the activities and services of The Institute have been satisfactorily maintained. The number of branch meetings, and the attendance at them, particularly in the case of the larger branches, has been gratifying, and from the branch news items published in The Journal it is evident that the branches in their activities have well kept in view the acquirement and interchange of professional knowledge, which is one of the main objects of The Institute. But, as will be seen from the committees' reports, it has not been possible to develop the work of The Institute along certain desirable lines, for Headquarters' expenditure has been strictly limited, and in some instances has had to be curtailed.

An outstanding event of the year has been the negotiation of an arrangement with the Council of The Royal Aeronautical Society for co-operation between that body and The Institute. This agreement provides that Aeronautical sections formed by Institute branches will be recognized also as Canadian sections of the Royal Aeronautical Society. Members of these sections will enjoy certain privileges as regards the publications of both bodies, and the arrangement will enable aeronautical engineers in Canada to connect themselves both with their own national organization and with a leading technical society devoted exclusively to the interests of their own branch of engineering work. This constitutes a new and promising departure in Institute policy, for it is hoped that when the scheme has been successfully worked out it may be possible to enter into similarly beneficial relations with other bodies of like standing dealing with other specialized branches of engineering.

A special Committee on the Publications of The Institute was appointed at the Plenary Meeting of Council in October, 1929, and reported at the 1930 Plenary Meeting; a number of its recommendations have already been put into effect, others being necessarily held over for financial reasons. The Plenary Meeting of Council directed the Publication committee to make preparations for the issue of a volume or volumes of Transactions including the principal technical papers contributed to The Institute since the publication of the last volume of Transactions in 1927. It is hoped that funds will be available for this purpose.

The Institute's Committee on Classification and Remuneration, appointed in April, 1930, has continued its work, and has studied the information obtained from some 1,200 of The Institute's members. Their report on this work is now before Council, together with a second report on the question of professional fees; the latter is now presented to the Annual Meeting.

In view of the fact that The Institute's membership during the past five years, while fluctuating, has shown no definite increase in numbers, a Committee on Membership was appointed at the Plenary Meeting of Council in September last, and is now studying the situation, particularly as regards the desirability of co-ordinating the methods of the branches in the recruitment of new members, especially from among recent graduates from Canadian engineering schools. In the opinion of Council a definite policy should be adopted in regard to this important question, which in the past has been left largely to the individual action of the various branch executive committees.

In regard to the relations between The Institute and the provincial associations of professional engineers, a subject which received considerable attention at the last Annual Meeting and at the recent Plenary Meeting of Council, it may be noted that certain suggestions of The Institute's committee as to the formation of a National committee were then outlined, and have been placed before the Councils of the various associations. The governing bodies of some of these have already concurred with the suggestions, and they are still under consideration by others. Pending the formation of the proposed National committee, it is hoped that the associations will permit The Institute's committee to save time by arranging for the collection of preliminary data regarding the present requirements for admission, etc., to the various associations. Progress in this important matter is necessarily slow, as each step involves obtaining the agreement and approval of nine separate bodies.

The work of The Institute's Employment Service Bureau has been actively continued during the year, and would be greatly assisted if a larger proportion of our members would furnish recent particulars of their careers by registering with the Bureau. During the first six months of 1930, employment conditions, while somewhat less favourable than in 1929, were not markedly so, but during the latter half of the year there has been a considerable falling off in the number of placements effected. This is due partially to seasonal causes, but largely also to the reduction which has taken place in the staffs of a number of our larger companies employing engineers.

There has been a gratifying increase in the extent to which members have used The Institute's library and information service at Headquarters. The Engineering Index, to which The Institute is and has been a subscriber for many years, makes it possible to advise members of the latest technical information appearing on any given engineering subject in a list of nearly two hundred technical periodicals in all the principal countries in the world.

The only amendments to the By-laws proposed this year by Council affect sections 66 and 67, dealing with the constitution of the Nominating committee. Council's proposal is intended to make the Nominating committee a more efficient body than at present, and to insure that in every case the Nominating committee, before preparing its list of nominees, shall obtain the opinions of the several branch executive committees as to the nominees they would recommend. The Nominating committee now consists of twenty-six members scattered all over Canada, and under the present arrangement its work must necessarily be carried on entirely by correspondence. Further, it is at present not compulsory for a member of the Nominating committee to consult his branch executive committee when putting forward a candidate or candidates.

The amendment to section 34, dealing with an increase in members' annual fees, which was proposed by Council in 1929 and again in 1930, has twice been rejected by the membership on ballot. Accordingly, while still urging that an increase in members' fees is inevitable if the work of The Institute is to develop as it should, Council has not thought it advisable to present this amendment again this year. There is, therefore, no possibility of increased revenue from members' fees during 1931-1932 unless the number of our members increases.

During the past year the deaths of an unusually large number of The Institute's members have been recorded, the list including no less than eleven of the senior members who joined the Canadian Society of Civil Engineers on its original formation in 1887. The names of such prominent members as C. E. W. Dodwell, Hon.M.E.I.C., Henry Holgate, M.E.I.C., Past-President R. W. Leonard, M.E.I.C., H. M. MacKay, M.E.I.C., W. F. McKnight, A.M.E.I.C., G. F. Porter, M.E.I.C., and F. L. Wanklyn, M.E.I.C., would partially indicate the extent of the loss sustained by The Institute.

The Fourth Plenary Meeting of Council was held at Headquarters on September 22nd, 23rd and 24th, 1930, when an attendance of thirty-three members of Council made it possible to discuss fully many important points of policy. The proceedings are reported in the Engineering Journal for November, 1930, pages 643 to 649

The Forty-fourth Annual General and General Professional Meeting was held in Ottawa on February 12th, 13th and 14th, 1930, and its marked success was principally due to the well organized activities of the Ottawa Branch Executive committee and members.

Canadian engineering achievement was well represented at the Second World Power Conference held in Berlin in June, 1930, and the Dominion was honoured by the selection of Dr. O. O. Lefebvre, M.E.I.C., as chairman of one of the sections. The Canadian contribution to the literature of the Conference consisted of a series of seven papers on Canadian engineering topics, all by prominent members of The Institute. These were published in the July number of The Engineering Journal.

At the Plenary Meeting of Council it was decided to establish eleven Engineering Institute of Canada Prizes, one at each of the principal engineering schools of the country, and these have been gratefully accepted by the governing bodies of the institutions concerned. It is hoped that these prizes will prove of marked benefit to the cause of engineering education in Canada.

Meetings

Annual General Meeting

The Forty-fourth Annual General and General Professional Meeting was held at Headquarters in accordance with the By-laws on Thursday, January 23rd, 1930, at 8 o'clock p.m., with Councillor O. O. Lefebvre, M.E.I.C., in the chair. After the approval of the minutes of the Forty-third Annual General Meeting and the appointment of the scrutineers and the auditors, the meeting was adjourned, to reconvene at 10 o'clock a.m., on Wednesday, February 12th, 1930, at the Chateau Laurier, Ottawa, Ontario.

On February 12th, the adjourned meeting duly took place, with President C. H. Mitchell, M.E.I.C., in the chair. The Nominating committee for 1930 was appointed, and a message from the Hon. Charles Stewart, Minister of the Interior, was presented, inviting The Institute to participate in the Canadian representation at the Second World Power Conference to be held in Berlin in June, 1930.

The medals and prizes of The Institute were then presented to the various recipients, and the meeting proceeded to discuss the Report of Council for 1929, the reports of the various committees, and the branch reports. Prolonged discussion took place on the report of the Committee on the Relations of The Institute with the Provincial Associations of Professional Engineers, outlining a course of action with a view to ultimate confederation of the various bodies concerned. The report was adopted, and the committee was authorized to place the suggestions it contained before the governing bodies of the various associations.

After discussion of Council's proposals for amendments to the By-laws, President C. H. Mitchell delivered his valedictory address, for which he received a hearty vote of thanks. The scrutineers' report was next presented, and the officers for 1930 were declared elected.

The newly-elected President, A. J. Grant, M.E.I.C., was then conducted to the chair, and after a brief address from Mr. Grant, and votes of thanks to the retiring President and Council for their services during 1929, and to the Ottawa Branch for their successful efforts in connection with the Annual Meeting, the business proceedings terminated.

General Professional Meeting

The technical sessions of the General Professional Meeting took place on February 13th and 14th, when a series of papers were presented and discussed, dealing principally with the work of engineers in the government service in connection with communication, transportation and the development of the natural resources of the country. An interesting demonstration of the operation of mechanical transport vehicles across country in snow was arranged by the Department of National Defence. The social features of the meeting included a luncheon on the 12th, at which a vigorous address was delivered by Sir Henry Thornton, M.E.I.C., President of the Canadian National Railways; a luncheon on the following day when Dr. H. M. Tory, President of the National Research Council, spoke on "The Place of Research in Canada," and the Annual Dinner of The Institute on the 14th, at which the principal speakers included the Hon. C. A. Dunning, Minister of Finance, the Hon. Charles Stewart, Minister of the Interior, and the Hon. T. A. Crerar, Minister of Railways and Canals. Through the kindness of the Gatineau Power Company a large party of members and visitors were conveyed to Paugan falls and inspected this very interesting power development. One of the outstanding events of the meeting was the reception and ball held on the evening of the 13th, which Their Excellencies the Governor-General and Viscountess Willingdon honoured with their presence, and which proved perhaps the most popular function of all.

Roll of The Institute

During the year 1930, two hundred and eighty-three candidates were elected to various grades of The Institute. These were classified as follows: nine Members, forty-four Associate Members, forty-six Juniors, one hundred and eighty-one Students, and three Affiliates. The elections during the year 1929 totalled one hundred and seventy-six.

Transfers from one grade to another were as follows: Associate Member to Member, twelve; Junior to Member, one; Junior to Associate Member, fifty-six; Student to Associate Member, forty-one; Student to Junior, thirty-five; Student to Affiliate, two; Affiliate to Junior, one; a total of one hundred and forty-eight.

The names of those elected or transferred are published each month immediately following the election.

Removals from the Roll

There have been removed from the membership roll, during the year 1930, for non-payment of dues, and by resignation, fifteen Members, forty-nine Associate Members, thirty-seven Juniors, ninety-two Students, and two Affiliates, a total of one hundred and ninety-five.

Twelve reinstatements were effected, eleven Life Memberships were granted, and twenty-four members were placed on the Suspended List.

Deceased Members

During the year 1930 the deaths of fifty of The Institute's members have been reported as follows:—

Honorary Member

Dodwell, Chas. E. W.

Members

Armour, Robert	Goulet, J. A. Godefroy
Balfour, Francis Henry	Handy, Henry Francis Troughear
Bowman, Henry Alexander	Hart, Percy Edward
Cross, William	Harkom, John William
Girdwood, Edward Prout	Hazen, Allen

Holgate, Henry
Irwin, Henry
Kelliher, Bartholomew Brosnan
Leluau, Charles Cesar
Leonard, Reuben Wells
Mackay, Henry Martyn
Matheson, William Grant
McCarthy, George Arnold
McCarthy, James Marmaduke
McConnell, Brian Douglas
Mitchell, Arthur Knox
Moberly, Frank
Moore, John MacKenzie
Osler, Stratton Harry
Pearce, William
Porter, George Frederick
Ryerson, William Newton
Smith, A. H.
Thompson, George William
Turner, John Harrison
Valiquet, Ulric
Wanklyn, Frederick Lumb
Wetmore, Charles Ludlow
York, John James

ASSOCIATE MEMBERS

Briggs, John Bennet
Culshaw, John Goldsworth
Eastman, Arthur Edward
McClory, Frank Cyril
McKnight, William Falconer
Mellor, Arthur Lees
Millican, Charles Arthur
Nelson, George John
Pense, Edward Herbert
Spencer, Arthur Thomas
Thomas, Edward Arnold
Warren, William Robert

JUNIOR

Williams, Stephen

STUDENTS

Doberer, Cameron
Mules, Nathan Ernest

TOTAL MEMBERSHIP

The membership of The Institute as of January 1st, 1931, totals four thousand six hundred and ninety-one. The corresponding number for 1929 was four thousand six hundred and eighty-three. These figures do not include members who have been placed on the Suspended List, or those who have not yet accepted election.

The details are as follows:

1930		1929	
Honorary Members	9	Honorary Members	10
Members	1,104	Members	1,124
Associate Members	2,309	Associate Members	2,248
Juniors	444	Juniors	468
Students	769	Students	780
Affiliates	56	Affiliates	53
	4,691		4,683

Respectfully submitted on behalf of the Council,

A. J. GRANT, M.E.I.C., *President.*
R. J. DURLEY, M.E.I.C., *Secretary.*

Finance Committee

The President and Council,—

In its report to Council last year your committee pointed out that The Institute's present income per member is much lower than in other technical societies affording comparable services to their members, and that in 1930 The Institute's expenditure would have to be curtailed in certain important respects unless the increase in members' fees, then proposed, received approval. That approval was not given, and, accordingly, it has been necessary to discontinue certain desirable activities. The financial statement now presented indicates the principal items on which money has been saved in this way. The Secretary's visits to many of the branches have had to be omitted, and no professional meetings, other than the general pro-

STATEMENT OF ASSETS AND LIABILITIES AS AT 31ST DECEMBER, 1930

ASSETS

PROPERTY		$ 89,041.64
FURNITURE:		
Balance as at 1st January, 1930	$ 5,686.17	
Less: 10% Depreciation	568.61	
		5,117.56
LIBRARY:		
Balance as at 1st January, 1930	2,452.39	
Less: 10% Depreciation	245.23	
		2,207.16
STATIONERY—On hand		454.75
GOLD MEDAL		45.00
INVESTMENTS—At Cost:		
Canada Permanent Mortgage Corp., 2 Shares of Par Value $100 each	215.00	
$500 Prov. of Saskatchewan 5% Bond, 1959	502.50	
$6,000 Montreal Tramways Bonds,		
$5,000 5%, 1955	4,689.00	
$1,000 5%, 1941	950.30	
$500 Title Trust & Guarantee Corp. Certificate	500.00	
$4,000 Dominion of Canada Victory Loan, 5½%, 1934	4,090.71	
$100 Dominion of Canada Victory Loan, 4½%, 1946	96.50	
40 Shares Montreal Light, Heat & Power Cons. of No Par Value (4 Shares part paid)	226.34	
		11,270.35
ACCOUNTS RECEIVABLE:		
Sundry and *Journal* Advertising	3,700.16	
Advances to Branches	406.40	
	4,106.56	
Less: Reserve for Bad Debts	258.39	
		3,848.17
ARREARS OF FEES—Estimated		2,500.00
CASH:		
Canadian Bank of Commerce:		
Current Account	1,732.48	
Savings Account	80.80	
Petty Cash	100.00	
		1,913.28
UNEXPIRED INSURANCE		200.00
SPECIAL FUNDS:		
Investments	10,369.34	
Cash in Savings Bank	2,644.33	
		13,013.67
POST MASTER—Deposit		100.00
		$129,711.58

LIABILITIES

ACCOUNTS PAYABLE:		
Sundry	$ 3,226.69	
Amounts due to Branches	353.44	
Reserve for part cost of transactions	2,500.00	
		$ 6,080.13
LOAN ACCCOUNT:		
Canadian Bank of Commerce		3,000.00
SPECIAL FUNDS:		
As per Schedule attached		13,013.67
LIFE MEMBERSHIP FEES:		
For Investment		300.00
SURPLUS:		
Balance as at 1st January, 1930	108,831.25	
Life Membership Fees invested	700.00	
Add: Amount over-reserved for Accounts Payable 1929	300.00	
	109,831.25	
Deduct: Deficit for year ended 31st December, 1930	2,513.47	
		107,317.78
		$129,711.58

MONTREAL, 14TH JANUARY, 1931.

(Signed) RIDDELL, STEAD, GRAHAM & HUTCHINSON, C.A.
Auditors.

STATEMENT OF REVENUE AND EXPENDITURE FOR THE YEAR ENDED 31st DECEMBER, 1930

Revenue

Membership Fees:		
Arrears	$ 3,461.25	
Current	28,079.78	
Advance	396.19	
Entrance	2,846.00	
		$34,783.22
Interest:		
On Overdue Fees	265.12	
" Victory Loan Bonds	234.26	
" Montreal Tramways Bonds	300.00	
" Savings Bank Account	62.12	
" Title Guarantee & Trust Corp., Certificate	30.00	
" Province of Saskatchewan Bond	5.51	897.01
Dividends:		
Canada Permanent Mortgage Stock	24.00	
Montreal Light, Heat & Power Cons	48.60	
		72.60
Publications:		
Journal Subscriptions	8,175.67	
Journal Advertising	29,956.69	
E-I-C. News Advertising	4,552.18	
Year Book Advertising	877.25	
Journal Sales:		
April 1929	100.25	
July 1930	766.50	
		44,428.54
Refund on Expenses of Hall		725.00
Certificates		139.17
Badges		35.80
Deficit:		
Excess of Expenditure over Revenue for the year ended 31st December, 1930		2,513.47
		$83,594.81

Expenditures

Building Expense:			
Taxes, Property and Water		$ 1,782.31	
Fuel		516.07	
Insurance		17.69	
Light and Gas		337.98	
Caretaker's Wages and Service		1,271.60	
Repairs and Expenses		642.80	
			$4,568.45
Office Expense:			
Salaries—Secretary and Office Staff		15,881.50	
Office Supplies and Stationery		1,653.90	
Postage and Telegrams		1,336.41	
Audit		300.00	
Legal Expenses		7.00	
Telephone		313.45	
Messenger and Express		84.57	
Miscellaneous		455.16	
			20,031.99
Publications:			
Year Book:			
Cost	$2,207.64		
Less: Reserve	821.00		
		1,386.64	
Journal		31,632.99	
E-I-C. News		6.597.34	
Sundry Printing		817.27	
Transactions — Reserve against part-estimated cost		2,500.00	
			42,934.24
General Expense:			
Annual and Professional Meetings		2,244.29	
Plenary Meeting of Council		1,859.97	
Committee on Remuneration		910.62	
" " Co-ordination		35.58	
Membership Committee		12.85	
Travelling Expense—Secretary		729.60	
Branch Stationery		170.75	
Students' Prizes		54.03	
Library Expenses and Magazines		2,013.55	
Depreciation on Furniture and Books—10%		813.84	
Bank Exchange and Discounts		215.46	
Examinations:			
Cost	$181.74		
Less: Collected	75.00		
		106.74	
			9,167.28
Rebates to Branches			6,892.85
			$83,594.81

Special Funds

Leonard Medal

Balance as 1st January, 1930	$568.93	
Add: Bond Interest	30.00	
Bank Interest	2.20	
		$601.13
Represented by:—		
Title Guarantee & Trust Corp. certificate 6%	500.00	
Balance in Bank	101.13	
	$601.13	

Plummer Medal

Balance as at 1st January, 1930	$520.58	
Add: Bond Interest	27.50	
Bank Interest	.79	
	$548.87	
Less: Cost of Medal	15.00	
		533.87
Represented by:—		
Victory Loan 1934, 5½%	500.00	
Balance in Bank	33.87	
	$533.87	

Fund in Aid of Members' Families

Balance as at 1st January, 1930	$1,950.40	
Add: Bond Interest	49.50	
Bank Interest	17.17	
Cash Received	27.50	
		$2,044.57
Represented by:—		
Victory Loan 1934, 5½%	1,400.00	
Balance in Bank	644.57	
	$2.044.57	
Forward		$3,179.57

Special Funds—*Continued*

Brought Forward		$3,179.57

Past-Presidents' and Prize Fund

Balance as at 1st January, 1930	$4,418.57	
Add: Bond Interest	152.50	
Bank Interest	19.54	
Cash Received	312.50	
		$4,903.11
Represented by:—		
$2,500 Dom. of Canada, C.N.R. 5%, 1954 Bonds	2,489.55	
$1,500 Title Guarantee & Trust Corp. 1933	1,500.00	
Balance in Bank	913.56	
	$4,903.11	

War Memorial Fund

Balance as at 1st January, 1930	$4,697.64	
Add: Bond Interest	210.00	
Bank Interest	23.35	4,930.99
Represented by:		
$2,000 C.P.R. Collateral Trust, 5%, 1934 Bonds	1,979.79	
$2,000 Dom. of Canada, 5½%, 1934 Bonds	2,000.00	
Balance in Bank	951.20	
	$4,930.99	
		$13,013.67

fessional meeting, have been held. Fortunately, there were no unforeseen expenses of any serious amount during 1930, and the revenue from advertising has been maintained, so that The Institute's total income for 1930 was practically the same as in 1929. There seems no prospect of any material increase of income for 1931.

At its Plenary Meeting in September, 1930, Council directed that certain expenditures be undertaken connected with the issue of Transactions free of cost to members; the establishment of eleven students' prizes to be awarded annually by the principal engineering schools of Canada; visits to branches by vice-presidents; co-operation with the Royal Aeronautical Society, and the work of the Committee on the Relations of The Institute with the Professional Associations. It is estimated that these items will require an expenditure of about $4,000. during 1931.

At the same meeting certain recommendations by the Special Committee on the Publications of The Institute were put in effect, with a view of economizing in the cost of The Journal by omitting the Engineering Index, and augmenting the advertising revenue by an increase in rates. It seems unlikely that these measures will yield more than $1,500 during the year.

Further suggestions by the Special Committee, which were endorsed but not adopted by the Plenary Meeting, recommended the publication of engineering abstracts; additional assistance in the editorial department at Headquarters; the holding of three regional professional meetings each year, and other very desirable features which would require a further outlay of about $10,000 annually.

Your committee draws attention to all these points to show the impossibility of further developing The Institute's work under present financial conditions.

In order to take account of present commitments for 1931 there has been included in the financial statement a reserve of $2,500 against part of the cost of the publication of Transactions, on which preliminary work has already commenced. Apart from this item the statement shows a practical balance between receipts and disbursements.

The accounts of members in arrears have been closely scrutinized, and appropriate action taken in each case, allowance having been made in instances where satisfactory explanations have been furnished. It will be noted that the amount of arrears of fees collected during the year has been less than in 1929, this being in accordance with the estimate in your Committee's report of last year.

Respectfully submitted,
G. R. MacLeod, m.e.i.c., *Chairman.*

Nominating Committee, 1931

Appointments to the Nominating committee for the year 1931 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: P. S. Gregory, m.e.i.c.

Branch	*Representative*
Halifax Branch	H. W. L. Doane, M.E.I.C.
Cape Breton Branch	K. H. Marsh, M.E.I.C.
Saint John Branch	J. P. Mooney, A.M.E.I.C.
Moncton Branch	G. L. Dickson, A.M.E.I.C.
Saguenay Branch	G. F. Layne, A.M.E.I.C.
Quebec Branch	P. Méthé, A.M.E.I.C.
St. Maurice Valley Branch	C. H. Jetté, A.M.E.I.C.
Montreal Branch	P. E. Jarman, A.M.E.I.C.
Ottawa Branch	W. D. McLachlan, M.E.I.C.
Peterborough Branch	A. L. Killaly, A.M.E.I.C.
Kingston Branch	W. L. Malcolm, M.E.I.C.
Toronto Branch	R. O. Wynne-Roberts, M.E.I.C.
Hamilton Branch	W. L. McFaul, M.E.I.C.
London Branch	F. C. Ball, A.M.E.I.C.
Niagara Peninsula Branch	C. G. Moon, A.M.E.I.C.
Border Cities Branch	J. Clark Keith, A.M.E.I.C.
Sault Ste. Marie Branch	W. S. Wilson, A.M.E.I.C.
Lakehead Branch	F. C. Graham, A.M.E.I.C.
Winnipeg Branch	J. W. Porter, M.E.I.C.
Saskatchewan Branch	H. R. Mackenzie, A.M.E.I.C.
Lethbridge Branch	R. Livingstone, M.E.I.C.
Edmonton Branch	E. Stansfield, M.E.I.C.
Calgary Branch	F. M. Steel, M.E.I.C.
Vancouver Branch	J. C. Oliver, Jr.E.I.C.
Victoria Branch	J. C. MacDonald, M.E.I.C.

Sir John Kennedy Medal

At the meeting of Council held on October 17th, 1930, it was decided to award the Sir John Kennedy Medal for the year 1930 to George Herrick Duggan, m.e.i.c. This distinction is the highest in the gift of The Institute.

Past-Presidents' Prize Committee

The President and Council,—

It is the unanimous opinion of your Committee that the Past-Presidents' Prize for 1929-30 should be awarded to Group-Captain E. W. Stedman, m.e.i.c., for his paper on "Rigid Airships," duly submitted for the prize and published in The Engineering Journal for February, 1930.

Respectfully submitted,
Chas. M. McKergow, m.e.i.c., *Chairman.*

Gzowski Medal Committee

The President and Council,—

Your Committee, having studied all of the papers eligible for consideration for the award of the Gzowski Medal for the prize year 1929-30, has decided to take advantage of the opportunity afforded by the fact that no medal was awarded last year, to award two medals this year, as follows:—

1. To F. M. Wood, a.m.e.i.c., for his paper "A Short Monograph on Nomography."
2. To P. B. Motley, m.e.i.c., for his paper "Reinforcement in Place of the Stoney Creek Arch Bridge."

The decision to make the above noted awards was a unanimous one on the part of the members of the Committee, but it was not arrived at without a considerable amount of discussion with respect to the relative merits of the papers under consideration, among which there were several of outstanding interest.

While this has made the work of the Committee extremely difficult, it is our feeling that The Institute is to be congratulated on the fact that it has been able to publish so many very excellent papers during a single medal year. Furthermore, we feel that The Institute is very much indebted to the authors of these very excellent papers.

Respectfully submitted,
W. C. Adams, m.e.i.c., *Chairman.*

Leonard Medal Committee

The President and Council,—

The proceedings of The Engineering Institute of Canada during the medal year 1929-30 did not contain any suitable papers, leaving, therefore, for consideration only papers presented to the Canadian Institute of Mining and Metallurgy and the Mining Society of Nova Scotia.

Your Committee unanimously recommend the following awards:—

1. The Gold Medal to C. G. McLachlan for his paper on "Twelve Months' Milling at Noranda"—C.I.M.M. Bulletin, February, 1930.
2. A Silver Medal to W. B. Boggs for a paper on "The Noranda Smelter"—C.I.M.M. Bulletin, March, 1930.
3. A third prize of books to A. E. Flynn for his paper on "Anhydrite Plasters and Cements"—C.I.M.M. Bulletin, June, 1930.

Last year your Committee was unable to recommend award of the medal because no paper of outstanding merit had been contributed to either Institute during the period under review; but this year we are glad to be able to avail ourselves of the privilege given by the rules to make the three awards above mentioned.

The Committee desires to express its opinion of the outstanding merit of a paper by the late Walter Herd, M.E.I.C., on "Bumps in No. 2 Mine, Springhill, Nova Scotia," which appeared in the September, 1929, bulletin of the Canadian Institute of Mining and Metallurgy, having previously by arrangement been presented to the American Institute of Mining Engineers.

The Committee also desires to express its regret at the recent death of the distinguished donor of the medal, Colonel R. W. Leonard, M.E.I.C., of St. Catharines, Ontario.

Respectfully submitted,

F. W. GRAY, M.E.I.C., *Chairman.*

Plummer Medal Committee

The President and Council,—

Your Committee, having examined the various papers published in The Engineering Journal during the medal year 1929-30 dealing with chemical and metallurgical subjects, is of the opinion that none of these are of sufficient merit to justify an award of the Plummer Medal for the past year.

Respectfully submitted,

J. R. DONALD, M.E.I.C., *Chairman.*

Students' and Juniors' Prizes

The reports of the examiners appointed in the various zones to judge papers submitted for the prizes for Students and Juniors of The Institute, were approved by Council at its meeting on January 20th, 1930, and make the following announcements:—

H. N. Ruttan Prize (Western Provinces)—No award; one paper received.

John Galbraith Prize (Province of Ontario)—No award; no papers received.

Phelps Johnson Prize (Province of Quebec, English)—To G. B. Jost, S.E.I.C., for his paper on "Steel Mitering Lock Gates on the Welland Ship Canal."

Ernest Marceau Prize (Province of Quebec, French)—No award; no papers received.

Martin Murphy Prize (Maritime Provinces)—No award; no papers received.

Library and House Committee

The President and Council,—

The information service at Headquarters has been well utilized, over eight hundred inquiries having been dealt with during the year. Twenty-eight bibliographies have been prepared, and two hundred and fifty-two pages of photostats have been supplied to members requiring copies of technical articles.

Accessions to the library during the past twelve months number 804, including several valuable sets of early technical periodicals presented by members, all of which have been duly acknowledged.

Necessary minor repairs have been made to The Institute premises, but no extensive work of this nature was needed during the year.

Respectfully submitted,

J. L. BUSFIELD, M.E.I.C., *Chairman.*

Publication Committee

The President and Council,—

The Publication committee wishes to submit the following report:—

In accordance with the decision of Council at its Plenary Meeting to publish Transactions this year, your committee was instructed at the meeting of October 17th to review the papers published in The Engineering Journal during the years 1926-1930 inclusive and to make a recommendation as to their inclusion in the new volume or Volumes of Transactions and as to the arrangements necessary for their publication.

Owing to the amount of material to be reviewed, covering, as it does, publications in The Journal for five years, your committee has not had sufficient time to complete its work but hopes to have its recommendations ready for submission to Council in the near future.

Respectfully submitted,

J. A. McCRORY, M.E.I.C., *Chairman.*

Legislation Committee

The President and Council,—

No questions regarding legislation were submitted during the past year.

In accordance with your instructions, your committee considered and reported upon the changes required in sections 66 and 67 of the By-laws to embody Council's proposal for a modification in the constitution of the Nominating committee, and these suggestions have been duly circulated to the membership.

Respectfully submitted,

J. L. BUSFIELD, M.E.I.C., *Chairman.*

Board of Examiners and Education

The President and Council,—

The results of the examinations held during 1930 for admission to The Institute are as follows:—

	Examined	Passed	Failed
For admission as Student (Schedule A)	1	..	1
For admission as Junior (Schedule B)	2	1	1
For admission as Associate Member (Schedule C):			
Electrical Engineering	3	2	1
Civil Engineering	2	2	..
Structural Engineering	3	2	1
	—	—	—
	11	7	4

While the proportion of candidates who satisfied the examiners is larger than last year, some of them have only succeeded after more than one trial.

Your Board would again draw attention to the difficulty which non-university applicants experience in preparing for The Institute's examinations. Practically all of these men are earning their living, and the opportunities in Canada (even in our larger cities) for obtaining advanced engineering instruction by attending evening classes are almost non-existent. The technical schools in Montreal, Toronto, Hamilton or elsewhere are admirable, but their efforts are necessarily directed along more elementary lines than those necessary for our examinations, and they do not give sufficiently advanced work in mathematics or physics. The various correspondence schools labour under obvious disadvantages and are of comparatively little assistance. There would seem to be a real need in this country for facilities such as are available in Britain, enabling a man, who is willing to give up the necessary time to evening study, to prepare himself for the engineering degrees of universities, such as London, Glasgow, and others.

Cannot The Institute do something to remedy this condition, possibly through the influence of its committee on Engineering Education?

Respectfully submitted,

C. M. McKERGOW, M.E.I.C., *Chairman.*

Committee on Engineering Education

The President and Council,—

Your committee on Engineering Education made specific suggestions in its report of a year ago, which were laid before the annual meeting, adopted with the exception of clause No. 4, and referred back to the committee for action, the committee being requested to give further consideration to this item. These recommendations were:—

1. The formation of a more intimate bond between The Institute and engineering universities throughout Canada, in order that The Institute may be in a position to advise on engineering education through its older and most successful members.
2. That steps be taken whereby The Institute becomes the definite agency—the active connecting medium —between engineering universities and industry.
3. That a study be made by a committee on technical education in its relation to industry and to the engineering profession.
4. That immediate steps be taken by conference with university heads with a view to adopting a six year course for engineers, or a much higher matriculation standard.
5. That the universities be urged to give consideration to giving additional time on the curriculum to public speaking and literature.
6. That immediate steps be taken leading to the formation of student branches of The Institute or student affiliations in every engineering university in the Dominion.

In order that a more definite contact be established with the universities, the committee was reorganized and constituted with the following members:—

Fraser S. Keith, M.E.I.C., *Chairman*
R. W. Brock, M.E.I.C.
C. V. Corless, M.E.I.C.
F. R. Faulkner, M.E.I.C.
E. P. Fetherstonhaugh, M.E.I.C.
A. Frigon, A.M.E.I.C.
W. J. Johnston, A.M.E.I.C.
H. M. MacKay, M.E.I.C.
C. J. Mackenzie, M.E.I.C.
C. H. Mitchell, M.E.I.C.
John Stephens, M.E.I.C.
R. S. L. Wilson, M.E.I.C.
A. R. Decary, M.E.I.C.

Since that time the members of the committee have had under discussion ways and means of putting into effect the recommendations of the previous committee.

Your committee acknowledges with gratitude the action of Council in again selecting as the title for the Past Presidents' Prize "Engineering Education in Canada," and it is the hope of your committee that valuable suggestions will be received. It is planned during the coming year to further discuss the problem and to give more definite effect to the desired end whereby The Institute may achieve a more definite leadership in the realm of engineering education.

Respectfully submitted,

Fraser S. Keith, M.E.I.C., *Chairman.*

Employment Service Bureau

The President and Council,—

The work of the Employment Service Bureau has been actively carried on during the year, but has naturally been affected by the slackening in engineering activity which has made itself felt to an increasing degree during the last six months. Employment conditions for engineers, however, do not appear to have been so unfavourable as in many other lines of endeavour. It is noteworthy that more than fifty per cent of those registering with the Bureau at present are non-members of The Institute, which would seem to indicate either that there are a comparatively small number of our members who are looking for positions, or that members are not so quick as outsiders in realizing the advantages of the service which The Institute offers.

As compared with 1929, there has been a considerable decrease in the proportion of replies received from employers to advertisements in the E-I-C. News, and a similar decrease in the number of positions available.

The number of placements of which definite information has been obtained during the year is 57, but, as pointed out in last year's report, only a small proportion of those obtaining positions notify us of the fact, so that the actual number of men placed must be considerably larger.

Our records are as follows:—

		1930 (12 months)	1929 (17 months)
Number of registrations:			
Members	127		
Non-members	180		
	——	307	345
Members advertisements published in E-I-C. News		160	183
Replies received from employers		70	392
Vacant positions registered		180	486
Vacancies advertised		103	
Replies received to advertised vacancies		754	1,699
Men notified of vacancies		114	347
Records forwarded to prospective employers		190	382

The work has included over 500 personal interviews with members and non-members seeking advice and employment, as well as correspondence with employing firms and others. The principal need of the Employment Bureau is the devotion of more time to its work, and better contact with possible or prospective employers. The E-I-C. News is mailed to a considerable list of employing organizations but this cannot take the place of personal communication which is particularly desirable at a time like the present. The requirements for further development of the Bureau work were clearly described in the report of the Service Bureau Committee for last year, but it has not been possible to provide for them.

Respectfully submitted,

R. J. Durley, M.E.I.C., *Secretary.*

Committee of International Co-operation

The President and Council,—

During the year 1930 there were two important opportunities for contact between members of The Institute and European technical bodies — the meeting of the Second Plenary World Power Conference in Berlin from June 5th to 16th, and the Plenary Meeting of the International Electrotechnical Commission in Scandinavia in July.

More than four thousand delegates attended the first named conference and were welcomed by the German Chancellor on behalf of President Hindenburg, who pointed out that "engineering is about to exercise greater influence than ever upon the economic life of the peoples and to establish a closer connection than ever before between their economic systems." The Canadian delegation included the following prominent engineers:

Charles Camsell, M.E.I.C., Deputy Minister, Department of Mines, Chairman Canadian National Committee.

John Murphy, M.E.I.C., Electrical Engineer, Department of Railways and Canals and Board of Railway Commissioners. Vice-Chairman Canadian National Committee.

F. A. Gaby, M.E.I.C., Chief Engineer, Hydro-Electric Power Commission of Ontario, Toronto.

O. Lefebvre, M.E.I.C., Chief Engineer, Quebec Streams Commission, Montreal.

T. H. Hogg, M.E.I.C., Chief Hydraulic Engineer, Hydro-Electric Power Commission of Ontario, Toronto.

G. Gordon Gale, M.E.I.C., Vice-President and General Manager, Gatineau Power Company, Ottawa.

A. B. Normandin, A.M.E.I.C., Hydraulic Service, Department of Lands and Forests, Quebec.

Hon. F. P. Burden, Minister of Lands, Victoria, B.C.

R. G. Gage, M.E.I.C., Chief Electrical Engineer, Canadian National Railways, Montreal.

G. A. Gaherty, A.M.E.I.C., President, Calgary Power Company, Calgary.

deGaspe Beaubien, M.E.I.C., Consulting Engineer, Montreal.

John Morse, M.E.I.C., Shawinigan Water and Power Company, Montreal.

J. B. McCarthy, Consulting Engineer, Montreal.

J. G. Glassco, General Manager, Winnipeg Hydro System, Winnipeg, Man.

A striking outcome of the conference, perhaps in direct opposition to popular belief, was the contention that the wider development and use of power must eventually reduce unemployment. Officials of the conference issued the following statement:—"Power, from year to year, multiplies the methods by which raw materials are transformed into finished products. New methods create new possibilities of work. New methods require new products for carrying them out, and the markets for the products of labour are thus increased. During the last one hundred and fifty years, 'the machine age,' the increase in the possibilities of work has been much greater than the reduction of the demand for physical labour—if it were otherwise the population of the civilized world could not have increased as it has."

In regard to the conference itself, conference officials said "The most important result of the conference lies in the fact that so many experienced specialists from all over the world have come into personal contact. Quite apart from the value which this has for the individuals and for the organizations to which they belong, it has served to bring the nations into closer touch."

In Scandinavia, the business programme of the International Electrotechnical Commission consisted of an attempt at securing unanimous decisions in regard to the standardization of the following matters, which have been in the hands of the various national committees for many years, namely:—

1.	Nomenclature	United States Committee.
2.	Rating of Machinery	British "
3.	Symbols	Swiss "
5.	Steam Turbines	United States "
6.	Lamp Caps and Holders	Central Office.
7.	Aluminum	Central Office.
8.	Voltages and Insulators	Italian Committee.
9.	Electric Traction Equipment	French "
10.	Insulating Oils	Central Office.
11.	Overhead Lines	Belgian Committee.
12.	Radio-communications	Dutch "
13.	Measuring Instruments	German "
14.	Rating of Rivers	United States "
15.	Shellac	British "
16.	Terminal Markings	Dutch "
17.	Oil Switches	Swedish "
19.	Internal Combustion Engines	United States "

The work of the Committee on Overhead Lines was of special interest. A comparison of practices throughout the world, which was made at Stockholm, showed that in no country was more being done to further the cause of safety than in Canada.

Canada has never taken as much interest in the International Electrotechnical Commission, in its work and its meetings, as her position in the power world warrants. Specialists in the many branches enumerated above should take an active part in the commission's meetings, and aid in the work of the Canadian National Committee.

A memorable opportunity for international contact occurred at the Fiftieth Anniversary celebrations of the American Society of Mechanical Engineers on April 5th to 9th, in New York, Hoboken and Washington. At these, The Institute was represented by Past-President C. H. Mitchell, M.E.I.C., and President A. J. Grant, M.E.I.C., the former contributing a monograph covering the development of engineering work in Canada which formed part of a series covering the humanistic aspects of engineering in all the principal industrial countries in the world. Celebrations of this kind are events of international significance interpreting the social and economic influence of engineering on civilization.

Respectfully submitted,

John Murphy, 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:—

P. L. Pratley, M.E.I.C., retires March, 1931.
C. J. Mackenzie, M.E.I.C., retires March, 1932.
J. M. Oxley, M.E.I.C., retires March, 1933.

Mr. Oxley has succeeded F. B. Brown, M.E.I.C.

Satisfactory progress has been recorded during the year, one of the chief features being the continuance of financial support from industrial interests. All but two of last year's sustaining members have renewed their subscriptions and seven additional memberships have been listed. The total number of sustaining members is now seventy-five and the total amount subscribed for the year is $6,600. In the face of the prevailing industrial depression this is most encouraging.

Co-operation from the press and technical publications has been very helpful, one of the features being the publication of an article by the Secretary in the special research number of "Industrial Canada." A descriptive article on the Canadian Engineering Standards Association also appeared in the "Commercial Standards Monthly" issued by the Bureau of Standards at Washington.

The sale of specifications is steadily growing and they are being used more and more by different government departments, municipal authorities and purchasing departments of industrial firms. An interesting feature has been the purchase of complete sets of specifications by individual firms.

The fourth Year Book of the association was issued in April and has been widely circulated. The Quarterly Bulletin is increasing in usefulness as a medium of disseminating information on the work of the association.

Six publications have been issued during the year, in all cases revised editions of previous specifications. A description of these publications follows:

B18-1930. This constitutes an Established List of Stove Bolts, similar to the Established List of Machine Screws published in 1929, and is a revision of the old specification B18-1925. The revision consists of a rearrangement of the data and there has been no radical change.

A16-1930, Standard Specification for Steel Structures for Buildings. This constitutes the second edition of the specification which was originally published in 1924. The chief items cover the raising of allowable unit stress for axial tension from 16,000 pounds to 18,000 pounds per square inch; the revising of the column formula, and other revisions to conform with the latest C.E.S.A. Specifications for Steel Railway and Steel Highway Bridges. Provisions for snow load on roofs and wind load have also been revised.

C22-1930, Canadian Electrical Code, Part I. This second edition was issued in January and contains many radical revisions which were made by the Code committee. Section 2, covering general rules, has been rearranged. Section 5, covering wiring methods, has been condensed, and Section 32, covering, hazardous locations, has been considerably rearranged. Section 8 has been expanded to take in additional rules concerning motors. In Section 6, conductors, rules have been added covering demand factors and wattage of outlets. Former Sections 33, garages, and 34, motion picture studios, have now been incorporated in Section 32, hazardous locations. Section 35, motion picture projectors and equipment, has been incorporated in Section 39, theatre installations. Many other revisions have been made and all material in the former edition which was not purely electrical has been deleted as far as possible. The book contains a cross-reference list so that the two editions may be readily compared.

G30-1930, Standard Specification for Billet-steel Reinforcing Bars. G31-1930, Standard Specification for Rail-steel Reinforcing Bars. G32-1930, Standard Specification for Steel Wire for Concrete Reinforcement. These constitute a revised edition of the former specification A9-1923 covering Reinforcing Materials for Concrete. It has been decided to reclassify these under Ferrous Metals, rather than under Civil Engineering and Construction, and a publication has been issued covering each type of reinforcing material. The specifications have been brought up-to-date in accordance with the latest practice and a feature of the first two publications is a supplement covering an established list of sizes for round and square reinforcing bars which provides a practical range of area for use in design. The use of the table by architects and designing engineers is strongly recommended.

Work in Progress

Civil Engineering and Construction

Wood Piles and Wood Pile Driving. The committee has had two meetings and a first draft of a specification is now under revision. It is hoped to include as much educational material as possible in this specification.

Mechanical Work

Cast Iron Pipe. No further progress has been made on this specification, as it has been deemed advisable to await information on experimental work which is now being carried on.

Screw Products. Under the Committee on Screw Products, four panels have been organized dealing with (1) Cap and set screws, studs, etc. (2) Machine, carriage and plough bolts. (3) Machine screw nuts. (4) Binder head screws. Reports from these four panels have been received and discussed at a second meeting of the Committee and it is hoped shortly to get these reports in form for publication. In this work considerable simplification will be accomplished and it is expected that the established lists which will be issued will be of considerable value to both the manufacturers and users of these products.

Standard Colour Scheme for the Identification of Piping Systems. A committee has been organized and has held its first meeting, at which a panel was appointed to consider available data and make a draft specification. Great interest has been aroused in this project and it is hoped that a useful specification will result.

Standard Connections for Cutting Edges and Mouldboards on Road Grading Machinery. A committee is now being organized to consider this question with the object of obtaining uniformity throughout Canada. A tentative scheme has been presented and this will be the basis for the proposed specification.

Electrical Work

Power Transformers. Comments on the second draft of this specification and also a special report from the panel of the committee, have been circulated to the members of the committee, and it is hoped to prepared a final draft very shortly. It has been held in the meantime for a report from the panel which is considering transformer bushings.

Transformer Bushings. A panel of the Committee on Transformers is considering the standardization of transformer bushing connections and held its first meeting during the year, at which the matter was thoroughly discussed. A sincere endeavour will be made to secure uniformity, and it is hoped to have a second meeting of the panel very shortly.

Transformer and Switch Oil. A summary of replies to the questionnaire which was sent out to the committee, asking for information on specifications, was sent out for comment, and a summary of the comments was also sent to the committee, which held its second meeting during the year. After considerable discussion a small panel was appointed, consisting of a representative of the power users, the transformer manufacturers and the oil interests. This panel will endeavour to frame a draft specification which will be duly submitted to the committee for comment.

Lead-Covered Power Cable. A committee is being organized to discuss a specification for this material, and it is hoped to have a preliminary meeting of this committee very shortly.

Canadian Electrical Code, Part II, covering Specifications for Electrical Apparatus. The draft specification covering Power-Operated Radio Devices has been circulated to the members of the Panel on Specifications. A meeting of this Panel was held during the year at which representatives of the Radio Manufacturers Association were present, and many revisions were decided upon. It is hoped to issue a revised draft shortly. A specification dealing with Electric Signs is now being prepared and will shortly be sent to the members of the Panel for comment.

Canadian Electrical Code, Part III, Outside Wiring Rules. Several meetings of the sub-panels have been held during the year, but it has been found rather difficult to make rapid progress. It is now proposed to reorganize the sub-panel on Grounding and Conductive Co-ordination, so that the questions concerning grounding will be assigned to the Grounding Panel which operates under the Code Committee.

Useful contacts have been established with industrial associations, the Secretary having addressed the Kiwanis Club at Lindsay, the Canadian Manufacturers' Association at Toronto, and the Canadian Purchasing Agents' Association at Hamilton. The Secretary also attended, by invitation, conventions of the Canadian Chambers of Commerce at Toronto, the Dominion Fire Prevention Association at Ottawa, American Trade Association Executives at Niagara Falls, the Canadian Electrical Association, and The Engineering Institute of Canada. There is already evidence that these contacts are bearing fruit as some useful suggestions for new work have been received as a result.

Respectfully submitted,

P. L. Pratley, M.E.I.C.
C. J. MacKenzie, M.E.I.C.
J. M. Oxley, M.E.I.C.

Honour Roll and War Trophies Committee

The President and Council,—

During the year 1930 active steps were taken to verify the list of names for the M.E.I.C. War Memorial, covering those who served with units not in the C.E.F. Up to the present, your committee have not been able to verify all the names in connection with the Memorial, but as those on which no confirmation of death is available are now reduced to three, it is the intention to proceed with the construction of the Memorial. It is thought that by leaving space at the bottom of the list of names on the Memorial, arrangements can be made by which a few names can be attached if their confirmation of death is received at a later date.

The total number of names to appear on the Memorial, including the three mentioned above, is one hundred and twenty-two.

Respectfully submitted,

Charles J. Armstrong, M.E.I.C., *Chairman.*

Committee on Tariff of Fees

The President and Council,—

The following schedules have been prepared for the guidance of engineers and clients as a general indication as to what has been found in practice to constitute a reasonable minimum tariff of fees. It is obviously impossible to provide for every contingency, but it is believed that sufficient information is given herewith to enable comparisons to be drawn for situations not actually covered. Judgment must of course be used in application of the various suggestions, as local conditions may quite frequently make desirable and proper serious departures from the schedules.

A:—Per Diem Basis

Ordinary Consultations

For consultations which do not necessitate a written report, the charge to the client shall be established in accordance with the time spent. The basis shall be a professional day of six hours remunerated at the rate of not less than $75.00, although much higher rates may be charged depending on the importance of the work and the standing of the engineer. Charges for fractions of a day shall be made as follows, namely $40.00 for one-half of a day, and for shorter time $25.00 for the first hour or fraction of an hour, depending on the importance of the consultation.

Written Reports, Valuations, Arbitrations, and Expert Testimony

For investigations or study of a project with a preliminary report based on reconnaissance only and not involving detailed surveys and preliminary plans, or for investigations or study of a report prepared by another engineer accompanied by a report on the subject, for study and report on questions in litigations for work as valuator or as arbitrator, or for preparations and depositions before a court of justice or a board of arbitration, or for attendance or evidence in Court during an enquiry, the engineer's fees shall be not less than $75.00 per day although much higher rates may be charged depending on the importance of the work and the standing of the engineer. The client will pay besides the above, all out-of-pocket expenses incurred by the engineer in connection with the work, and shall also pay for all salaries paid for by the engineer to his assistants together with an additional sum equivalent to 100 per cent of the said salaries to cover office and overhead expenses. The client shall deposit with the engineer before the commencement of the investigations an amount equal to the estimated out-of-pocket expenses thereon.

B:—Percentage Basis

The following table and subsequent explanatory remarks outline the recommended minimum schedules for remuneration on the basis of a percentage of the cost of the work.

1	2	3	4	5
Cost of Work not exceeding	Preliminary Work	Preparatory Work	Partial Supervision	Complete Supervision
	$	$	$	$
Minimum fee	100.00	300.00	300.00	700.00
$	%	%	%	%
50,000	2	3	3	7
100,000	1¾	2½	2½	6
200,000	1½	2½	2½	6
500,000	1½	2½	2½	5
1,000,000	1¼	2½	2	4
2,000,000	1	2	2	3½

Explanatory Remarks.

Column 1. The cost of the work shall in the first place be the estimated cost of the project, but in cases where the works proceed to construction the fees shall be in accordance with the total cost of the undertakings, although if a report is made on a major project which finally is only partly completed the fees for all preliminary work shall be based on the estimate of the major project.

Column 2. Preliminary plans, estimates and report. The fees given in this column are for the preparation of a written report on a project with surveys, investigations, studies and conferences, including preliminary plans and estimates of cost.

In addition to the above fees the client shall pay all out-of-pocket expenses incurred by the engineer in connection with the work, and shall also pay for all salaries paid by the engineer to his assistants together with an additional sum equivalent to 100 per cent of the said salaries to cover office and overhead expenses. The client shall deposit with the engineer before the commencement of the investigation an amount equal to the estimated out-of-pocket expenses thereon, and pay to the engineer further sums from time to time as he may request to cover the salaries of assistants actually employed in connection with the project.

Column 3. Preparation of construction plans and specifications. The fees given in this column cover the preparation of construction drawings and specifications necessary for obtaining tenders for the work, and the reporting on such tenders.

Column 4. Partial supervision of construction. In this column are given fees covering partial supervision of the work and comprising consultations at the engineer's office and occasional visits to the works during the normal duration of construction.

Column 5. Complete supervision of construction. The fees in this column cover the complete supervision of the work, comprising consultations at the engineer's office, visits to the works, and in addition the necessary representative of the engineer on the works, the testing of supplies and machinery and the acceptance of machinery or works.

Example. On a project estimated to cost $475,000 the engineer's fee for making the preliminary survey and investigation and reporting thereon will be 1½ per cent of this amount plus the out-of-pocket expenses and overhead referred to above under "Column 1." If the owner then decides to proceed with the work the engineer prepares the construction drawings to enable tenders to be called for, his fee will be 2½ per cent for this part of the work. Finally, if the owner decides to complete the work but only requires a partial supervision from the engineer the fee will be 2½ per cent of the actual cost of the works for this supervision, or, alternatively, if the owner wants the engineer to completely supervise the construction, the fee therefor will be 5 per cent of the actual cost of the works.

This schedule of fees, however, should not be applied to works of the nature of rehabilitation, remodelling, and so forth, as in cases of this sort the actual cost of the works may be a comparatively small amount and yet the engineering work involved may be as great and as responsible as in the original construction of the whole undertaking.

C:—General Conditions

1. A day's work shall be computed as six hours. Nevertheless, when an engineer is obliged to go out of the

city where his office is situated, his fees, when working on the per diem basis, shall be computed for each calendar day at the rate fixed, and each 24 hours or fraction thereof shall be considered as a whole day without taking into consideration the time actually spent on the work each day.

2. The fees of an engineer in case of questions in litigation shall not be contingent on the decisions of the court, and shall be settled by the client immediately after the enquete.

3. For reports, studies, plans and specifications, the client shall pay one-half of the fees of the engineer at the time the engineer will inform him that the preliminary studies have been terminated, and the other half shall be payable upon the delivery of the report or the plans and specifications. Otherwise payments shall be made to the engineer on a monthly basis, and the amount of the payments shall be a reasonable proportion of the estimated monthly proportion of the whole estimated fee based on the estimated length of time for the completion of the works. The balance of any amount due shall be paid promptly by the client on the completion of the works.

4. When it is necessary for special investigations to be made such as borings, tests, soundings, assays or analyses such work shall be carried out at the cost of the client, who shall also pay the engineer the cost of the direction of this particular work in addition to the schedule fee.

5. If the client desires changes in accepted specifications or plans, the engineer shall be entitled to remuneration based upon the necessary delay and time required to alter such plans and specifications either by himself or by his office staff, the said remuneration to be based upon the per diem rates hereinbefore mentioned.

6. In the preparation of specifications and plans or during the supervision of construction, particular problems may arise which may necessitate obtaining additional consulting advice. In such case the fees of the additional consultant, whose engagement must be authorized by the client, shall be directly paid by the client in addition to the fees of the engineer.

7. The actual cost of all travelling expenses and other disbursements incurred by the engineer in connection with the supervision of works, except the salaries, travelling expenses and living expenses of his staff to and from and on the works, shall be paid monthly by the client in addition to the percentage of fees given above.

8. The percentages in the above schedule for supervision during construction are intended to cover the services of the engineer and of his staff during the period ordinarily expected to be covered by such construction, and in the event of delays occurring in the construction, through no fault of the engineer, the engineer's remuneration shall be increased to compensate him for the extra time necessarily spent by him and his staff in supervision, on the basis of the per diem rates for personal services and staff mentioned above.

9. In case of bankruptcy or failure of a contractor on the construction work involving additional works on the part of the engineer over and above that contemplated in his original agreement, or in case any other work may be necessary and not directly relating to the preparation of specifications and plans to the supervision of the work or in case the client and contractor become involved in litigation or arbitration, the client shall reimburse the engineer and his staff on the per diem basis hereinabove mentioned for all additional services required for such purposes.

10. All specifications and plans, and construction documents and data are the property of the engineer. The client is entitled to a copy of plans and specifications for record purposes only and he shall not use any of these for the construction of another project without remunerating the engineer therefor.

Respectfully submitted,

J. L. Busfield, M.E.I.C., *Chairman.*

Committee on Relations of The Engineering Institute of Canada with the Provincial Associations of Professional Engineers

The President and Council,—

During the year the sub-committee appointed to approach the Provincial Associations prepared its recommendations as to the way in which its task should be commenced and these were submitted and discussed at the Plenary Meeting of Council in September last.

In order eventually to bring about a co-ordination of interests and activities of the various professional associations and The Engineering Institute of Canada, the committee were of opinion that a study of the possibilities in this matter should be made by a committee of members nominated by all of the Provincial Associations and The Engineering Institute, and suggested that this committee should be known as "The National Committee." It was felt also that until this National committee could be organized, The Engineering Institute's sub-committee might be permitted to act in making the necessary preliminary arrangements for the collection of data and the mutual interchange of views and suggestions.

It was also proposed that the preparation of an analysis and comparison of the various provincial acts and requirements for admission to membership should be undertaken in so far as they might affect the subject under consideration, and, this analysis having been prepared, it was suggested that three members should be selected by the National committee from among its members, representing respectively the Maritime provinces, Ontario and Quebec, and the provinces west of Ontario, these three members to meet and prepare a draft set of by-laws and requirements for membership that could apply to all the Provincial Associations and to The Engineering Institute of Canada. The committee, further, was of the opinion that when this draft had been prepared it should be communicated to all members of the National committee for their criticisms, and when reasonable agreement had been obtained by correspondence, a meeting of the National committee might be held. It was hoped that such a meeting might agree on a definite set of draft requirements, which could then be submitted to the Councils of the Provincial Associations and The Engineering Institute of Canada.

In so far as The Institute is concerned, this course was approved by its Council, and the sub-committee's proposals have accordingly been forwarded to the governing bodies of the eight Professional Associations for their consideration and criticism. Some of the Councils have already concurred and replies are awaited from the others.

Respectfully submitted,

H. H. Vaughan, M.E.I.C., *Chairman.*

Committee on Membership

The President and Council,—

The Membership committee which was appointed at the Plenary Meeting of Council in October last has endeavoured, in the short period available before the Annual Meeting of The Institute, to make some progress in formulating a policy for increasing the membership and to immediately put into practical effect temporary plans to bring this about.

Your committee "appointed to study the whole question of membership," consisting of Messrs. W. C. Adams, M.E.I.C., H. F. Bennett, A.M.E.I.C., C. J. Mackenzie, M.E.I.C., D. C. Tennant, M.E.I.C., with C. H. Mitchell, M.E.I.C., as chairman, had perforce to carry on its deliberations by correspondence and in doing so considered various methods of procedure to increase membership. Having before them the advantage of the views expressed by fellow members of the Council at the Plenary Meeting, several methods were considered.

One of these methods was that of prosecuting a widespread membership campaign organized on a large scale from Headquarters, in a manner that has commonly been done by other similar societies. Another method was that of a somewhat similar campaign carried out under the direction of a large membership committee embracing representatives of The Institute from coast to coast. A third was a method by which the twenty-five Branches of The Institute would themselves form district or regional membership committees for the purpose.

Your committee has considered that the last method is preferable, for the present at any rate, and has much to commend it. It was felt that a highly organized campaign would, throughout the wide area concerned, prove to be unwieldy and would require very considerable effort and no small expense. On the other hand, with the excellent branch organizations already in existence and desirous of extending the influence of The Institute in their own particular region, the committee considered it most desirable and indeed necessary, to enlist the interest and efforts of the Branches for the purpose.

Your committee, having arrived at this conclusion as a means of serving the immediate situation, recommends that this procedure be adopted in the interval and that it be proceeded with. The committee, however, feeling that no time should be lost in putting some plan into operation in advance of the Annual Meeting of The Institute, took upon itself as a first practical step, communication with the Branches in the hope that they could inaugurate a movement with this in view.

The Branches were accordingly appealed to by letter, the form of which was agreed upon by the committee, and these twenty-five letters were sent out under date of 8th December, signed by the chairman of the committee. These letters placed before the Branches the situation in The Institute with respect to declining membership and while indicating that a general plan for increasing membership was being formulated, pointed out that it was highly desirable to take immediate steps to extend the membership to at least maintain the numbers necessary to meet the normal decreases due to deaths, resignations, and removals.

It was pointed out, and it is for the general interest of the Council and the members of The Institute to note, that during the past five years the annual loss in membership, due to the foregoing causes, has averaged three hundred and thirty-three. It thus appears that in order merely to maintain the membership of The Institute at its present number, it is necessary that annual admissions should be maintained at that number at least or say three hundred and fifty.

In appealing to the Branches, therefore, at this time in presenting these facts and in order to put the situation before them in a practical form, it was pointed out to the individual Branches that, based upon their own proportionate membership, if all uniformly produced an increase, the figure for each would approximately be the following per annum:

Halifax	12	Hamilton	12
Cape Breton	5	London	5
Saint John	7	Niagara	11
Moncton	5	Windsor	9
Saguenay	3	Sault Ste Marie	9
Quebec	10	Winnipeg	20
St. Maurice	4	Lethbridge	4
Montreal	90	Edmonton	6
Ottawa	32	Calgary	10
Peterborough	8	Vancouver	26
Kingston	6	Victoria	4
Toronto	45	Lakehead	4
		Saskatchewan	10

It has been gratifying to the chairman of the committee to receive such hearty responses from so many of the Branches in the short space of time which has elapsed since these letters went out. Over half of the Branches have already replied and are already at work exerting an effort in response to the request, and this with the holiday season intervening.

In the letter sent out to the Branches, certain suggestions were made as to procedure and the difficulties in the way of soliciting new members were pointed out.

One of these suggestions was that individual members should be asked not to go further than to send in to the local committee the names and information concerning prospective candidates, so that later action can be taken by the Branch officials. This suggestion was due to the possibility of embarrassment to the Branch or Council later, should the qualifications of the prospective member prove to be insufficient under the regulations for admission.

It might be interesting at this stage—especially for the information of Branches and the membership generally —to quote a few extracts from some letters the chairman has already received with respect to the efforts being made.

> One Branch, a small one in the Maritime provinces, says, "When a prospective member is discovered, his name is handed to either the chairman or secretary of the Branch, who examines the qualifications of the proposed candidate and advises as to the action likely to be taken by Council. If considered eligible, the prospect is interviewed by a member of the Executive, and urged to send in his application. By following this procedure we avoid, as far as possible, the embarrassment caused by having a man apply for membership, only to be later turned down by Council."

> Another Branch, a small one in Ontario, says, "Your letter—and this step—is very opportune, especially if the several branches will appoint active membership committees, so that the Headquarters committee can issue instructions to them and keep up their interest, at least during one year. In this way we should be able to increase our membership, provided sufficient care is taken by these committees to interest only those we are sure will be elected by Council."

> A small Ontario Branch on the other hand, says, "It was the opinion of this Branch that we had obtained all possible members in this vicinity but that there might be engineers in outlying communities affiliated with this Branch who were not members. We are, therefore, going to get in touch with these communities through members resident there and ask them to give us such information as possible on those who they think are entitled to membership and should be members of The Institute."

> A small Branch in Quebec says, "Campaign for enlisting new members is continuously on in our district and will continue more actively than ever, in accordance with the request of your committee."

A large Branch and the Headquarters office as well, contributes for the committee's information a statement and chart which indicates that "the larger branches are increasing in membership while the smaller branches show a tendency to diminish."

The foregoing outline and activities of your committee and of the Branches are, however, only a beginning. As already stated, the whole question is still under further consideration and your committee would be glad if the Council would arrange to have the membership matter put on the agenda for full discussion so that further views may be obtained. In so far, therefore, this communication forms a progress report in this important matter.

Respectfully submitted,

C. H. Mitchell, M.E.I.C., *Chairman.*

Publicity Committee

The President and Council,—

Owing to the fact that the major suggestion made by your committee in last year's report, which was adopted at the annual meeting, namely:—

> That provision be made in the budget for the engagement of the services of a man familiar with newspaper publicity and capable of carrying out a campaign calculated to bring the engineer more prominently to the notice of the public.

was not possible of fulfilment by the Council owing to lack of funds, your committee has been unable to carry out its previous plans during the past year. It is hoped, however, that during the coming year means may be found of carrying out this proposal, if not in its entirety at least in part, so that eventually this plan may become an integral part of The Institute's functions.

Your committee awaits with interest the reports of the various branches as to the action they have taken in appointing a committee of at least two, as recommended in our previous report, the result of which will no doubt be evidenced in the various branch annual statements.

In connection with the inherent ambition of the engineering profession to be better known and better appreciated, the various articles issued under the direction of the Publicity committee of the Ottawa Branch and published throughout Canada are substantial proof of what can be done in that direction, as they were commented upon editorially in many daily papers and brought to the attention of the public the service the engineer is performing for mankind. The Ottawa Branch is to be congratulated on the good work it has done along this line.

Respectfully submitted,
FRASER S. KEITH, M.E.I.C., *Chairman.*

Committee on Remuneration

The report of this committee is not presented at this time as it is to be submitted for further consideration by the incoming Council.

Branch Reports

Border Cities Branch

The President and Council,—

The work of the Border Cities Branch has been carried on during 1930 by the following committees:—

Papers and Entertainment.......... H. J. Coulter, JR.E.I.C.
Publicity.......................... R. J. Desmarais, A.M.E.I.C.
Membership......................... C. G. R. Armstrong, A.M.E.I.C.
Nominating......................... F. H. Kester, M.E.I.C.
Reception.......................... Fred. Stevens, A.M.E.I.C.
Representative on directorate of the Border Chamber of Commerce... Orville Rolfson, A.M.E.I.C.
Branch News Editor and Assistant Secretary-Treasurer.............. Harold J. A. Chambers, A.M.E.I.C.

The following meetings have been held:—

Jan. 10.—Mr. J. H. Walker, Superintendent of Central Heating for the Detroit Edison Co., spoke on **Central Heating.** We also had a demonstration of rapid calculating by Professor Krieger. Attendance, 50.

Feb. 14.—Prof. W. L. Badger, Professor of Chemical Engineering in the University of Michigan, spoke on **The Use of Diphenyl as a Heating Medium.** Attendance, 20.

Mar. 14.—Mr. S. A. Thoresen spoke on **The Design, Construction and Ventilation of the Detroit and Canada Tunnel.** This was an illustrated lecture. Attendance, 33.

Apr. 11.—Mr. Hugh McIntosh and Mr. Austin Ion of the Bell Telephone Co. spoke on **The Dial System** and the **Mechanics of Automatic Telephone Operation** respectively. Attendance, 29.

May 23.—Mr. Thos. Adams, town planning expert of New York and London, spoke on **Town Planning.** Mayor Jackson of Windsor was a visitor on this occasion. Attendance, 25.

Oct. 10.—Mr. W. H. Furlong, Windsor barrister, spoke on **Some Aspects of the Local Improvement Act.** Attendance, 18.

Nov. 14.—Mr. C. R. Halladay, of General Motors Corporation, Detroit, gave an illustrated talk on the **General Motors Proving Ground.** Attendance, 22.

Dec. 12.—Mr. N. C. Hobson, of Canadian Industries, Ltd., spoke on **The Development of the Salt, Chlorine and Alkali Industry in this District.** Attendance, 27.

This gives an average attendance of 28.

Averages for other years are as follows:—

1926	31	1928	38
1927	20	1929	34

This report would not be complete without some reference to the splendid assistance rendered the secretary by H. J. A. Chambers, A.M.E.I.C., during the past year.

FINANCIAL STATEMENT
(1930)
Receipts

Balance in bank, December 31, 1929	$224.29	
Cash	.50	
	224.79	
H.Q. Rebates, 1930	220.50	
H.Q. Branch News and advertising	32.35	
Meals at meetings	220.25	
		$697.89

Expenditures

Notices	$ 53.11	
Stamps and telegrams	6.40	
Typing	15.00	
Speakers' expenses	33.95	
Meals	241.00	
Cigars	31.25	
Miscellaneous	63.27	
	$443.98	
Balance on hand	253.91	
		$697.89

Audited and found correct.

Respectfully submitted,
R. C. LESLIE, A.M.E.I.C., *Secretary-Treasurer.*

Calgary Branch

The President and Council,—

On behalf of the Executive committee we beg to submit the following report of the activities of the Calgary Branch for the calendar year of 1930:—

MEMBERSHIP

	Dec. 31, 1929 Resident	Non-Resident	Total
Members	22	8	30
Associate Members	49	18	67
Juniors	3	1	4
Students	5	4	9
Branch Affiliates	12	..	12
Totals	91	31	122

	Dec. 31, 1930 Resident	Non-Resident	Total
Members	23	7	30
Associate Members	55	20	75
Juniors	4	1	5
Students	4	1	5
Branch Affiliates	12	..	12
Totals	98	29	127

MEETINGS

The Executive met eleven times during the year to deal with the various questions which arose.

The committee in charge of the Annual Ball met four times. As a result of their efforts a very successful ball was held at the Palliser hotel on Friday, November 22. Four hundred and five guests, including members, were present and it is evident that the affair is growing in popularity and is established as one of the important events in the social life of Calgary.

Ten general meetings were held with a very fair attendance and some excellent papers and discussions.

Details of the meetings and speakers follow:—

Jan. 9.—This meeting was held to consider the question of increase in dues. Attendance, 17.

Jan. 16.—**Things We See** by Dr. H. J. Macleod, M.E.I.C., Professor of Electricity, University of Alberta. Attendance, 49.
Jan. 30.—**Town Planning** by Mr. Doughty-Davis, Town Planning Engineer of the City of Calgary. Attendance, 45.
Feb. 13.—**The Construction of the Ghost Water Power Dam** by H. J. McLean, A.M.E.I.C., Production Superintendent of the Calgary Power Company. Attendance, 64.
Feb. 20.—**The Toronto Water Works System** by W. Gore, M.E.I.C., of Messrs. Gore, Nasmith and Storrie. Attendance, 31.
Mar. 9.—Annual Meeting and Election of Officers. Attendance, 15.
Mar. 9.—Annual Dinner. Attendance, 60.
June 21.—A meeting of the members to visit the Ghost Dam of the Calgary Power Company. Attendance, 30.
Aug. 29.—The Annual Golf Tournament.
Oct. 30.—**The Red Coulee Oilfield** by Dr. P. B. Williams, Consulting Geologist. Attendance, 87.
Nov. 21.—Annual Ball. Attendance, 405.
Nov. 25.—**Nickel** by Mr. G. C. Bateman, Secretary of the Mining Institute of Canada. Attendance, 61.
Dec. 11.—**The Trend of Modern Steam Plants** by W. H. Broughton, A.M.E.I.C., Instructor at the Institute of Technology and Art, Calgary. Attendance, 51.

The average attendance was 45, excluding the Annual Ball and the Annual Dinner.

FINANCIAL STATEMENT
(Year ending December 31st, 1930)

Receipts

Bank Bal. Jan. 1st, 1930	$381.23		
Rebates due	5.85		
		$ 387.08	
Int. on Bonds and Savings		46.12	
Rebates from Headquarters:			
Rec'd	$237.90		
Due	3.30		
		241.20	
Branch News		22.10	
Branch Affiliates:			
Rec'd	21.00		
Due	24.00		
		45.00	
			$ 741.50

Expenditures

Meeting Expenses, etc	$238.70		
Presentation to retiring Secretary	50.00		
		$ 288.70	
Wreath		10.00	
Stenographers account		42.93	
Stamps, Printing account		113.69	
Annual Ball. Payments	833.71		
Less receipts	810.00		
		23.71	
Cash in Bank, Dec. 31st	225.11		
Less cheque outstanding	6.00		
	219.11		
Add coupons deposited in Jan	26.45		
" cash in Secretary's hands	22.55		
" due on rebates	3.30		
" due from Affiliates	24.00		
	295.41		
Less accounts payable	32.94		
		262.47	
			$ 741.50

Assets

Cash in Bank	$225.11		
Less cheque outstanding	6.00		
	219.11		
Add deposited Jan	26.45		
		$ 245.56	
Cash in Treasurer's hands		22.55	
Dues collectable from Affiliates		24.00	
Rebates due		3.30	
Bonds per Balance Sheet, Dec. 31, 1929		1,057.92	
			$1,353.33

Liabilities

Accounts outstanding:			
Terrils	$10.00		
Burnands	17.94		
Bd. of Trade	5.00		
		$ 32.94	
Surplus		1,320.39	
			$1,353.33

Surplus Dec. 31, 1929	$1,445.00
Surplus Dec. 31, 1930	1,320.39
Decrease in Assets	$ 124.61

W. ST.J. MILLER, A.M.E.I.C. } Auditors.
R. S. TROWSDALE, A.M.E.I.C. }

Respectfully submitted,

B. RUSSELL, M.E.I.C., *Chairman.*
A. W. P. LOWRIE, A.M.E.I.C., *Secretary-Treasurer.*

Cape Breton Branch

The President and Council,—

During the year the Cape Breton Branch held eight meetings at which papers were read and discussed. The average attendance was 68, largely due to the fact that members of the Mining Society of Nova Scotia availed themselves of an invitation to attend. These meetings were as follows:—

Jan. 25.—**Civil Aviation** by J. A. Wilson, A.M.E.I.C., Controller, Civil Aviation, Dept. of National Defence.
Feb. 11.—**Steam—Its Place and Limitations** by M. W. Booth, M.E.I.C., Steam Engineer, British Empire Steel Corporation.
Mar. 11.—**Coal Mining, Past, Present and Future** by T. L. McCall, M.E.I.C., Chief Mining Engineer, British Empire Steel Corporation.
Apr. 8.—**Labour Unionism** by John Moffatt, Safety Dept., Dominion Coal Co.
May 1.—Dinner Meeting, with address by the General Secretary, E.I.C.
Oct. 17.—**Manufacture of Structural Steel and Allied Products** by G. A. Richardson, Technical Lecturer, Bethlehem Steel Co.
Oct. 21.—**Care and Use of Explosives** by E. Godfrey, Technical Representative, Canadian Industries, Ltd.
Nov. 21.—**Aerial Photographic Surveying** by F. H. Peters, M.E.I.C., Surveyor General, Department of the Interior.

The Executive feels that the year was successful from the point of view of meetings held, as all papers were of a high order and the lively discussions which took place were notable.

A Summer Outing and Dance was held at Mira Ferry on Sept. 9 and was well attended.

FINANCIAL STATEMENT

Receipts

Balance from 1929	$ 40.09	
Rebates from H.Q.	138.51	
Br. Aff. Sub. to Journal	6.00	
Dinner Meeting	17.50	
Summer Outing	40.00	
Credit supplies returned	1.52	
		$243.62

Expenditures

Meetings	$ 22.25	
Dinner	28.05	
Summer Outing	68.04	
Printing	6.57	
Telegrams	2.31	
Postage	4.56	
Exch. on cheques	.30	
Br. Aff. Dues to H.Q.	6.12	
Wreath	10.00	
Cash on hand	95.42	
		$243.62

Respectfully submitted,

A. L. HAY, M.E.I.C., *Chairman.*
S. C. MIFFLEN, M.E.I.C., *Secretary-Treasurer.*

Edmonton Branch

The President and Council,—

The Executive Committee of the Edmonton Branch begs to submit the following report on the activities of the Branch during the year 1930:—

OFFICERS

January to May

Chairman	R. W. Ross, A.M.E.I.C.
Vice-Chairman	J. Garrett, A.M.E.I.C.
Secretary-Treasurer	H. R. Webb, Jr.E.I.C.
Committee	W. H. Greene, M.E.I.C.
	A. W. Haddow, A.M.E.I.C.
	C. A. Robb, M.E.I.C.
	E. Stansfield, M.E.I.C.
Ex-officio	V. Pearson, A.M.E.I.C.
	R. S. L. Wilson, M.E.I.C.

May to December

Chairman........................J. Garrett, A.M.E.I.C.
Vice-Chairman....................C. A. Robb, M.E.I.C.
Secretary-Treasurer...............W. E. Cornish, Jr.E.I.C.
Committee.........................T. W. Brown, A.M.E.I.C.
R. M. Dingwall, A.M.E.I.C.
R. J. Gibb, M.E.I.C.
H. J. MacLeod, M.E.I.C.
Ex-officio.......................R. W. Ross, A.M.E.I.C.
E. Stansfield, M.E.I.C.

MEETINGS

Lectures and papers given before the Branch during the year were as follows:—

Jan. 28.—**Fuel Development in Europe** by E. Stansfield, M.E.I.C., Research Professor of Fuels, University of Alberta.

Feb. 25.—**The Romance of Map Making** by M. P. Bridgland, of the Topographical Survey Office, Calgary.

Apr. 15.—**Aerial Photographic Surveying** by A. W. Wolfe-Merton, S.E.I.C., Civil Engineering Department, University of Alberta.

Oct. 22.—Joint Meeting with the Northern Alberta Branch of the C.I.M.M. **Recent Electrical Achievements** by Dr. H. J. MacLeod, M.E.I.C., Head of the Department of Electrical Engineering, assisted by W. E. Cornish, Jr.E.I.C.

Nov. 28.—**Edmonton's Natural Gas System** by Julian Garrett, A.M.E.I.C., Manager, Northwestern Utilities Ltd.

MEMBERSHIP

The Branch Membership is now as follows:—

	Resident	Non-Resident
Members	15	1
Associate Members	23	7
Junior Members	6	1
Student Members	13	..
	57	9

FINANCIAL STATEMENT

Receipts

Balance on hand Jan. 1, 1930	$234.11	
May 31. Rebates from Headquarters	91.80	
Oct. 13. Rebates from Headquarters	10.50	
Dec. 17. Rebates from headquarters	3.30	
		$339.71

Expenditures

Expenses, Meetings and Speakers	$ 23.70	
Printing, postage, etc	18.55	
Honorarium to Sec.-Treas	50.00	
Balance on hand, Dec. 31, 1930	247.46	
		$339.71

Respectfully submitted,

JULIAN GARRETT, A.M.E.I.C., *Chairman.*
W. E. CORNISH, Jr.E.I.C., *Secretary-Treasurer.*

Halifax Branch

The President and Council,—

We have the honour to submit the following report on the activities of the Halifax Branch of the Engineering Institute of Canada for the year 1930:—

The Executive held several meetings throughout the year at which the routine business of the Branch was attended to, following out the scheme outlined at the last annual meeting arranging the programme of the regular meetings so that only matters of major importance would be taken up.

The membership of the Branch shows a slight increase. Though the Council of The Institute has suspended a number of members for non-payment of dues, the number of new members have more than offset this loss, and the Branch will benefit thereby

The meetings committee arranged for interesting and instructive addresses for each meeting, and their efforts were evidently appreciated by the members of the Branch, as the average attendance at the regular meetings shows a decided increase over last year.

The management of the Nova Scotian hotel approached the Executive regarding the holding of our meetings at the hotel and after considering the proposal it was decided to accept it.

The regular meetings were as follows:—

Jan. 23.—**Progress of Aviation in Canada** by J. A. Wilson, A.M.E.I.C., Director, Department Civil Aviation, Department National Defence.

Feb. 20.—**Sugar** by J. S. Misener, M.E.I.C., Manager, Acadia Sugar Refinery.

Mar. 20.—**The Manufacture of Skates** by Mr. W. L. Davies, Manager, Starr Mfg. Co.

Apr. 24.—**The Electrical Transmission of Speech** by W. A. Winfield, M.E.I.C., Maritime Telegraph and Telephone Company.

May 2.—**The Activities of The Institute** by General Secretary, R. J. Durley, M.E.I.C., Montreal, P.Q.

Oct. 15.—Student's Meeting at Nova Scotia Technical College. Address by Mr. J. A. Richardson, Technical Lecturer of the Bethlehem Steel Corporation.

Nov. 5.—Noon meeting at Nova Scotian hotel in honour of Mr. H. F. Bennett.

Nov. 19.—**Modern Surveying** by F. H. Peters, M.E.I.C., Surveyor General of Canada.

Nov. 24.—**Remuneration and Classification** by J. L. Busfield, M.E.I.C.

The annual meeting was held on Thursday, December 18th, and the following officers were elected for the year 1931:—

Chairman........................J. L. Allan, M.E.I.C.
Executive........................L. M. Allison, A.M.E.I.C.
W. H. Noonan, A.M.E.I.C.
J. J. Sears, A.M.E.I.C.
W. J. DeWolfe, A.M.E.I.C.
A. F. Dyer, A.M.E.I.C.
J. D. Fraser, Jr.E.I.C.
G. S. Stairs, M.E.I.C.
S. L. Fultz, A.M.E.I.C.
J. H. Clark, A.M.E.I.C.
Auditors.........................F. R. Faulkner, M.E.I.C.
G. H. Burchill, Jr.E.I.C.

FINANCIAL STATEMENT

Receipts

Cash on hand Jan. 1, 1930	$266.42	
Rebates	264.30	
Branch News	36.86	
Bank Interest	8.61	
Canadian Bank of Commerce	9.69	
		$585.88

Expenditures

Office	$ 68.90	
Meetings	165.52	
Miscellaneous	17.60	
Secretary	50.00	
	$302.02	
Balance on hand	283.86	
		$585.88

Respectfully submitted,

W. P. COPP, 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 year 1930:—

The Branch year dates from June 1st, so that two Executive committees were in office during the calendar year as follows:

January to May

Chairman........................H. A. Lumsden, M.E.I.C.
Vice-Chairman....................A. H. Munson, A.M.E.I.C.
Committee.........................F. P. Adams, A.M.E.I.C.
W. D. Black, M.E.I.C.
J. B. Carswell, M.E.I.C.
H. S. Philips, M.E.I.C.
Secretary-Treasurer...............W. F. McLaren, M.E.I.C.
Councillor........................E. H. Darling, M.E.I.C.
Past-Chairman.....................W. L. McFaul, M.E.I.C.
News Editor.......................J. R. Dunbar, A.M.E.I.C.

June to December

Chairman........................W. F. McLaren, M.E.I.C.
Vice-Chairman....................F. P. Adams, A.M.E.I.C.
Committee.........................J. B. Carswell, M.E.I.C.
H. S. Philips, M.E.I.C.
E. M. Coles, A.M.E.I.C.
G. A. Colhoun, A.M.E.I.C.
Secretary-Treasurer...............J. R. Dunbar, A.M.E.I.C.
Councillor........................E. H. Darling, M.E.I.C.
Past-Chairman.....................H. A. Lumsden, M.E.I.C.
News Editor.......................J. A. M. Galilee, Affiliate E.I.C.

MEMBERSHIP

	Dec. 31, 1929		
	Resident	Non-Resident	Total
Members	24	6	30
Associate Members	49	10	59
Affiliates E.I.C	2	0	2
Juniors	9	5	14
Students	36	6	42
Branch Affiliates	23	0	23
Total	143	27	170

	Dec. 31, 1930 Resident	Non-Resident	Total
Members	25	5	30
Associate Members	46	9	55
Affiliates E.I.C	3	0	3
Juniors	11	4	15
Students	28	3	31
Branch Affiliates	20	0	20
Total	133	21	154

MEETINGS

The following meetings were held during the year:—

Jan. 14.—**Toronto-Leaside Transformer Station of the Hydro-Electric Power Commission of Ontario:—Electrical Equipment** by C. F. Publow; **Structural Features** by H. E. Brandon, A.M.E.I.C. Attendance, 60.

Feb. 21.—**Engineering in Europe** by Professor R. W. Angus, M.E.I.C. Dinner Meeting. Attendance, 30.

Mar. 19.—**Recent Developments in Arc Welding** by R. E. Smythies, M.E.I.C. Attendance, 40.

Apr. 22.—**St. Lawrence Power** by R. O. Sweezey, M.E.I.C. The Hamilton Branch E.I.C. were the guests of the Hamilton Chamber of Commerce at this meeting.

Apr. 25.—**Lightning Studies and Field Surge Investigations** by E. F. W. Beck. Joint meeting with Toronto Section A.I.E.E. Attendance, 310.

Apr. 30.—**The Hudson River Bridge** by F. W. Skinner. Annual Business Meeting and Dinner. Attendance, 76.

Sept. 11.—**The Future of The Institute and How to Improve Finances and Increase Membership** by A. J. Grant, M.E.I.C., President of The Institute. Several members of the Niagara Peninsula Branch were our guests at this meeting. Dinner Meeting. Attendance, 40.

Oct. 10.—**Mechanical and Electrical Features of the Welland Ship Canal** by J. B. McAndrew, A.M.E.I.C., and L. P. Rundle. The Hamilton Branch E.I.C. were the guests of the Ontario Section A.S.M.E. at this meeting. Joint dinner meeting of Ontario Section A.S.M.E., Toronto Section A.I.E.E., and Toronto Branch E.I.C. Attendance: 113 at dinner; 175 at the meeting.

Oct. 21.—(1) **Illumination of the Endless Caverns of Virginia** by G. F. Foot; (2) **Floodlighting and its Applications** by G. F. Mudgett. Attendance, 60, including ten ladies.

Nov. 4.—**Combustion of Pulverized Fuel** by E. G. Bailey. The members of the Hamilton Branch E.I.C. were the guests of the Engineering Society of Babcock-Wilcox and Goldie-McCulloch Company at this meeting. Attendance, 175.

Nov. 12.—**Weather Reporting to the R100** by J. Patterson. Attendance, 35.

Dec. 10.—**The Telephone Carrier System** by W. A. Dancey. Attendance, 55.

FINANCIAL STATEMENT

Receipts

Brought forward	$1,110.47	
Branch Affiliates	66.00	
Journal Subscriptions	6.00	
Rebates on Fees	241.50	
Branch News	56.06	
Bank Interest	42.39	
April, 1929, Journal	1.00	
Entrance Fee, G. F. Mudgett	15.00	
		$1,538.42

Expenditures

Printing and Postage	$ 80.83	
Lecture Expenses	46.05	
Refreshments	30.00	
Journal Subscriptions	6.00	
Stenographer	50.00	
Dinner, Feb. 24	17.70	
Annual Meeting and Dinner	93.75	
Fall Opening Dinner, Sept. 11	22.75	
Miscellaneous	3.77	
Entrance Fee, G. F. Mudgett	15.00	
Balance	1,172.57	
		$1,538.42

Respectfully submitted,

W. F. McLAREN, M.E.I.C., *Chairman.*
J. R. DUNBAR, A.M.E.I.C., *Secretary-Treasurer.*

Kingston Branch

The President and Council,—

During the year 1930 five meetings were held by the Branch, as follows:—

Jan. 10.—Address by Mr. J. W. Kelly, of the Portland Cement Institute, on **The Physical Nature of Concrete.**

Jan. 30.—Address by the Branch Secretary on **The Development of Architecture.**

Feb. 20.—Address by C. D. Howe, M.E.I.C., of C. D. Howe and Co., Elevator Engineers, Port Arthur, on **Grain Marketing and Grain Elevators.**

Nov. 6.—Address by Brig.-Gen. Sir Charles Delmé-Radcliffe on **A New Method of Aerial Surveying.**

Nov. 14.—Address by Mr. H. H. Richardson, of the Aluminum Company of America, on **Aluminum as a Structural Material.** This meeting was held jointly with the Engineering Society.

The total attendance at these meetings was 299, giving an average of 60.

The membership of the Branch is as follows:

	Resident	Non-Resident
Honorary Member	1	
Members	12	
Associate Members	9	3
Junior Members	1	2
Students	33	1
Affiliate	1	
Totals	57	6

This compares with 70 at the last annual meeting.

FINANCIAL STATEMENT

Receipts

Balance last account	$ 82.65	
June 6—Branch News	10.66	
" 6—Rebates	81.60	
" 30—Interest	.62	
Oct. 31—Rebates	12.30	
		$187.83

Expenditures

Jan. 10—Dinner, etc., for Mr. Kelly	$ 3.75	
" 8—Lunch, Mr. Smith	5.50	
Feb. 22—Dinner, Mr. Howe	6.45	
" 27—Use of Physics Room	2.00	
Mar. 27—Dinner expenses	1.90	
" 27—Half honorarium	25.00	
Apr. 28—Printing	5.47	
Oct. 31—Half honorarium	25.00	
Nov. 2—Telegrams	1.00	
" 7—Dinner, Sir Charles Delmé-Radcliffe	1.25	
" 7—Taxis	1.50	
" 14—Gratuity, janitor	2.00	
" 14—Dinner, Mr. Richardson and guests	10.40	
" 4—Printing	4.43	
" 4—Expenses of representative, Peterboro	6.20	
Cash in bank	85.98	
		$187.83

Respectfully submitted,

L. F. GRANT, M.E.I.C., *Secretary-Treasurer.*

Lakehead Branch

The President and Council,—

On behalf of the Executive Committee, the following Annual Report of Lakehead Branch of the Engineering Institute of Canada is submitted:—

MEMBERSHIP

On January 1st, 1930, there were 41 Corporate Members and 10 Non-Corporate Members, and on December 31st, 1930, there were 41 Corporate Members and 11 Non-Corporate Members, showing a gain of 1 Non-Corporate Member.

MEETINGS

It is regretted that no meetings were held during the past year.

FINANCIAL STATEMENT
(1930)

Receipts

Balance in Bank, December 31st, 1929	$118.55	
Rebates on Fees	67.35	
Refund Travelling Expenses to Plenary Meeting	106.09	
Interest	6.61	
		$298.60

Expenditures

Balance in Bank, December 31st, 1930	$298.60

Respectfully submitted,

GEO. P. BROPHY, A.M.E.I.C., *Secretary-Treasurer.*

Lethbridge Branch

The President and Council,—

The following report of the past year's activities of the Lethbridge Branch is herewith submitted for your consideration:—

During the calendar year, twelve regular meetings were held with an average attendance of 39, and eight executive meetings with an average attendance of over eight. All the regular meetings commenced with a dinner after which a musical programme was enjoyed.

The subjects and speakers during the year were of a very high order, and the excellence of our meetings has been due, to a very great extent, to the energetic manner in which the Programme committee have handled a problem which is becoming more arduous every year. Mention must also be made of the great assistance towards the success of the meetings rendered by the Entertainment committee whose splendid efforts have been repeatedly acknowledged by the Branch.

The following is a list of the speakers and their subjects since January 1st, last.

Jan. 4—Corporate members meeting. Discussion on report of Councillor G. S. Brown, A.M.E.I.C., on the Plenary Council Meeting.

Jan. 11.—Joint meeting with the Association of Professional Engineers of Alberta. H. L. Seymour, M.E.I.C., Town Planning Commissioner for Alberta. Subject: **A Year of Town Planning in Alberta.**

Jan. 25.—R. S. Trowsdale, A.M.E.I.C., Canadian General Electric Co. Subject: **The Electrical Industry and its Control.** W. P. Campbell, Petroleum Branch, Department of the Interior, Subject: **Water Problems Encountered in Development of Oil Fields.**

Feb. 8.—Dr. K. A. Clarke, Scientific and Industrial Research Council. Subject: **Bituminous Sands of Northern Alberta.**

Feb. 22.—C. G. Childe, A.M.E.I.C., Resident Engineer, Rocky Mountain Parks. Subject: **Highways and Byways in the National Parks.**

Mar. 8.—Dr. R. Neidig, Consolidated Mining & Smelting Co. Subject: **A General Talk on Fertilizers.**

Mar. 29.—Annual meeting.

June 28.—Corporate members meeting. Discussion of Branch activities.

Sept. 9.—Corporate members meeting. Discussion of Plenary Council matters and general business.

Oct. 4.—B. L. Thorne, M.E.I.C., Department of Natural Resources, Canadian Pacific Railway Company. Subject: **Through Oil Lands in Europe and Africa.**

Oct. 18.—Joint meeting with Association of Professional Engineers of Alberta. F. N. Rhodes, A.M.E.I.C., Institute of Technology and Art. Subject: **Efficiency.**

Nov. 1.—R. M. Gourlay, Canadian Western Natural Gas Co. Subject: **Prevention of Waste of Natural Gas.**

Nov. 15.—E. G. Hazell. Subject: **Crow's Nest Lime Works.**

Nov. 29.—E. E. Eisenhauer, A.M.E.I.C., Alberta Wheat Pool. Subject: **The Wheat Pool and the Handling of Wheat.**

Dec. 13.—J. H. Doughty-Davies, Town Planner, Calgary. Subject: **A Talk on Town Planning.**

Most of the addresses were illustrated with lantern slides or motion picture films, which added greatly to the general interest.

At the annual meeting of the Branch held on March 29th, the following officers were chosen for the season 1930-31.

Chairman	C. S. Clendening, A.M.E.I.C.
Vice-Chairman	N. Marshall, M.E.I.C.
Executive	R. F. P. Bowman, Jr.E.I.C.
	N. H. Bradley, A.M.E.I.C.
	R. Livingstone, M.E.I.C.
Ex-officio	J. B. deHart, M.E.I.C.
Councillor	G. N. Houston, M.E.I.C.
Auditors	P. M. Sauder, M.E.I.C.
	C. S. Donaldson, A.M.E.I.C.
Secretary-Treasurer	W. Meldrum, A.M.E.I.C.

The membership of the Branch as at Dec. 31, 1930, is as follows:

	Resident	*Non-Resident*	*Total*
Members	6	0	6
Associate Members	19	5	24
Junior Members	1	1	2
Student Members	1	2	3
Branch Affiliates	30	0	30
Total	57	8	65

FINANCIAL STATEMENT
(As at December 31st, 1930)

Receipts

Bank balance as at Dec. 31, 1929	$241.46		
Rebates due from H.Q., Dec. 31, 1929	1.20		
		$242.66	
Rebates received from Headquarters		79.50	
Branch News from Headquarters		25.94	
Branch Affiliate fees		106.50	
Donation for Orchestra		25.00	
Proceeds from dance		7.00	
Bank interest		7.60	
Rebates due from Headquarters as per telegram		8.40	
			$502.60

Expenditures

Printing and stationery		$ 41.05	
Meeting expenses, speakers, music, etc		151.40	
Headquarters, Journal fees for Branch affiliates		30.00	
Gratuities, hotel staff and orchestra		25.00	
Postage, telegrams, etc		16.70	
			$264.15

Assets

Bank balance at Dec. 31, 1930	$248.55		
Less outstanding cheques	18.50		
		$230.05	
Rebates due from Headquarters		8.40	
Percentage of members fees in arrears		28.43	
			$266.88

Liabilities

Headquarters for Journal subscription	$ 2.00

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.

P. M. SAUDER, M.E.I.C. }
C. S. DONALDSON, A.M.E.I.C. } Auditors.

Respectfully submitted,

C. S. CLENDENING, A.M.E.I.C., *Chairman.*
WM. MELDRUM, A.M.E.I.C., *Secretary-Treasurer.*

London Branch

The President and Council,—

On behalf of the Executive committee of the London Branch we beg to submit the following summary of London Branch activities for the year ending December 31st, 1930:—

Six meetings of the Executive committee were held and seven general Branch meetings.

The annual dinner meeting in January was held at the hotel London. Reports of the year's activities were read and the officers for the year 1930 were elected. Following the dinner Mr. R. L. Stratton, District Superintendent of the Bell Telephone Co., spoke on **The Origin of the Telephone.** In the absence of Mr. W. J. Piggott, Division Superintendent of the Canadian National Railways, his paper on **Phases of Motive Power Development on Railways** was read by J. Ferguson, A.M.E.I.C.. Mr. E. G. Wood rendered appropriate vocal selections.

The February meeting was devoted to land surveying, two papers being presented by Ontario Land Surveyors. The first speaker was W. G. Ure, A.M.E.I.C., and his subject **Land Surveying in Western Ontario.** The second speaker, F. W. Farncomb, M.E.I.C., took as his subject **Early Surveys in the District of London.** The speakers described the methods and difficulties of early surveyors and supplemented these with personal experiences.

The speaker for the March meeting was W. R. Smith, A.M.E.I.C. He gave an illustrated address on **Railway Construction through the Yellowhead Pass.** Mr. W. L. Hill, of the Bitumal Company, showed two motion picture films which illustrated the application of the products of his company in highway construction.

Mr. H. B. R. Craig was the speaker at the April meeting and his subject **Some Aspects of Harbour Engineering.** The paper dealt with the factors that enter into the design of harbour works, and included some notable examples of storm damage.

Branch activities were suspended during the summer, to be opened by the October meeting, held in the University of Western Ontario, in the Science building, with Dr. R. C. Dearle, Professor of Physics, speaking on **Ultra-Violet Light.** Many demonstration were conducted during the evening illustrating the properties and effects of this light.

The Telegraph—Yesterday and Today was the subject and Mr. R. B. Steele, Assistant Chief Engineer of the Canadian National Telegraphs, was the speaker, at the regular November meeting. The paper on the development of the telegraph was supplemented by a description of the train telephone.

The last meeting of the year was held in December and A. B. Crealock, A.M.E.I.C., was the speaker. Mr. Crealock drew from his experiences with the Ontario Department of Highways in describing bridges built by that Department and in giving detailed descriptions of some of the more important structures.

The Branch has been particularly successful during this year in selecting speakers and subjects that drew forth a much larger attendance than formerly, the average being 42.

The membership of the London Branch at the close of 1930 was as follows:—

Members	14
Associate Members	30
Juniors	4
Students	8
Affiliates	2
Branch Affiliates	4
Total	62

FINANCIAL STATEMENT
(Year ending December 31st, 1930)
Receipts

Balance on hand, Jan. 1, 1930	$ 88.74	
Rebates from Headquarters for Dec. 1929	2.10	
Rebates from Headquarters for 1930:		
Dues	96.30	
Branch News	26.20	
Fees from Branch Affiliates	15.00	
	$228.34	
Rebates due from Headquarters	11.10	
		$239.44

Expenditures

Journal subscriptions for Branch Affiliates	$ 6.00	
Notices, printing and stationery	35.50	
Postage	10.50	
Telephone and telegrams	1.87	
Annual dinner	32.00	
Refreshments, cigars, etc	13.00	
Hotel rooms and railway fares for speakers	25.85	
Stenographer, janitor, elevator	11.00	
Flowers	10.00	
Badges	10.00	
Bank balance	72.62	
Rebates due from Headquarters	11.10	
		$239.44

We have examined the above statement prepared by the Secretary-Treasurer and find the same to be a correct and true account of the financial standing of the London Branch.

J. R. ROSTRON, A.M.E.I.C. }
V. A. MCKILLOP, A.M.E.I.C. } Auditors.

Respectfully submitted,

W. G. URE, A.M.E.I.C., *Chairman.*
FRANK C. BALL, A.M.E.I.C., *Secretary-Treasurer.*

Moncton Branch

The President and Council,—

On behalf of the Executive committee we beg to submit the eleventh annual report of Moncton Branch:—

The Executive committee held four meetings. There were eight meetings of the Branch held, three of which were supper meetings and two were open to the public.

MEMBERSHIP

Our membership at present consists of forty-seven members, as follows:

	Resident	Non-Resident
Members	10	2
Associate Members	19	8
Juniors	1	1
Students	2	3
Affiliates	1	..
	33	14

OFFICERS

The annual meeting of the Branch was held on June 10, 1930. The following officers were elected for 1930-31:—

Chairman	L. H. Robinson, M.E.I.C.
Vice-Chairman	G. E. Smith, A.M.E.I.C.
Secretary-Treasurer	V. C. Blackett, A.M.E.I.C.
Executive	E. T. Cain, A.M.E.I.C.
	A. S. Gunn, A.M.E.I.C.
	A. F. Stewart, M.E.I.C.

The members of the Executive committee in addition to the above are:—

	T. L. S. Landers, M.E.I.C.
	J. G. Mackinnon, A.M.E.I.C
	C. S. G. Rogers, A.M.E.I.C.
Ex-officio	M. J. Murphy, A.M.E.I.C.

FINANCIAL STATEMENT
(Year ending December 31st, 1930)
Receipts

Balance in bank, Jan. 1, 1930	$191.54	
Cash on hand, Jan. 1, 1930	3.78	
Rebates on dues	95.55	
Affiliate dues	5.00	
Branch news	18.18	
Tickets sold for supper meetings	93.00	
Bank interest	5.70	
Moncton Tramways Electricity & Gas Co	9.50	
Rental of lantern	7.00	
Rebates due from Headquarters	2.10	
		$431.35

Expenditures

Expenses of meetings	$130.10	
Printing and advertising	36.50	
Postage	4.56	
Telegrams and telephones	8.80	
Miscellaneous	35.75	
Balance in bank	209.12	
Cash on hand	4.42	
Rebates due from Headquarters	2.10	
		$431.35

Audited and found correct,

E. T. CAIN, A.M.E.I.C. }
R. H. EMMERSON, A.M.E.I.C. } Auditors.

Respectfully submitted,

L. H. ROBINSON, M.E.I.C., *Chairman.*
V. C. BLACKETT, A.M.E.I.C.. *Secretary-Treasurer.*

Montreal Branch

The President and Council,—

We wish on behalf of the Executive committee of the Montreal Branch to submit the following report covering the activities of the year 1930:—

During the past year the personnel of the committee consisted of the following:

Chairman	D. C. Tennant, M.E.I.C.
Vice-Chairman	A. Duperron, M.E.I.C.
Secretary-Treasurer	C. K. McLeod, A.M.E.I.C.
Past-Chairman	J. A. McCrory, M.E.I.C.
Executive	A. Cousineau, A.M.E.I.C.
	W. McG. Gardner, A.M.E.I.C.
	N. L. Morgan, A.M.E.I.C.
	P. E. Jarman, A.M.E.I.C.
	J. A. Lalonde, A.M.E.I.C.
	F. Newell, M.E.I.C.
Ex-officio	F. P. Shearwood, M.E.I.C.
	F. S. Keith, M.E.I.C.
	O. O. Lefebvre, M.E.I.C.
	G. R. MacLeod, M.E.I.C.
	P. B. Motley, M.E.I.C.
	F. A. Combe, M.E.I.C.
	J. C. Smith, M.E.I.C.
	J. L. Busfield, M.E.I.C.
	J. A. McCrory, M.E.I.C.

MEMBERSHIP

The membership of the Branch at present is 1,126, which is the largest in its history, comparing with a membership of 1,089 at the end of last year. The chairman of the Membership committee is W. McG. Gardner, A.M.E.I.C., and the standing of the Branch membership reflects credit on his committee.

It is with the deepest regret that we report the deaths of several important members during the past year, and wish to record the following list:—

Henry Holgate, M.E.I.C., died on January 21st. He had been associated with many engineering projects in and around Montreal during his lifetime, and was at different times a Councillor and Vice-President of The Institute.

A. T. Spencer, M.E.I.C., died on January 26th, his engineering work having been associated with the Dominion Coal Company, with the Toronto Transportation Commission and with the Montreal Tramways.

On March 3rd, Henry Irwin, M.E.I.C., passed away. He was at one time Councillor of The Institute and for many years was its Treasurer. He held several important offices with the Canadian Pacific Railway.

C. C. Leluau, M.E.I.C., died on March 10th. His engineering career began in France, where he served in the Franco-Prussian War, being awarded the Decoration of "Chevalier de la Légion d'Honneur." In his latter years he was Professor of Physics and Hydraulics at Laval University, now the University of Montreal.

Geo. W. Thompson, M.E.I.C., died on April 1st. He was best known as the Manager of the city of Westmount, and as such he is greatly mourned.

John J. York, M.E.I.C., died on April 8th. He gave his lifetime of engineering service to the St. Lawrence Sugar Refinery.

On August 3rd, F. L. Wanklyn, M.E.I.C., died at Grimsby, England. He was associated with many railway companies including the Tramways in both Toronto and Montreal, and the Canadian Pacific Railway. He was at one time a Councillor of The Institute.

Arthur A. Mellor, A.M.E.I.C., died in September. His engineering work began in England and later he was with the Milton Hersey Company in Montreal in connection with the Montreal Harbour Bridge.

On October 25th, H. M. Mackay, M.E.I.C., Dean of the Faculty of Applied Science at McGill University, passed away. In his earlier days he was associated with Dr. W. Bell Dawson and also with Messrs. Waddell & Hedrick, Consulting Engineers in Kansas City. He had been a Councillor in The Engineering Institute.

Seldom, if ever, has the Branch in one year mourned the loss of so many important members, notable as they were for their engineering ability, their high type of citizenship and genuine humanity.

Papers and Meetings Committee

The Papers and Meetings committee, under the chairmanship of P. E. Jarman, A.M.E.I.C., deserves special mention. The members of it having worked so well that we think all their names should be mentioned. It is composed as follows:—

Chairman........................P. E. Jarman, A.M.E.I.C.
Vice-Chairman....................H. G. Thompson, A.M.E.I.C.
Ex-officio.......................C. K. McLeod, A.M.E.I.C.
Civil Section, Chairman............R. M. Robertson, A.M.E.I.C.
Vice-Chairman........A. E. Oulton, A.M.E.I.C.
Electrical Section, Chairman........J. L. Clarke, A.M.E.I.C.
Vice-Chairman....H. Milliken, M.E.I.C.
Mechanical Section, Chairman.......L. H. Birkett, A.M.E.I.C.
Vice-Chairman..S. Hermans, A.M.E.I.C.
Municipal Section, Chairman.......C. Jos. LeBlanc, A.M.E.I.C.
Vice-Chairman...F. E. V. Dowd, A.M.E.I.C.
Railway Section, Chairman.........J. W. McAllister, A.M.E.I.C.
Aeronautical Section, Chairman......J. L. Busfield, M.E.I.C.
Vice-Chairman.C. M. McKergow, M.E.I.C.
Student Section, Chairman..........H. W. Lea, S.E.I.C.

It will be noted that during the year there was no lack of papers, in fact, two extra meetings were held in May whereas it is usual to hold the final meeting in the spring in April. The fall programme has also been well filled and for the first session of the year 1931, from January to April inclusive, the committee reports a surplus of papers, which is something almost unheard of here before. That the quality of the papers has also been good, is evidenced by the attendance throughout the year, which has been considerably better than usual. The papers given throughout the year 1930 are as follows:—

Jan. 9.—Branch Annual Meeting.
" 16.—**Process of Zinc Coating Steel Wires** by A. D. Turnbull, S.E.I.C.
" 23.—**Telephone Lines Outside North America** by J. L. McQuarrie.
" 30.—**Scientific Developments Leading to Sound Pictures** by Paul B. Findlay.
Feb. 6.—**Construction of the Sun Life Building in Montreal** by A. H. Harkness, M.E.I.C.
" 13.—No meeting. Supper dance.
" 20.—**Reinforcing Stoney Creek Arch Bridge, B.C.** by P. B. Motley, M.E.I.C.
" 27.—**Transformer Load Ratio Control** by C. E. Sisson, M.E.I.C.
Mar. 6.—**Climatic Cycles as Affecting Water Power** by A. Streiff.
" 13.—**Welded Airplane Structures** by Arthur Piche.
" 13.—**The Problems in Long Distance Telephone** by Messrs. Roll and Rouselle.
" 20.—**Road Building** by E. L. Miles, M.E.I.C.
" 27.—**Toronto Sewer System** by Geo. Phelps, A.M.E.I.C.
Apr. 3.—**Water Power in Brazil** by A. W. K. Billings, M.E.I.C.
" 8.—**The Engineer and Aviation** by J. A. Wilson, A.M.E.I.C.
" 10.—**Point St. Charles New Locomotive Shops and Power Plant** by J. Roberts.
" 17.—**The Hudson River Bridge Span** by F. W. Skinner.
" 24.—**Hydraulic Fill on Ghost Power Development** by W. H. Abbott, A.M.E.I.C.
May 1.—**Electricity in the Eighteenth Century** by Dr. L. E. Pariseau.
" 8.—**The Cottrell Process of Electric Precipitation** by P. E. Landolt.
" 21.—**The Quest of the Unknown** by Harold B. Smith.
Oct. 2.—**The Phenomena of Oil Circuit Breaker Interruption** by J. O. Bason.
" 9.—**Steel Castings** by H. R. Bartell.
" 16.—**Aeronautics as a Branch of the Engineering Profession** by Flight-Lieut. Alan Ferrier, A.M.E.I.C., A.F.R.Ae.S.
" 23.—**Operation of Trains on Single Tracks by Centralized Traffic Control** by C. L. Hacket.
" 30.—**Surveying in the Three Dimensions by a New Photogrammetric Method** by Brig.-Gen. Sir Charles Delmé-Radcliffe, K.C.M.G.
Nov. 6.—**The New Mill at Copper Cliff for the International Nickel Company** by L. M. Sheridan.
" 13.—**The Practical Aspects of System Stability** by F. A. Hamilton, Jr.
" 20.—**Royal Canadian Air Force as a Career** by Wing-Commander L. S. Breadner, A.M.E.I.C.
" 27.—**Filling Lyon Creek Trestle** by M. S. Blaiklock, M.E.I.C.
Dec. 4.—**Recent Investigations at McGill University** by various Members of McGill.
" 11.—**Rapide Blanc Bridge** by Palmer E. Savage, S.E.I.C.; **Steam Distribution and Control in Paper Machine Dryers** by C. B. Charlewood.
" 18.—**Turbo Blowers and Compressors** by John Avery.

It will be noted in the above that an aeronautical section of the Branch is included for the first time. This section, which was inaugurated on April 8th, 1930, had as its principal officers J. L. Busfield, M.E.I.C., and C. M. McKergow, M.E.I.C. This is the first aeronautical section to be formed by any branch of The Institute, and it is already one of our most active sections. The Royal Aeronautical Society has corresponded with The Engineering Institute during the past year expressing its willingness to co-operate in the formation of aeronautical sections and the interchange of technical information between the two societies.

An important change from the regular routine of weekly meetings was that on December 4th, the meeting of the Branch took place at the Engineering building of McGill University where explanations were given by the Engineering Faculty regarding various work done recently in the laboratories, including tests on steelwork and concrete, investigations regarding welding, and also work in the hydraulic, steam, mechanical and electrical laboratories. After the explanations had been given members of the Branch were conducted by the students and staff of the University to whatever portions in the laboratories they were most interested in, and thus a most profitable evening was spent. Arrangements have been made to make a similar visit to the laboratories in the University of Montreal in the next few months and it is hoped that similar visits can be arranged frequently in the future to give the members of the Branch an opportunity of seeing the work in our universities and strengthen in every way possible the bond between the universities and the engineering profession.

Activities with Other Organizations

During the year the Branch has availed itself of several opportunities to co-operate with other organizations. Early last year it was thought desirable, in view of the forthcoming annual meeting of the American Institute of Electrical Engineers in Toronto, to have a visit from their president, Mr. H. B. Smith. It was accordingly arranged, and he addressed the Branch on May 21st, his subject being "The Quest of the Unknown."

During the summer months the Society for the Promotion of Engineering Education held their annual meeting in Montreal, and representatives of the Branch attended the banquet given on that occasion.

The Branch has a representative on the standing committee of the City Improvement League, which is doing a great deal of good work in our metropolitan area.

The Province of Quebec Safety League appointed a sub-committee of their construction division to prepare a safety code for the use of the construction industries in the province. The Branch was asked to co-operate, and appointed a committee under the chairmanship of Geo. Templeman, M.E.I.C., to report on a draft code which had been drawn up. This code has not been approved by the Branch Executive, and it is hoped that further steps may be taken, as your Executive have offered their assistance.

During the year the Branch Secretary has been in communication with several of the other branches in Quebec and Ontario, and the Branch chairman attended the annual dinner of the Peterborough Branch.

Visits

While no extensive trips were taken by the Branch members this year we were fortunate in being able to have two excursions, each of which took half a day only. On August 7th, the members of the Montreal Branch visited the St. Hubert Airport and were privileged to inspect the interior of the airship "R100," which was then at St. Hubert. This trip was very greatly enjoyed by all. About 100 members availed themselves of the invitation.

The Beauharnois Construction Company invited the Branch to visit the work in connection with the construction of the new Beauharnois canal and power house on October 31st. Almost 150 members took in this trip,—transportation from Montreal being provided by private automobiles. The visit proved both enjoyable and instructive.

Annual Dinner Dance

An innovation was made by the Branch this year in holding a dinner dance which took place at the Windsor hotel on February 25th. This proved to be a most successful function and it is recommended that a similar event be held each year, excepting those years in which the annual meeting of The Institute will be held in Montreal, in which case its place would be taken by the activities of the annual meeting.

The Reception committee activities were handled by Mr. J. B. O. Saint-Laurent, A.M.E.I.C., who was always very much in evidence during the year, and to whom the thanks of the Branch should be extended.

In previous years the publicity was taken care of by a Branch reporter. The Executive felt that the most suitable person to act as Branch reporter would be the vice-chairman of the Papers and Meetings committee. The reason for this decision was that he would act as a liaison between the activities of the various sections of the Branch on the one hand, and The Engineering Journal and the public press on the other. Accordingly, H. G. Thompson, A.M.E.I.C., took charge of this work with very desirable results.

An Unemployment committee has been appointed to co-operate with The Institute Unemployment Bureau in trying to help solve, as far as possible, unemployment that may exist amongst members of the Montreal Branch. It is felt that this is a timely move, and it is hoped that the incoming Executive will make of this committee the most effective instrument possible.

A sub-committee on admissions and transfers consisted of J. A. Lalonde, A.M.E.I.C., and N. L. Morgan, A.M.E.I.C., during the past year, and they have made abstracts of the qualifications of the various applicants which have been greatly appreciated by the Executive, and have expedited the Executive committee work in this connection.

FINANCIAL STATEMENT

Ordinary Revenue		
Branch news	$ 46.23	
Affiliate dues	91.00	
Rebate from Headquarters	1,745.05	
Interest	31.03	
		$1,913.31
Extraordinary Revenue		
Balance from 1929	$1,277.62	
Dance	595.50	
		1,873.12
		$3,786.43
Ordinary Expenditures		
Post card notices	$ 740.03	
Miscellaneous printing	78.59	
Stationery and stamps	18.20	
Secretary's honorarium	300.00	
Clerical assistance	120.00	
Telephone	62.30	
Movies, slides, etc	84.90	
Subscriptions to Journal	58.00	
Miscellaneous	289.85	
		$1,751.87
Extraordinary Expenditures		
Dance		717.75
Balance on hand December 31st, 1930		1,316.81
		$3,786.43

ANNUAL GENERAL AND PROFESSIONAL MEETING

In preparation for the Annual General and Professional meeting of The Institute to be held on February 4th, 5th and 6th, 1931, under the auspices of the Montreal Branch, the Executive has appointed the following committee:—

Chairman	D. C. Tennant, M.E.I.C.
Secretary	C. K. McLeod, A.M.E.I.C.
General Duties	A. Duperron, M.E.I.C.
Hotel Arrangements	J. L. Busfield, M.E.I.C.
Luncheons	J. A. McCrory, M.E.I.C.
Registration and Reception	H. Massue, A.M.E.I.C.
Papers and Meetings	P. E. Jarman, A.M.E.I.C.
Inspection Trips	F. Newell, M.E.I.C.
Smoker	C. M. McKergow, M.E.I.C.
Publicity	H. G. Thompson, A.M.E.I.C.
Ladies	W. McG. Gardner, A.M.E.I.C.

This committee has already had quite a number of meetings, and arrangements are well under way.

Respectfully submitted,

D. C. TENNANT, M.E.I.C., *Chairman.*
C. K. McLEOD, A.M.E.I.C., *Secretary.*

Niagara Peninsula Branch

The President and Council,—

The Executive of the Niagara Peninsula Branch present herein the report for the year 1930:—

The Executive held five meetings with an average attendance of 10.4, or 65 per cent.

Nine regular meetings of the Branch and an Electoral meeting were held.

The policy of using our meetings to advertise the profession has been continued. There have been some visitors present at every meeting.

The meetings are listed hereunder:—

Jan. 29.—Dinner meeting at Niagara Falls. **The Future of Engineering** by Professor C. R. Young, M.E.I.C. Attendance, 44.

Feb. 26.—Complimentary dinner to A. J. Grant, M.E.I.C., President E.I.C. Attendance, 169.

Mar. 21.—Joint meeting with Frontier Section American Institute Electric Engineers, at Buffalo. **By-products of Radio** by Dr. Phillips Thomas, Attendance E.I.C., about 50.

Apr. 10.—Dinner meeting at Niagara Falls. **The World Engineering Congress at Tokio** by John Murphy, M.E.I.C. Attendance, 30.

Apr. 29.—Dinner meeting at St. Catharines. **The 3,500-foot span of the Hudson River Bridge, and Comparative Construction Features of Largest Typical Spans.** by Frank W. Skinner, Consulting Engineer. Attendance, 40.

May 22.—Electoral meeting at Lookout Point Golf Club. Attendance, 20.

June 4.—Annual meeting. Dinner meeting and dance at St. Catharines. **Geology from a Motor Car** by Dr. A. P. Coleman, M.A., Ph.D., F.R.S. Attendance, 150.

Oct. 24.—Joint trip and dinner meeting with the Ontario Association of Professional Engineers. **Mechanical and Engineering Features of The Welland Ship Canal** by J. B. McAndrew, A.M.E.I.C., and L. P. Rundle. Attendance, 75.

Nov. 19.—Dinner meeting at Bridgeburg. **The Niagara Area** by Louis Blake Duff, Esq. Attendance, 60.

Dec. 16.—Dinner meeting at Welland. **Nickel** by G. C. Bateman, Secretary, Ontario Mining Association. Attendance, 29.

MEMBERSHIP

	At end 1929	At end 1930	Loss	Gain
Members	20	20	..	..
Associate Members	70	69	1	..
Junior Members	17	16	1	..
Student Members	24	14	10	..
Branch Affiliates	20	17	3	..
Total	151	136	16	0

The decrease is due to the approaching completion of the large engineering works in the district.

The most serious item, however, has been the loss by death of E. H. Pense, A.M.E.I.C., and R. W. Leonard, M.E.I.C.

FINANCIAL STATEMENT
(January 1st to December 31st, 1930)

Receipts		
Balance on hand	$ 262.71	
Rebates	245.25	
Branch news	42.28	
Proceeds meetings	912.75	
Branch Affiliates fees	80.55	
Miscellaneous	2.70	
Bank interest	3.20	
		$1,549.44
Expenditures		
Telephone	$ 12.60	
Telegrams, etc	14.97	
Expenses meetings	1,149.41	
Printing and stationery	40.87	
Stamps and postcards	35.00	
Journal subscriptions Branch Affiliates	40.00	
Presentation	7.75	
Secretary's honorarium	100.00	
Rebates	.90	
Balance on hand	147.94	
		$1,549.44

Respectfully submitted,

WALTER JACKSON, M.E.I.C., *Chairman.*
R. W. DOWNIE, 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 1930:—

During the year the Managing committee held six meetings. In addition the Branch held four evening meetings and fourteen luncheons, one luncheon being a joint meeting with the Ottawa Branch of the Queen's Alumni Association.

The outstanding events of the year were the holding in Ottawa, in February, of the 44th Annual General Meeting of The Institute, and the development of a scheme for co-operation with the Royal Aeronautical Society.

It is with deep regret that we report the loss through death of two members—Colonel S. H. Osler, M.E.I.C., and U. Valiquet, M.E.I.C., and one Branch affiliate, Geo. Mothersill.

PROCEEDINGS AND PUBLICITY

During the year fourteen luncheons and four evening meetings were held as follows:—

Jan. 9.—Annual meeting—Daffodil Tea Rooms.

Jan. 16.—**The St. Lawrence Waterways** by Hon. E. C. Drury; luncheon meeting at the Chateau Laurier.

Jan. 30.—**Impressions of Japan and the Far East** by Tom Moore, President of the Dominion Trades and Labour Congress; luncheon meeting at the Chateau Laurier.

Feb. 28.—**Talking Motion Pictures** by O. R. Harvey of the Northern Electric Company; evening address at the Chateau Laurier.

Mar. 13.—**Darwin** by Colonel Alexander MacPhail, M.E.I.C., of Queen's University; joint luncheon meeting with the Ottawa Branch of Queen's Alumni Association at the Chateau Laurier.

Mar. 27.—**The Technical Service Council and Its Works** by Lieut.-Col. R. E. Smythe, A.M.E.I.C., Secretary, Technical Service Council; luncheon meeting at the Chateau Laurier.

Apr. 10.—**The Engineer's Contribution to Industry** by G. C. Bateman, Secretary, Ontario Mining Association; luncheon meeting at the Chateau Laurier.

Apr. 16.—**A Trip to Japan** by John Murphy, M.E.I.C., Electrical Engineer, Department of Railways and Canals; evening address at the Victoria Memorial Museum.

May 8.—**Industrial Development of Sudbury Area** by E. A. Lapierre, M.P.; luncheon meeting at the Chateau Laurier.

May 22.—**The Arvida Operations of the Aluminum Co. of Canada** by R. E. Parks, A.M.E.I.C., General Superintendent; luncheon meeting at the Chateau Laurier.

Aug. 8.—**The Atlantic Crossing of the R100** by Group-Captain R. B. B. Colmore, O.B.E., and Major G. H. Scott, O.B.E., A.F.C.; luncheon meeting at the Chateau Laurier.

Oct. 23.—**Explorations in Northern Canada** by Major L. T. Burwash, M.E.I.C., Exploratory Engineer of the North West Territories and Yukon Branch, Department of the Interior; luncheon meeting at the Chateau Laurier.

Oct. 30.—**Surveying by a New Photogrammetric Method** by Sir Charles Delmé-Radcliffe, K.C.M.G., Chairman of the Board of Directors of British Cadastral and Topographical Air Surveying Company; luncheon meeting at the Chateau Laurier.

Nov. 6.—**The Engineer in the Nation** by R. W. Boyle, F.R.S.C., M.E.I.C., of the National Research Council; luncheon meeting at the Chateau Laurier.

Nov. 14.—**Dial System Telephony** by C. F. Inglis of the Bell Telephone Co. of Canada; evening address at the Victoria Memorial Museum.

Nov. 20.—**Recent Developments in Acoustical Practice** by Major G. M. Thomson, Director of Research, Gypsum, Lime and Alabastine Canada, Limited; luncheon meeting at the Chateau Laurier.

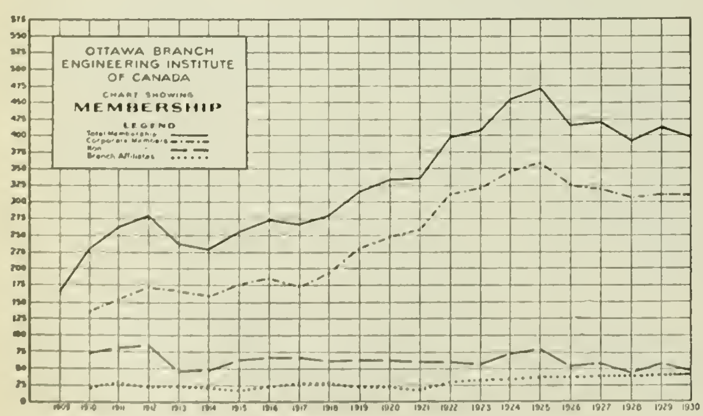
Dec. 4.—**Speeding-up Communications** by J. C. Burkholder, Chief Engineer, Canadian National Telegraphs; luncheon meeting at the Chateau Laurier.

Dec. 18.—**Wolfe's Cove Tunnel, Quebec** by Lieut.-Colonel D. Hillman, D.S.O., M.E.I.C., Engineer of Construction, Canadian Pacific Railway Co.; luncheon meeting at the Chateau Laurier.

The average attendance at the luncheon meetings was 112 and at the evening meetings (including the Annual Meeting) was 154.

In August it was a special privilege to have had as guests Group-Captain R. B. B. Colmore, O.B.E., Director, and Major G. H. Scott, O.B.E., A.F.C., Assistant Director of Airship Development in the Air Ministry, on the occasion of the successful flight of the airship R100 to Canada. These gallant airmen made many friends during their stay in Canada. In consequence it was a matter of intense regret to learn later of their tragic death in the attempt of the R101 to make a trip to India.

The annual ball of the Ottawa Branch was not held on account of a ball being one of the features of the Annual General Meeting of The Institute held in Ottawa on February 12th, 13th and 14th.



MEMBERSHIP

Owing to deaths, resignations and members removed from the roll the membership shows a decrease of 19 for the year. The accompanying chart shows graphically the membership of the Branch from 1909 to date.

The following table shows, in detail, the comparative figures of the Branch membership for the years 1928, 1929 and 1930:—

	1928	*1929*	*1930*
Honorary Members	1	1	1
Members	107	108	107
Associate Members	199	204	202
Affiliates of Institute	7	7	4
Juniors	23	24	17
Students	14	27	22
Branch Affiliates	40	41	40
Total	391	412	393

ROOMS AND LIBRARY

The Branch library is still situated on the third floor of the Stephen Building where it is open to consultation by members under the same conditions as have previously prevailed.

ADVERTISING IN THE JOURNAL

Commissions due for advertising in the Journal during 1929 amount to $29.50, which is approximately equivalent to the rebates from fifteen Associate members.

FINANCES

The statements below of assets and liabilities and of receipts and expenditures show that the Branch closed the year with a balance of $629.10 in the bank, $13.31 cash on hand, and $1,000 in Victory Bonds, a total balance of $1,642.41. In addition to this balance the Branch has assets of $95.76 in rebates due from the main Institute, $29.50 in commissions due for advertising in The Journal, and $201 in furniture, equipment, etc., making a total of $1,968.67, a decrease of $340.15 as compared with 1929. This decrease is due to the expenses incurred in connection with the Annual General Meeting held in Ottawa in February, 1930. The financial standing of the Branch from 1910 to date is shown on the accompanying chart.

The income for the past two years was:—for 1929, $864.67, and for 1930, $1,035.79; the expenditure for 1929, $940.03, and for 1930, $1,249.70. The annual income from Victory Bonds is $52.50.

OFFICERS FOR 1931

The Annual Meeting of the Branch will be held in Ottawa on January 8th when the officers and members of the Managing committee for the year 1931 will be elected.

FINANCIAL STATEMENT

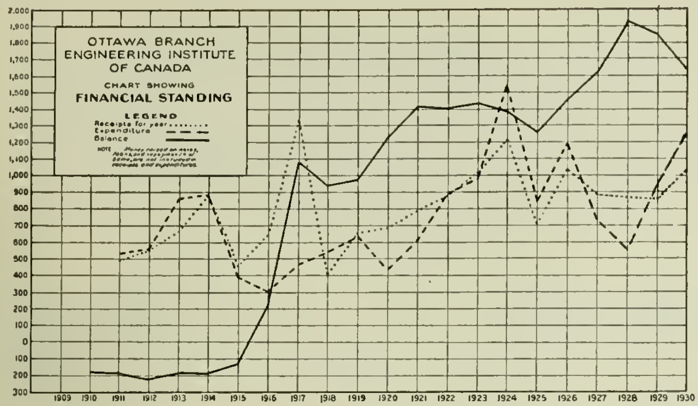
(December 31, 1930)

Receipts

Balance in bank, Jan. 1, 1930	$ 848.20	
Cash on hand, Jan. 1, 1930	8.12	
Interest on Victory Bonds	52.50	
Bank interest	16.16	
Rebates from Institute, Dec., 1929	41.00	
" " " Jan. to April, 1930	489.50	
" " " May to Aug., 1930	55.20	
" " " Sept. to Nov., 1930	37.00	
" " " Branch news, Apr., 1930	10.00	
" " " May to July, 1930	25.29	
" " " Sept. to Nov	14.74	
" " " Advertising, 1929	130.55	
Refund from Main Institute—re editorials	144.85	
Branch affiliate fees	84.00	
Proceeds from sale of luncheon tickets	761.25	
Refund from Annual Meeting committee	11.54	
Refund from United Service Institute	34.41	
		$2,764.31

Expenditures

Chateau Laurier, luncheons	$1,207.85	
Daffodil Tea Rooms	31.50	
R. B. Farrell, for editorials	65.00	
Scrims—for flowers	10.56	
Board of Trade Membership fee	15.00	
Advance to Annual Meeting committee	500.00	
Insurance	3.40	
Subscription to Engineering Journal	6.00	
Printing, stationery, etc	50.52	
Advertising	40.90	
Petty cash, postage, etc	131.97	
Sundries, entertainment, etc	59.20	
Balance in bank, Dec. 31, 1930	629.10	
Cash on hand, Dec. 31, 1930	13.31	
		$2,764.31



Assets

Furniture (cost $200)	$ 80.00	
Stationery and equipment	20.00	
Library:		
Book cases (cost $105)	75.00	
Bound magazines (nominal)	1.00	
Books	25.00	
Rebates due from main Institute on 1930 fees	95.76	
Rebates due from main Institute for Advertising, 1930	29.50	
Victory Bonds due November 1, 1934	500.00	
" " " October 15, 1943	500.00	
Cash in bank	629.10	
Cash on hand	13.31	
		$1,968.67

Liabilities

Surplus	$1,968.67	
		$1,968.67

Audited and found correct,
H. C. Craig, A.M.E.I.C.

Respectfully submitted,

John McLeish, 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 of the Peterborough Branch we take pleasure in submitting the following report covering the various activities of the Branch during the year 1930:—

Meetings and Papers

Jan. 9.—**The Construction of a Modern Locomotive** by W. A. Newman, Chief Mechanical Engineer, Canadian Pacific Railway Company.

Jan. 23.—**Developments in the Mining Industry** by W. R. Rogers, A.M.E.I.C., Ontario Department of Mining and Metallurgy.

Feb. 13.—**The Age of Speed.** Moving pictures shown by the Norton Company of Canada.

Feb. 27.—**Aerial Mapping** by A. M. Narraway, M.E.I.C., Chief Aerial Surveys Engineer, Department of the Interior, Ottawa.

Mar. 13.—Students Papers:
The Diesel Engine by A. E. Jagger.
Power Rectifiers by R. L. Morrison, S.E.I.C.
Forestry in Alberta by J. J. Taylor, S.E.I.C.

Mar. 27.—**Ball and Roller Bearings** by R. F. Runge, Vice-President S.K.F. Industries Inc., N.Y.

Apr. 10.—**Aluminum as an Engineering Material** by H. H. Richardson, Chief of Technical Department of Aluminum Company of Canada.

Apr. 24.—**Rural Power Service** by J. W. Purcell, A.M.E.I.C., engineer, Hydro-Electric Power Commission of Ontario.

May 8.—Annual meeting and joint meeting with the Toronto Branches of the A.I.E.E., A.S.M.E., and E.I.C. held in Peterborough.

Sept. 13.—Annual Picnic.

Oct. 9.—Inspection of plant of the Western Clock Company, with an address by J. H. Vernor.

Oct. 23.—**Canadian Patent and Requisites of a Patentable Invention** by L. C. Prittie, A.M.E.I.C., Patent Attorney.

Nov. 13.—**The R 100 at St. Hubert Air Port** by A. L. Killaly, A.M.E.I.C., and R. L. Dobbin, M.E.I.C.

Nov. 25.—Annual dinner.

Dec. 11.—**Copper in the Electrical Industry** by H. C. Jennison, Assistant Technical Supervisor and Assistant Metallurgist of the Anaconda American Brass Company.

Membership

	Jan. 1, 1929	*Jan. 1, 1930*
Members	20	18
Associate Members	31	30
Juniors	20	20
Students	30	23
Branch Affiliates	25	17
Total	126	108

At the joint meeting held on May 8th, there were present 16 members of Toronto Branches of the American Institute of Electrical Engineers, American Society of Mechanical Engineers and The Institute, and 10 visitors. Tours of inspection were made to the various factories in the afternoon and a bowling tournament and dinner were held in the evening. At the dinner an address on **Water Powers** was given by R. O. Sweczey, M.E.I.C. The attendance at the dinner was 88.

The following members were elected to the Executive committee on May 29th, 1930.

Chairman	W. E. Ross, A.M.E.I.C.
Secretary	F. G. A. Tarr, S.E.I.C.
Treasurer	A. B. Gates, A.M.E.I.C.
Executive	A. E. Caddy, M.E.I.C.
	P. P. Westbye, M.E.I.C.
	A. L. Killaly, A.M.E.I.C.
	B. Ottewell, A.M.E.I.C.
	H. R. Sills, Jr.E.I.C.
	W. F. Stewart, Jr.E.I.C.
Ex-officio	R. L. Dobbin, M.E.I.C.
	R. C. Flitton, A.M.E.I.C.
	S. O. Shields, Jr.E.I.C.

Financial Statement
(Year ending December 31, 1930)

Receipts

Bank balance Jan. 1, 1930	$ 44.64	
Rebates on fees	136.80	
Journal news	51.21	
Affiliate fees	48.00	
Balance from joint meeting	16.50	
Annual dinner receipts	154.00	
		$451.15

Expenditures

Rent	$ 55.00	
Printing	92.22	
Meetings and speakers	23.50	
Affiliate Journal subs	24.00	
M.P. machine insurance	7.20	
Annual dinner expense	146.25	
Flowers	10.00	
Miscellaneous expenses	6.28	
Bank balance, Dec. 31, 1930	86.70	
		$451.15

A. B. Gates, A.M.E.I.C., *Treasurer.*

Respectfully submitted,

W. E. Ross, A.M.E.I.C., *Chairman.*
F. G. A. Tarr, S.E.I.C., *Secretary.*

Quebec Branch

The President and Council,—

The Council of the Quebec Branch has the honour of submitting the following report for the year 1930:—

Membership

	Resident	*Non-Resident*	*Total*
Honorary Members	1	..	1
Life Members	2	..	2
Members	15	..	15
Associate Members	64	10	74
Juniors	11	4	15
Students	12	3	15
Affiliate Members	2	..	2
Total	107	17	124

Annual Meeting

The annual meeting of the Quebec Branch was held on May 26th, 1930, under the chairmanship of A. B. Normandin, A.M.E.I.C., president of the Branch; the following officers were elected for the year 1930-31:

Honorary Chairman for life	A. R. Décary, D.A.Sc., M.E.I.C.
Chairman	S. L. deCarteret, M.E.I.C.
Vice-Chairman	J. M. Hector Cimon, M.E.I.C.
Secretary-Treasurer	Philippe Méthé, A.M.E.I.C.
Councillors	T. J. F. King, A.M.E.I.C.
	Alexandre Larivière, A.M.E.I.C.
	L. C. Dupuis, A.M.E.I.C.
	J. A. Lefebvre, M.E.I.C.
	Louis Beaudry, A.M.E.I.C.
	J. G. O'Donnell, A.M.E.I.C.
Ex-officio (Vice-Pres. E.I.C.)	W. G. Mitchell, M.E.I.C.
Ex-officio (Past-Pres. Branch)	A. B. Normandin, A.M.E.I.C.
Ex-officio (Past-Pres. Branch)	A. E. Doucet, M.E.I.C.

BRANCH ACTIVITIES

Four meetings were held during the year 1930:

Jan. 27.—J. E. Noulan Cauchon, A.M.E.I.C., president of the Ottawa Town Planning Commission, guest of honour; his subject being **Hexagon Town Planning.**

Mar. 24.—Guest of honour, H. R. Wake, A.M.E.I.C., Property Engineer for the Aluminum Company of Canada; subject: **The Buildings of the Company at Arvida, Que.**

May 7.—A. A. MacDiarmid, M.E.I.C., and J. S. Bates, A.M.E.I.C., of Price Bros. Ltd. on **The properties and process of manufacturing of Donnacona insulating board, and the mill required to manufacture it.**

Dec. 3.—Sir Charles Delmé-Radcliffe, K.C.M.G., explains the **Theory and Operation of Aerial Surveying by the Nistri Photogrammetric Method.**

FINANCIAL STATEMENT

Receipts

Cash in bank, Jan. 1, 1930	$225.85	
Interest on deposit	3.76	
Rebates	222.54	
		$452.15

Expenditures

Printing, stamps, telephone, etc	$ 40.02	
Meetings	101.60	
Honorarium to the secretary	100.00	
	$241.62	
Cash in bank, Jan 1, 1931	210.53	
		$452.15

Respectfully submitted,

PHILIPPE MÉTHÉ, A.M.E.I.C., *Secretary-Treasurer.*

Quebec Branch

Au Président et au Conseil,—

Le conseil de la Section de Québec a l'honneur de vous soumettre son rapport annuel pour l'année 1930, comme suit:—

ROLE DES MEMBRES

	Résidents	*Non-Résidents*	*Total*
Membres honoraires	1	..	1
Membres à vie	2	..	2
Membres	15	..	15
Membres associés	64	10	74
Membres Juniors	11	4	15
Membres étudiants	12	3	15
Membres affiliés	2	..	2
	107	17	124

ASSEMBLEE ANNUELLE

L'assemblée annuelle de la Section de Québec eut lieu le 26 mai, sous la présidence de monsieur A. B. Normandin, A.M.E.I.C., président; les officiers dont les noms suivent furent élus pour l'année 1930-31.

Président honoraire à vie	A. R. Décary, M.E.I.C., D.A.Sc.
Président	S. L. deCarteret, M.E.I.C.
Vice-président	Hector Cimon, M.E.I.C.
Secrétaire-trésorier	Philippe Méthé, A.M.E.I.C.
Conseillers	F. T. J. King, A.M.E.I.C.
	Alex Larivière, A.M.E.I.C.
	L. C. Dupuis, A.M.E.I.C.
	J. A. Lefebvre, M.E.I.C.
	Louis Beaudry, A.M.E.I.C.
	J. G. O'Donnell, A.M.E.I.C.
Ex-officio (Vice-prés. E.I.C.)	W. G. Mitchell, M.E.I.C.
Ex-officio (ancien président)	A. B. Normandin, A.M.E.I.C.
Ex-officio (ancien président)	E. A. Doucet, M.E.I.C.

ACTIVITES DE LA SECTION DE QUEBEC

Pendant l'année 1930, les membres de la Section de Québec ont eu le plaisir de se réunir et d'écouter les conférenciers suivants:—

Le 27 janvier.—J. E. Noulan Cauchon, A.M.E.I.C., président de la Commission d'Urbanisme d'Ottawa, nous entretient d'urbanisme et expose sa méthode de lotissement hexagonal.

Le 24 mars.—H. R. Wake, A.M.E.I.C., ingénieur préposé aux édifices de l'Aluminum Company of Canada, à Arvida, traite des différents édifices de l'immense usine d'aluminium d'Arvida.

Le 7 mai.—A. A. MacDiarmid, M.E.I.C. et J. S. Bates, A.M.E.I.C., de la Cie Price Bros. Ltd. exposent devant les membres de la Section les propriétés et les procédés de fabrication du Donnacona insulating board, et donnent une description du moulin où il est fabriqué.

Le 3 décembre.—Sir Charles Delmé-Radcliffe, K.C.M.G. expose la théorie et les diverses opérations de l'arpentage aérien par la méthode photogrammetrique de Nistri.

RAPPORT FINANCIER

Recettes

En caisse au 1er janvier 1930	$225.85	
Intérêts sur dépôt	3.76	
Remises du bureau chef	222.54	
		$452.15

Déboursés

Impression, timbres, téléphones, etc.	$ 40.02	
Réunions	101.60	
Gratification au secrétaire	100.00	
	$241.62	
En caisse au 1er janvier 1931	210.53	
		$452.15

PHILIPPE MÉTHÉ, A.M.E.I.C., *Secrétaire-trésorier.*

Saint John Branch

The President and Council,—

On behalf of the Branch Executive committee the annual report of the Saint John Branch is submitted herewith for the year ending December 31st, 1930:—

EXECUTIVE COMMITTEE

During the year eleven Branch Executive meetings were held. The personnel of the Executive committee to date is as follows:—

Chairman	W. J. Johnston, A.M.E.I.C.
Vice-Chairman	J. N. Flood, A.M.E.I.C.
Secretary-Treasurer	A. A. Turnbull, A.M.E.I.C.
Executive	G. A. Vandervoort, A.M.E.I.C.
	C. C. Langstroth, A.M.E.I.C.
	H. F. Morrissey, A.M.E.I.C.
Ex-officio	E. J. Owens, A.M.E.I.C.

It is with regret that we have to report the death of E. A. Thomas, A.M.E.I.C., who was chairman of this Branch from May, 1929, to January, 1930. He was always a consistant, loyal and active supporter of Branch affairs and his presence is greatly missed by both the Executive and members of the Branch.

COMMITTEES

The chairmen of standing committees of the Branch are as follows:—

Programme and Meetings	S. R. Weston, M.E.I.C.
Entertainment	J. C. Nutter, A.M.E.I.C.
Employment	J. A. W. Waring, A.M.E.I.C.
Membership	Branch Executive.
Policy	Branch Executive.
Salaries	A. Gray, M.E.I.C.
Publicity	F. M. Barnes, A.M.E.I.C.
Natural Resources and Engineering Industries	F. P. Vaughan, M.E.I.C.
Town Planning	A. R. Crookshank, M.E.I.C.
Auditor	C. M. Hare, S.E.I.C.

BRANCH MEETINGS

During the year nine Branch meetings were held including the joint meeting with the Engineering Society of the University of New Brunswick at Fredericton, N.B., the joint meeting with the Professional Engineers of the Province of New Brunswick at Saint John, N.B., and the Branch annual dinner.

PROGRAMME

Jan. 16.—Joint dinner meeting with the Association of Professional Engineers of the Province of New Brunswick. **Progress of Aviation** by J. A. Wilson, A.M.E.I.C., Controller of Civil Aviation, Ottawa, Ontario.

Feb. 20.—**Forestry on the Pacific Coast** by Prof. J. M. Gibson, B.Sc.F., University of New Brunswick, Fredericton, N.B.

Mar. 20.—**Canada** by C. H. Wright, M.E.I.C., District Manager, Canadian General Electric Co., Halifax, N.S.

Apr. 4.—Joint meeting with the University of New Brunswick Engineering Society at Fredericton, N.B. **High Potential and High Frequency Apparatus and Experiments** by F. P. Vaughan, M.E.I.C.

Apr. 17.—**The Evolution of Artillery** by Major E. M. Slader, O.C. 4th Medium Battery, Saint John, N.B.

Apr. 28.—**Annual meeting** held at the Riverside Golf and Country Club.

Nov. 17.—**Aerial Photographic Survey** by F. H. Peters, M.E.I.C., Surveyor General of Canada, Ottawa.
Nov. 19.—**A Modern Testing Laboratory** by W. P. Dobson, M.E.I.C., Chief Testing Engineer of the Hydro-Electric Power Commission of Ontario.
Nov. 25.—**The Work of the Remuneration Committee** by J. L. Busfield, M.E.I.C., of Montreal, Chairman of Remuneration Committee of The Institute.

MEMBERSHIP

A statement of membership as at December 31st, 1930, is as follows:—

	Resident	*Non-Resident*	*Total*
Members	13	7	20
Associate Members	21	16	37
Juniors	2	2	4
Students	6	7	13
Affiliates	1	0	1
Total	43	32	75

Membership at the end of 1929 was 86, making a net loss of 11 for the year 1930.

FINANCIAL STATEMENT
(Year ending December 31st, 1930)

Receipts		
Balance in bank, Dec. 31, 1929	$241.20	
Rebates from H.Q., Dec. 31, 1929	3.30	
" " " Jan., Feb., Mar. and Apr. 1930	103.50	
" " " May, June, July and Aug. 1930	6.90	
" " " Sept., Oct. and Nov. 1930	6.75	
Branch news, Feb. and Apr.	8.44	
" " May and June	15.40	
" " November	2.50	
Donation	2.00	
		$389.99
Expenditures		
Stamps and post cards, etc.	$ 18.99	
Printing	40.28	
Meetings	70.04	
Stenographic services	15.00	
Miscellaneous (flowers)	10.00	
Secretary's services	25.00	
Balance in bank, Dec. 31, 1930	210.68	
		$389.99
Assets		
Balance in bank, Dec. 31, 1930	$210.68	
Rebates due from H.Q. for Dec. 1930	5.40	
		$216.08
Liabilities		
Outstanding accounts	..	
Surplus at Dec. 31, 1930	216.08	
		$216.08

Respectfully submitted,
W. J. JOHNSTON, A.M.E.I.C., *Chairman.*
A. A. TURNBULL, A.M.E.I.C., *Secretary-Treasurer.*

St. Maurice Valley

Au président et au conseil,—

Nous avons l'honneur de vous soumettre les opérations de la Branche de la Vallée du St-Maurice, de l'Engineering Institute of Canada pour l'année 1930.

La Branche n'a tenu que deux assemblées. La première le 21 juin 1930 au Château De Blois aux Trois-Rivières.

Le conférencier fut A. A. Wickenden, A.M.E.I.C., P.E.Q.Q.L.S., ingénieur en chef du Département forestier de la Canada Power & Paper Company Limited aux Trois-Rivières.

Sa conférence traita du sujet de la construction, des avantages et du maintien des routes à travers les limites de cette compagnie. Cette conférence fut publiée dans les journaux de l'Engineering Institute of Canada au mois d'août 1930. Une discussion s'ensuivit, à laquelle prirent part A. N. Budden, A.M.E.I.C., Elwood Wilson, M.E.I.C., H. Dessaulles, M.E.I.C., et autres.

La deuxième conférence a été tenue au Cascade Inn, à Shawinigan Falls. L'orateur fut Olivier Lefebvre, M.E.I.C., ingénieur en chef de la Commission des Eaux Courantes de la province de Québec, qui parla du voyage qu'il fit avec le Comité International des Pouvoirs d'eau, en Allemagne.

Ce diner était rehaussé de la présence du Docteur A. R. Décary, M.E.I.C., et de R. J. Durley, M.E.I.C., Secrétaire de l'Institut.

Le même bureau de direction a été maintenu en fonction pour l'année 1930 et les membres réélus pour 1931 sont E. Wilson, M.E.I.C., de Grand'Mère comme président et H. Dessaulles, M.E.I.C., de Shawinigan Falls comme conseiller, A. A. Wickenden, A.M.E.I.C., des Trois-Rivières comme conseiller et Bruno Grandmont, A.M.E.I.C., des Trois-Rivières comme conseiller.

Roméo Morrissette, A.M.E.I.C., du Cap de la Madeleine a été réélu secrétaire-trésorier. C. H. Jetté, A.M.E.I.C., a été appointé sur le comité des nominations.

Quoique la Branche n'ait eu que deux assemblées dans le cours de l'année dernière, elles ont été très enthousiastes et avec un grand pourcentage de présences.

La Branche de la Vallée du St-Maurice comprend les ingénieurs, habitants des villes de Grand'Mère, Shawinigan Falls, Trois-Rivières et Cap de la Madeleine. C'est pourquoi les assemblées mensuelles avec un bon pourcentage de présences sont rendues difficiles et le comité de direction a jugé qu'il était mieux de ne faire que deux ou trois assemblées par année avec succès.

Le tout humblement soumis,
ELLWOOD WILSON, M.E.I.C., *Président.*
R. MORRISSETTE, A.M.E.I.C., *Secrétaire.*

Saguenay Branch

The President and Council,—

On behalf of the Executive committee, we beg to submit the following report covering the activities of the Saguenay Branch of the Engineering Institute of Canada during the calendar year 1930:—

MEMBERSHIP

On December 31st, 1930, the membership of the Branch was as follows:—

Members	6
Associate Members	25
Juniors	7
Students	11
	49

This shows an increase of 3 over the total of 46 on December 31st, 1929.

FINANCIAL STATEMENT
(As at December 31st, 1930)

Receipts		
Balance on hand Dec. 31, 1929	$245.30	
Rebates from Headquarters	112.80	
Interest	3.42	
		$361.52
Expenditures		
Stationery and postage	$ 31.44	
Meetings	65.40	
Telegraph Charges	.54	
	$ 97.38	
Balance on hand	264.14	
		$361.52

BRANCH MEETINGS

On February 24th, 1930, N. D. Paine, A.M.E.I.C., Superintendent of the Hydro-Electric Department of Price Brothers and Company Ltd., gave a very interesting lecture on **Electric Drives for Paper Machines.** This meeting was held in Arvida and was attended by thirty-five members.

On June 25th, 1930, the annual general meeting of the Branch was held at Arvida, in the main office of the Aluminum Company of Canada.

The election of officers for the Executive committee of the Branch for the year 1930 took place and resulted as follows:—

Chairman	N. D. Paine, A.M.E.I.C.
Vice-Chairman	J. F. Grenon, A.M.E.I.C.
Secretary-Treasurer	W. P. C. LeBoutillier, JR.E.I.C.
Executive Committee	G. E. LaMothe, A.M.E.I.C.
	G. O. Vogan, A.M.E.I.C.
	G. F. Layne, A.M.E.I.C.
	J. W. Ward, A.M.E.I.C.

H. R. Wake, A.M.E.I.C., the Branch Councillor, then reported the activities of the Council and outlined a few of the more important matters which were discussed at the last Council meeting.

We were also very fortunate in having with us Mr. M. G. Saunders of the Aluminum Company of Canada, who gave a most interesting talk on **Repairs and Maintenance in Plants located great distances from Industrial Centres.**

Previous to the meeting, the group were shown through the aluminum plant at Arvida, a tour which proved to be of great interest to all.

On November 12th, 1930, C. P. Dunn, M.E.I.C., Chief Engineer for the Alcoa Power Company at Chute à Caron, gave a short informal talk on the design, construction and the dropping of the obelisk at Chute à Caron. His lecture was illustrated by a movie film which showed the obelisk at different stages during construction and also dropping it into position in the Saguenay river. The film had been taken by Mr. Geo. Low, of the Aluminum Company of Canada, who had kindly consented to show it to the meeting.

Respectfully submitted,
N. D. PAINE, A.M.E.I.C., *Chairman.*
W. P. C. LEBOUTILLIER, JR.E.I.C., *Secretary-Treasurer.*

Saskatchewan Branch

The President and Council,—

On behalf of the Branch Executive we beg to submit the following report concerning the activities of the Saskatchewan Branch for the calendar year 1930:—

MEMBERSHIP

The membership of the Branch shows an increase of two over last year with the usual fluctuations due to transfers, etc.

The present membership of the Branch is:

	Resident	*Non-Resident*	*Total*
Members	7	11	18
Associate Members	41	39	80
Juniors	5	4	9
Students	3	8	11
Affiliates	1	1	2
Branch Affiliates	5	0	5
Total	62	63	125

MEETINGS

The Executive held seven meetings for the transaction of Branch affairs. There were six regular meetings of the Branch and one special meeting (ladies night) which took the form of a dinner dance at the Champlain hotel, Regina. The Branch meetings in all cases were preceded by a dinner. The average attendance at Branch meetings was 36, and the general interest in the meetings has been satisfactory.

During the year the Association of Professional Engineers of Saskatchewan came into being. The bill for incorporation of the engineers was sponsored by the Saskatchewan Branch of The Institute and the relations between the two bodies are most cordial. This Branch however feels the need for closer co-ordination of the two bodies.

We regret to record the loss by death of one of our members, the late Wm. R. Warren, A.M.E.I.C., Deputy Minister of Telephones for Saskatchewan. Mr. Warren served as chairman of the Branch in 1921 and always took a keen and active interest in the affairs of The Institute.

PROGRAMME

The programme for the year was as follows:—

Jan. 24.—**The Nipawin Bridge** by H. D. Brydone-Jack, A.M.E.I.C., Assistant Engineer, Canadian Pacific Railway Co.

Feb. 14.—Ladies night, dinner dance, Champlain hotel, Regina.

Mar. 21.—Thirteenth annual meeting. Address by Dr. J. S. Huff, Commissioner of Education, on **The New Curricula for Secondary or High Schools.**

May 30.—Address by Prof. Howard E. Simpson, State Geologist of University of North Dakota, on the **Ranco La Brea Tar Pits of Southern California.**

Oct. 24.—Report of Councillor D. A. R. McCannel, M.E.I.C., joint meeting with the Association of Professional Engineers of Saskatchewan.

Nov. 21.—Address by S. R. Muirhead, A.M.E.I.C., on **Experiments in the Transmission of Speech and Music Illustrated with the Aid of Gramophone Records.**

Dec. 12.—Address by E. M. Moore, Engineer, Tri-Cities Utilities Ltd., on **Gas Supply Engineering, with Special Reference to Regina and Other Saskatchewan Cities.**

SCHOLARSHIP

The annual scholarship of $50 offered by the Branch to the most deserving student in the graduating class in Engineering at the University of Saskatchewan was awarded to Mr. B. A. Evans.

FINANCIAL STATEMENT

Receipts		
Balance from 1929	$326.32	
Headquarters rebates	216.90	
Branch dues	8.00	
Sundries, Branch news, etc	126.19	
		$677.41
Expenditures		
Meetings	$ 38.70	
Stationery, notices, etc	79.39	
Scholarship	50.00	
Honorarium	137.00	
Sundries	115.00	
Cash in bank	141.12	
Cash on hand	116.20	
		$677.41

Respectfully submitted,

W. G. WORCESTER, M.E.I.C., *Chairman.*

R. W. E. LOUCKS, A.M.E.I.C., *Secretary-Treasurer.*

Sault Ste. Marie Branch

The President and Council,—

There were eight regular meetings and one special meeting held during the year and also one trip of inspection.

The papers and meetings that were arranged for by the Papers committee were much appreciated by all who attended. The difficulty in obtaining speakers seems to be increasing from year to year and the committee for 1930, and particularly the chairman, are to be congratulated.

The meetings held and the papers given were as follows:—

Jan. 24.—**Electro-Chemical Appliances** by Mr. James Kelleher of the Superior Alloys Ltd.

Feb. 28.—**Winter Maintenance of Roads and Sidewalks** by A. H. Russell, A.M.E.I.C., City Engineer.

Mar. 28.—**The Construction of the Michipicoten Coal Dock** by A. M. Wilson, Jr.E.I.C., of the engineering department of the Algoma Central Railway, and **The History of Dam Construction** by L. F. Harza, M.E.I.C., consulting engineer of Chicago, who is associated with the Algoma District Power Company.

Apr. 25.—**Recent Research Studies of Fire, Heat, Sound and Condensation Problems** by Mr. James Govan, Research Engineer for the Gypsum, Lime and Alabastine Co. of Canada.

Apr. 30.—**The Detroit-Windsor Tunnel** by Mr. R. B. Value.

May 30.—**The Steam Engine on the North American Continent** by R. S. McCormick, M.E.I.C., General Superintendent of the Algoma Central Railway.

Sept. 26.—An inspection trip through the store, roundhouse and machine shop of the Algoma Central Railway.

Nov. 7.—**General Discussion of Civic Affairs** in lieu of paper on New Windsor hotel, which was not given owing to unavoidable absence of contractors from the city.

Nov. 8.—An inspection trip of the New Windsor hotel.

Nov. 28.—**Sanitation** by Dr. Nelson Graham, Director of the Local Branch of the Provincial Board of Health.

MEMBERSHIP

	Resident	*Non-Resident*	*Total*
Members	8	11	19
Associate Members	16	36	52
Juniors	3	10	13
Students	0	8	8
Affiliates	2	1	3
Branch Affiliates	14	0	14
Total	43	66	109

This is a decrease of 19 members from last year.

FINANCIAL STATEMENT

Receipts		
Balance from 1929—current account	$123.44	
Balance from 1929—savings account	216.33	
Income from H.Q. rebates	188.25	
Income from H.Q. advertising	30.00	
Income from H.Q. Branch news	13.55	
Affiliate fees	41.00	
Journal subscriptions	14.00	
Dinners	64.50	
Interest on savings	6.52	
		$697.59
Expenditures		
Postage and stationery	$ 15.00	
Printing and advertising	42.59	
Gratuities and donations	80.00	
Stenographer	25.00	
Meetings	49.49	
Dinners	72.75	
Entertainment, etc	29.05	
Journal subscriptions	14.00	
Taxi	1.00	
Honorarium to secretary	25.00	
Sundries	.17	
	$354.05	
Balance in current account	120.69	
Balance in savings account	222.85	
		$697.59

Outstanding Affiliate fees $32.

Respectfully submitted,

C. H. E. ROUNTHWAITE, A.M.E.I.C., *Chairman.*

A. A. ROSE, A.M.E.I.C., *Secretary-Treasurer.*

Toronto Branch

The President and Council,—

The Executive committee of the Toronto Branch respectfully submits the following report for the calendar year 1930:—

The Executive committee holding office during this period is as follows, the present members being elected at the annual meeting of the Branch on April 3rd, 1930:

EXECUTIVE COMMITTEE

January to April, 1930

Chairman	T. Taylor, M.E.I.C.
Vice-Chairman	J. J. Traill, M.E.I.C.
Secretary-Treasurer	J. J. Spence, A.M.E.I.C.
Executive	G. H. Davis, M.E.I.C.
	A. B. Crealock, A.M.E.I.C.
	H. N. Mason, A.M.E.I.C.
	C. S. L. Hertzberg, M.E.I.C.
	J. R. Cockburn, M.E.I.C.
	C. B. Hamilton, M.E.I.C.
Ex-officio	L. W. Wynne-Roberts, A.M.E.I.C.
Councillors	J. G. R. Wainwright, A.M.E.I.C.
	T. R. Loudon, M.E.I.C.
	R. B. Young, M.E.I.C.

April to December, 1930

Chairman	J. J. Trail, M.E.I.C.
Vice-Chairman	C. S. L. Hertzberg, M.E.I.C.
Secretary-Treasurer	J. J. Spence, A.M.E.I.C.
Executive	*F. B. Goedike, A.M.E.I.C.
	*J. W. Falkner, A.M.E.I.C.
	A. B. Crealock, A.M.E.I.C.
	J. R. Cockburn, M.E.I.C.
	C. B. Hamilton, M.E.I.C.
	†G. H. Davis, M.E.I.C.
Ex-officio	T. Taylor, M.E.I.C.
Councillors	J. G. R. Wainwright, A.M.E.I.C.
	T. R. Loudon, M.E.I.C.
	R. B. Young, M.E.I.C.
	L. W. Wynne-Roberts, A.M.E.I.C.

*Elected for period of 2 years.
†Elected for period of 1 year.

STANDING COMMITTEES

The following standing committees, with the chairman of each, were appointed by the Executive:

January to April, 1930

Papers	T. Taylor, M.E.I.C.
Finance	J. J. Traill, M.E.I.C.
Publicity	C. S. L. Hertzberg, M.E.I.C.
Membership	H. N. Mason, A.M.E.I.C.
Meetings	G. H. Davis, M.E.I.C.
Library	J. R. Cockburn, M.E.I.C.
Student Relations	W. B. Dunbar, A.M.E.I.C.
Branch Editor	A. B. Crealock, A.M.E.I.C.

April to December, 1930

Papers	J. J. Traill, M.E.I.C.
Finance	C. S. L. Hertzberg, M.E.I.C.
Publicity	T. Taylor, M.E.I.C.
Membership	G. H. Davis, M.E.I.C.
Meetings	F. B. Goedike, A.M.E.I.C.
Library	J. R. Cockburn, M.E.I.C.
Student Relations	J. R. Cockburn, M.E.I.C.
Branch Editor	A. B. Crealock, A.M.E.I.C.

The Executive committee of this Branch held six meetings during the year for the transaction of Branch business and thirteen general meetings.

The various meetings for the year 1930 were as follows:—

Jan. 9.—**The Internal Structure of Concrete** by J. W. Kelly of the Portland Cement Association, Chicago.

Jan. 23.—**A Pioneer Canadian Industry** by C. E. Macdonald, Assistant to Vice-President, International Nickel Company of Canada, Ltd.

Feb. 6.—**Construction Features of the 220,000-Volt Gatineau-Toronto Steel Power Lines** by A. E. Davison, Transmission Engineer, Hydro-Electric Power Commission of Ontario.

Feb. 20.—**The Petroleum Industry** by A. W. Sime, Technical Engineer, Imperial Oil Ltd., Toronto.

Mar. 6.—**Signalling and its Relation to Speed and Safety of Railroad Operation** by S. J. Turreff, Assistant Resident Engineer, Union Switch and Signal Co. of St. Louis.

Mar. 20.—**The Design and Construction of the Detroit-Windsor Tunnel** by Col. B. R. Value, Executive Engineer of Parsons, Knapp, Brinckerhoff and Douglas, Designers and Engineers of the Detroit-Windsor Tunnel. This meeting was in conjunction with the Association of Professional Engineers of Ontario.

Apr. 3.—**Annual Meeting** of the Branch.

Apr. 17.—**Water Power Development in Brazil** by A. W. K. Billings, M.E.I.C.

Oct. 10.—**The Mechanical and Electrical Features of the Welland Ship Canal** by L. P. Rundle and J. B. McAndrew, A.M.E.I.C. This meeting was in conjunction with the American Society of Mechanical Engineers (Ontario Section) and the American Institute of Electrical Engineers (Toronto Section).

Oct. 30.—**The Hudson's Bay Railway** by Dr. H. A. Innis, Professor of Political Economy, University of Toronto.

Nov. 13.—**Aero Photometric Surveys** by General Sir Charles Delmé-Radcliffe and **Industrial Engineering** by William Snaith.

Nov. 27.—**Recent and Projected Improvements to the Waterworks System of the City of Hamilton** by W. F. McFaul, M.E.I.C., City Engineer, Hamilton.

Dec. 11.—**Arc Welding in Steel Fabrication** by A. S. Wall, M.E.I.C., Dominion Bridge Company, Ltd., Montreal.

MEMBERSHIP

The membership as listed at December 31st, 1930 is as follows:—

	Resident	Non-Resident	Total
Members	125	2	127
Associate Members	272	12	284
Juniors	63	1	64
Students	63	9	72
Affiliates	5	..	5
Branch Affiliates	2	..	2
Total 1931	530	24	554
Total 1930	510	24	534
	+ 20		+ 20

The Branch deeply regrets the loss by death of P. E. Hart, M.E.I.C., G. A. McCarthy, M.E.I.C., F. C. McClory, A.M.E.I.C., Robert Armour, M.E.I.C., J. W. Moffat. M.E.I.C.

FINANCIAL STATEMENT
(For calendar year 1930)

Receipts

Bank balance at Jan. 1, 1930	$1,313.75	
Rebates and Branch news,	747.09	
Bank interest	32.95	
Affiliate fees	20.00	
Rebate—Professional Engineers of Ontario	18.65	
		$2,132.44

Expenditures

Advertising and printing	$ 191.25	
Room rental	85.50	
Stenography	27.10	
Librarian fees	35.00	
Chairman's expenses	52.60	
Vice-Chairman's expenses	4.82	
Secretary's honorarium and expenses	167.30	
Meeting expenses for outside speaker	30.30	
Affiliate Journal fees	4.00	
Expenses joint meeting A.S.M.E	11.25	
	$ 609.12	
Bank balance at Dec. 31, 1930	1,523.32	
		$2,132.44

Respectfully submitted,

J. J. TRAILL, M.E.I.C., *Chairman.*
J. J. SPENCE, 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 of The Institute for the year 1930:—

MEETINGS

During 1930 nine meetings of the Branch were held as outlined below:—

Feb. 27.—Student night.

Mar. 27.—H. B. Muckleston, M.E.I.C., on **A Method of Equalizing Stresses in Masonry Arches.**

Apr. 2.—N. C. Stewart, B.C.L.S., on **Modern Methods of Surveying.**

May 16.—W. E. Harper, F.R.S.C., on **Observatories and their Work.**

May 19.—Luncheon meeting. Speaker, Brigadier-General H. St.J. L. Winterbotham, C.M.G., D.S.O.

May 31.—Trip to Ruskin Lake Power Plant.

July 5.—Trip to Pacific Coast Terminals' Cold Storage Plant.

Oct. 29.—Inspection of C.P. S.S. "Empress of Japan."

Dec. 29.—**Annual Meeting.**

In this regard mention must be made of the fact that while the various trips were well attended, the ordinary meetings at which papers were read were not so well supported.

EXECUTIVE

During the year five meetings of the Executive were held to transact the routine business of the Branch and to discuss matters of policy.

Walter Moberly Memorial Prize

The prize for 1930 was awarded to William R. Selby, s.e.i.c., for an essay on "The Sullivan Mine," being the best essay submitted by any student in the senior year of the Faculty of Applied Science at the University of British Columbia.

Library

With the approaching closing of the University Club the problem of the future disposition of the library became serious, and a committee was appointed consisting of a member from each major engineering organization in the city to consider the whole problem of meeting places and the establishment of an engineering library. Discussion soon made it evident that the various bodies were not strong enough financially at present to establish any central quarters, so that the problem of the Branch library was not solved in any way by this committee. Finally negotiations were opened with the Carnegie Public Library and they agreed to take our collection, select what they required and dispose of the remainder as the Branch saw fit. These books taken over by the library would be indexed in the usual manner and made available to the public as reference books. It is the intention of the Public Library to establish a reading room for professional men as soon as funds and space permit, and when this is accomplished, the Branch collection will be placed therein.

The total cost, then, of disposing of the Branch library amounted to $24 for moving the books to the Public Library, of which the Association of Professional Engineers paid $12.

Relations with the Association of Professional Engineers

The relations between the Branch and the Association of Professional Engineers have been very harmonious, and the two bodies have co-operated in obtaining speakers and in the problem of the Branch library.

Relations with Vancouver Section, American Institute of Electrical Engineers

This past year has seen close co-operation between our Branch and the local Section of the American Institute of Electrical Engineers. Two joint meetings have been held to hear papers on topics of interest to both branches and a very valuable precedent has been established in this regard.

Membership

	Dec. 1928	Dec. 1929	Dec. 1930
Branch Resident			
Members	58	59	59
Associate Members	77	79	82
Juniors	11	14	13
Students	61	76	84
Affiliates	2	2	2
	209	230	240
Branch Non-Resident			
Members	16	17	17
Associate Members	40	46	50
Juniors	8	9	14
Students	17	19	16
Affiliates	0	0	0
	81	91	97

Student Section

The Student section of the Branch at the University of British Columbia has had a successful year. In February a very good meeting was held at the university, three excellent papers being given by the students. In addition noon-hour meetings were held during the term where prominent engineers spoke on various topics, technical and otherwise.

Elections

Sixty-seven ballots were returned out of a total of 157 mailed.

Finances

The attached financial statement shows a balance on hand of $181.83 at the end of the year's activities.

Financial Statement

(December 18th, 1929, to December 29th, 1930)

Receipts

Bank balance as at Dec. 18, 1929	$ 81.07		
Cash in hand	9.69		
Rebates from Headquarters, August 1929 to August 1930	379.01		
Library rent (Association of Professional Engineers)	50.00		
Library moving (Association of Professional Engineers)	12.00		
			$531.77

Expenditures

Office Expenses:			
Rent	$ 75.00		
Petty cash	29.69		
Telegrams	3.16		
Stenographer	15.00		
		$122.85	
Meetings:			
Notices and ballots	58.59		
Rent of auditorium	10.00		
		68.59	
Student Section		9.50	
Library:			
Rent	75.00		
Moving	24.00		
		99.00	
Honorarium for Secretary—1929		50.00	
Balance:			
Bank	181.33		
Cash	.50		
		181.83	
			$531.77

Walter Moberley Memorial Fund

(December 18th, 1929, to December 29th, 1930)

Receipts

Bank balance at Dec. 18, 1929	$ 66.19	
City of Vancouver Bond interest 1930	25.00	
Dominion of Canada Bond interest 1930	5.00	
Bank interest	2.46	
		$ 98.65

Expenditures

Bursar, University of B.C	25.00	
Bank balance, Dec. 29, 1930	73.65	
		98.65

Library Capital Account

(December 29th, 1930)

	Dr.	Cr.
To loan from Headquarters	$300.00	
By instalment repaid—1927		$ 25.00
" " " 1928		100.00
" " " 1929		50.00
Balance debit		125.00
	$300.00	$300.00

Student Section

The Executive of the 1930-31 session of the Students' section is composed of the following:—

President.....M. C. Nesbitt, s.e.i.c.
Vice-President.....L. F. Swannell, s.e.i.c.
Secretary-Treasurer.....R. V. Anderson, s.e.i.c.
Assistant-Secretary.....P. D. Rossiter.

The work of the section consists mainly in procuring prominent speakers from the various fields of engineering to deliver regular noon-hour talks to the students. The meetings are well attended and thoroughly appreciated.

During the fall term the following papers were delivered:

E. A. Wheatley, a.m.e.i.c., Secretary of the Association of Professional Engineers of B.C., on **The Engineer and The Engineering Institute.**

Mr. E. F. Elderton, the Boeing Aircraft Company of Canada, on **The Design and Construction of Aircraft.**

Patrick Philip, m.e.i.c., Deputy Minister of Public Works for B.C., on **Civil Engineering as a Career.**

J. A. Walker, a.m.e.i.c., Consultant to the Vancouver Town Planning Commission, on **The History of Town Planning in Vancouver.**

F. A. Lazenby, s.e.i.c., B.C. Electric Construction Dept., on **The Ruskin Development.**

Dr. W. E. Cockfield, Geological Survey of Canada, on **The Relation of Geology to the Engineer.**

Mr. W. S. Barwick, Vulcan Engineering Works, on **Foundry Practice in British Columbia.**

A field trip was taken to the Vulcan Engineering Works, located in the industrial section of Granville island. Here the students were privileged to see the actual procedure in foundry practice.

The plant is equipped with two electric furnaces for making cast steel. The melt is "doctored" with ferro-silicon, ferro-manganese, ferro-chrome and carbon to rid it of impurities and give it the required chemical composition. The moulds are prepared from specially selected sand. The entire process of making the cope and drag and preparing the moulds for pouring was witnessed with keen interest. The largest castings in the shop at the time were some gear wheels for use in raising the tainter gates of the new Ruskin dam.

Respectfully submitted.

John C. Oliver, jr.e.i.c., *Secretary-Treasurer.*

Victoria Branch

The President and Council,—

During the year there has been a slight increase in the membership of the Branch and some members have left to take up positions in other places. M. P. Blair, M.E.I.C., has gone to Winnipeg, Engineer-Commander A. D. M. Curry, M.E.I.C., has gone to Halifax and D. K. Penfold, A.M.E.I.C., to Kelowna. We welcome the following Members and Associate Members to our Branch: H. L. Swan, M.E.I.C., Major E. C. G. Chambers, A.M.E.I.C., C. F. Corbett, A.M.E.I.C., A. W. Ferguson, A.M.E.I.C., N. H. Gahan, A.M.E.I.C., J. H. MacIntosh who has been transferred from Student to Associate Member, and M. C. Trueman, Jr.E.I.C., and Wm. Hall, S.E.I.C.

The numbers are as follows:—

	Resident	*Non-Resident*
Members	18	1
Associate Members	25	5
Juniors	2	0
Students	6	4
Affiliates	2	0
Total	53	10

Total membership of Branch 63.

This compares very favourably with a total of 55 last year being an increase of four residents and four non-residents.

The activities of the Branch were much curtailed during the year, though the Branch held a successful dinner at Hamsterley, on March 28th, which was well attended. A complimentary dinner was given to F. C. Green, M.E.I.C., on April 11th to congratulate him on his appointment as Surveyor General. Some visits to construction work are contemplated this coming winter.

The club room with its library and current engineering magazines has been maintained during the year.

Financial Statement
(1930)

Receipts

Balance in hand, Dec. 1, 1929		$ 69.13	
3 Branch dues 1929	$ 9.00		
25 Branch dues 1930	75.00		
		84.00	
Rebates on subscriptions paid by H.Q.		117.00	
Branch news in the Journal		3.03	
10 Volumes of Scientific American Magazine		6.00	
Balance from the dinner, April 11		5.00	
Journal January 1919 sold		1.00	
			$285.16

Expenditures

Rent of room 25, Brown Bldg. for 12 months		$150.00	
Electric light		9.00	
Magazines		13.77	
Social dinner, March 26, expenses		16.50	
Insurance on books		3.85	
Printing and mimeographing		6.25	
Stamps and sundries		5.07	
Balance in Royal Bank	$58.13		
Balance in cash	1.44		
Balance in transit from H.Q.	21.15		
		80.72	
			$285.16

Audited and found correct,

I. C. Barltrop, A.M.E.I.C. } Auditors.
F. S. Aldous, A.M.E.I.C. }

Respectfully submitted,

H. F. Bourne, A.M.E.I.C., *Chairman.*
K. M. Chadwick, M.E.I.C., *Secretary-Treasurer.*

Winnipeg Branch

The President and Council,—

The following report for the year ending December 31st, 1930, of the Winnipeg Branch, is respectfully submitted:—

The membership at the end of the year stood as follows:

	Resident	*Non-Resident*	*Total*
Members	41	4	45
Associate Members	96	31	127
Juniors	10	3	13
Students	53	6	59
Affiliates	5	0	5
Branch Affiliates	12	0	12
Total	217	44	261

We regret to report that the Corporate Membership of the Branch was reduced by the death of one of its charter members, the late Captain H. A. Bowman, M.E.I.C., also by the death of the late Captain Charles A. Millican, A.M.E.I.C.

There were eight regular meetings held during the year as tabulated below:

Jan. 9.—R. H. Varcoe, **Talking Pictures.** Attendance, 53.
Feb. 6.—J. C. Burkholder, **Carrier Current.** Attendance, 52.
Mar. 6.—F. Pugh, **Manitoba Limestone.** Attendance, 26.
Apr. 3.—J. C. N. B. Krumm, **Hydro-Electric Power Development at Grand Falls, N.B.** Attendance, 52.
May 1.—Prof. J. J. Hinman, **Treating a Tropical Water Supply in South America.** Attendance, 33.
Oct. 16.—J. Gilchrist, **Forgings for Locomotives.** Attendance, 48.
Nov. 20.—J. C. Davis, **Fire Protection and Fire-Proofing.** This meeting was held jointly by the Branch and Engineering students of the University of Manitoba. Attendance, 150.
Dec. 18.—Prof. Frank Allen, **Physics of the Stars.** Attendance, 31.

The Branch awarded four prizes for Students' papers, two to Students in Civil Engineering, and two to Students in Electrical Engineering.

Financial Statement

Receipts

Bank balance, Dec. 31, 1929	$ 392.14	
Rebates from Headquarters	364.74	
Advertising	18.00	
Interest on Victory Loan	13.75	
Bank interest	5.75	
Journal subscriptions	20.00	
Dues net	368.50	
		$1,182.88

Expenditures

Secretary's honorarium	300.00	
Student prizes	80.00	
Expenses Secretary to Duluth convention	40.00	
Annual joint supper-dance	200.00	
Refreshments at Branch meetings	35.92	
Printing notices of Branch meetings, postage on same, printing and posting ballots	125.01	
Petty cash and miscellaneous	20.00	
		$ 800.93
Bank balanceat Dec. 31, 1930	$319.45	
Cash on hand	62.50	
		381.95
		$1,182.88

Respectfully submitted,

Eric W. M. James, A.M.E.I.C., *Secretary.*

THE

ENGINEERING JOURNAL

THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIV FEBRUARY 1931 No. 2

The Forty-Fifth Annual General Meeting

The last occasion on which the members of The Institute gathered in Montreal at an Annual General Meeting was in 1928, when we were honoured by the presence of His Excellency the Governor-General at the Annual Dinner, a very successful meeting took place, and many pleasant memories were left in the minds of those who attended.

This year the Montreal Branch again sponsored the Annual Meeting and provided an equally attractive programme, both as regards social features, visits to engineering works of interest and the technical papers to be presented and discussed. The Montreal Branch Committee certainly maintained its reputation for organizing attractive Annual Meetings and the efforts of the Branch were fittingly recognized by a cordial vote of thanks at the conclusion of the first day's proceedings.

The Professional Status of the Engineer

It is a commonplace to say that the functioning of the social organization as we know it to-day is only possible as a result of the work of the engineer, using that word in its widest sense as denoting one who by his technical skill has aided in producing the present mechanized system of civilization. But even those who realize that the events of their daily lives are dependent upon the engineer's achievements in power development, transportation, communication or construction, give little or no recognition to engineers as a professional body. Engineers of eminence who have been responsible for great public works, or whose undertakings are in the public eye, are accorded general respect, and "engineering" as a career has a romantic but somewhat indefinite appeal to our boys. The general public, however, knows little, and cares less, about the rank and file of the engineering fraternity. This is largely because the daily work of an engineer, unlike that of a lawyer, doctor or dentist, does not bring him into personal contact with the everyday affairs of the people who benefit from his skill and knowledge. His professional relations are largely with those associated in his work, not with the "man in the street."

It is usual to refer to the typical engineer as inarticulate, but his failure to impress himself upon the public as a professional man is not so much due to inability to express himself as to the technical nature of his work, which has to do with forces and materials much more than with the troubles or difficulties of mankind. The majority of engineers are not voiceless; on the contrary, they have much to say, but their opportunities for expressing themselves freely are usually in connection with professional matters, and therefore they reach only a limited audience.

In a recent address, Professor Wickenden happily defined professional status as "an implied contract to serve society in consideration of the honour, rights and protection society extends to the profession. Through all professional relations runs a threefold thread of accountability, to colleagues, to clients and to the public. The obligations of a profession are so much a matter of attitude that codes alone are not sufficient to sustain them. Equal importance attaches to the state of mind known as professional spirit, which results from associating together men of superior type, and from their common adherence to an idea which puts service above gain, excellence above quantity, self-expression above pecuniary incentives and loyalty above individual advantage. The professional man cannot evade the responsibility to contribute to the advancement of his group. His skill he rightly holds as a personal possession, and when he imparts it to another he rightly expects a due reward in money or in service. His knowledge, however, is to be regarded as part of a common fund; hence the obligation to publish researches and to share advances in professional practice." These are high ideals; how far are engineers putting them into practice?

In the very nature of things, certain professions, for example law and medicine, and to a lesser extent architecture, have been able to form their members into definite groups, increasing their solidarity, raising their standards for admission, and developing adequate methods of governing their members. In these more compact professions there is a clear line of demarcation between the professional man and persons working with him, which can only be crossed by a definite entrance into an organized professional body. No amount of experience in dispensing prescriptions will convert a druggist into a physician. In the case of engineers we are dealing with a calling whose work merges into that of a large number of subsidiary specialists. Engineering organizations contain not only fully qualified engineers, but also draughtsmen, detailers, sales representatives, inspectors, superintendents, and the like, all of whom do some engineering work, and are developed by the experience they obtain. Hence it is increasingly difficult, in many cases, to say whether a man is or is not qualified by experience to enter the professional ranks. Of late years conditions have changed rapidly in another respect. The number of engineers who are doing consulting or advisory work on their own responsibility has greatly diminished, and much of the designing and similar work, which used to be performed by consulting engineers, is now taken care of by corporations organized for the purpose. In fact there is an increasing tendency for engineers to be more and more employees of large industrial or governmental organizations.

Such circumstances go far to explain the lack of recognition of engineering as a definite profession, and the situation is made more confusing in the public mind by the general misuse of the term "engineer," by the lack of a generally understood means of distinguishing between qualified engineers and non-engineers, and by the democratic nature of the engineer's work, which necessarily permits capable men to rise by experience from sub-professional to professional status, engineering thus differing essentially from law or medicine as now organized. Further, it must not be forgotten that the work of all engineers has an underlying economic basis. The undertakings or structures which he plans must pay their way. The expenditure on the apparatus he designs must be justified by its performance and commercial success. This condition recalls the old saying that an engineer is a man who can do for one dollar what any fool can do for two, and in these respects also it is obvious that engineering differs fundamentally from many other professions.

It is essential that a profession govern itself, and it is effective organization for this purpose which really confers professional status. While the conditions which have just been outlined certainly add to the difficulty of the task of maintaining such status, they do not relieve the engineer from the necessity of undertaking it; on the other hand, they render the duty more imperative.

It has long been realized that engineers should themselves take steps to protect the public against incompetent or non-ethical practices, and that such protection necessarily involves to a large extent the protection of the members of the profession themselves. It is therefore interesting to note the methods adopted for this purpose in various countries. In England, for example, it is held that certain grades of membership in one of the principal national engineering societies should be regarded as a guarantee of professional competence and status. Accordingly powers have been obtained in the charters of several of these organizations granting to their duly qualified members the exclusive use of the titles "Chartered Civil Engineer," "Chartered Electrical Engineer," or as the case may be. The privilege of admission to the institutions in question is carefully guarded, and the educational qualifications of those applicants who are not university graduates are tested by means of examinations in general and professional subjects, carried out by the institutions themselves. As a result there is growing up a general appreciation of the status conferred in this way. On the continent of Europe, on the other hand, the great professional schools, such as the Ecole Polytechnique in France, confer by their diplomas the right to use the title of engineer, and their graduates accordingly have a professional status as engineers, as distinguished from that of technicians.

In the United States the policy of state licensing of engineers has been adopted, not without a good deal of argument and discussion. The protection of the public is there a state concern and not a Federal responsibility. Accordingly, in more than twenty states of the Union, licensing boards have been established, deriving authority from acts of the state legislatures, and these bodies examine and license professional engineers quite independently of any membership in national or local engineering societies. This movement has, as yet, not been generally supported in the United States, nor have the various state acts been universally enforced. Further, the necessary methods for co-operation between the voluntary technical societies in the United States, who have no specific educational requirements for membership, and the state licensing bodies, who demand proof of educational qualification before admission, have still to be worked out.

In Canada the majority of engineers seem always to have been in favour of professional registration, which, as affecting the public safety is a provincial and not a Dominion concern. Indeed, the inception of our present registration methods was due to the Canadian Society of Civil Engineers, who, in 1898, obtained in the Quebec Act a definite provincial recognition of the professional status of engineers. From this time on, gradual development took place, and in 1920-1922, owing very largely to the activities of the Council and members of The Engineering Institute of Canada, a policy of provincial registration was definitely embarked upon, so that at the present time Provincial Associations of Professional Engineers exist in eight of the nine provinces of the Dominion. The primary duty of these bodies is, of course, the licensing of engineers for practice; the provincial acts differ considerably in details, but they all recognize this as their main function. Very encouraging success has attended the efforts of most of the Associations, and while in some provinces progress has been slow, the foundations for further work have been laid. Much, however, remains to be done before members of the Associations can have other than a provincial status as engineers, and there is a marked need for concerted action among the Associations with a view to the co-ordination of their special activities and requirements for admission, and with the ultimate aim of conferring upon their members a Dominion-wide rather than a provincial qualification.

The relations of The Engineering Institute of Canada with the Provincial Associations, and the manner in which The Institute can aid those bodies in their work, are naturally of real interest to our members, a very large proportion of whom properly belong to their respective Provincial Associations. As is well known, this subject has been under consideration by an important committee of The Institute for the past three years, and that committee's report was received, and its recommendations endorsed, at the Annual Meeting of The Institute in 1930. The committee is continuing its work under the chairmanship of Past-President H. H. Vaughan, M.E.I.C., and, as will be seen from the report just presented at the Annual Meeting, is endeavouring to aid in the work of co-ordination, while, at the same time, discussing the relationship which an essentially voluntary body like The Engineering Institute of Canada will eventually bear towards the legally constituted Provincial Professional Associations. There is still a long way to travel along the road of professional confederation, but those who remember the years of effort required for the establishment of a Dominion qualification to practise medicine will not be discouraged. In the meantime, it is evidently the duty of all engineers who have the interests of the profession at heart, to comply themselves, and urge others to comply, with the requirements of the existing Provincial Registration Acts, for it is only in this way that definite progress can be made towards consolidation of the profession in Canada.

COMMITTEE

of the

MONTREAL BRANCH

In Charge of Arrangements for

The Annual General Professional Meeting

FEBRUARY 4th, 5th and 6th, 1931

D. C. Tennant, M.E.I.C.,
Designing Engineer,
Dominion Bridge Company, Montreal.
Chairman of
Annual Meeting Committee.

A. Duperron, M.E.I.C.,
Chief Engineer,
Montreal Tramways Commission,
Montreal.
Chairman, Montreal Branch.

J. A. McCrory, M.E.I.C.,
Office Engineer,
Power Engineering Company, Montreal.
Chairman of
Committee in Charge of Luncheons.

C. K. McLeod, A.M.E.I.C.,
Busfield McLeod Limited, Montreal.
Secretary of
Annual Meeting Committee.

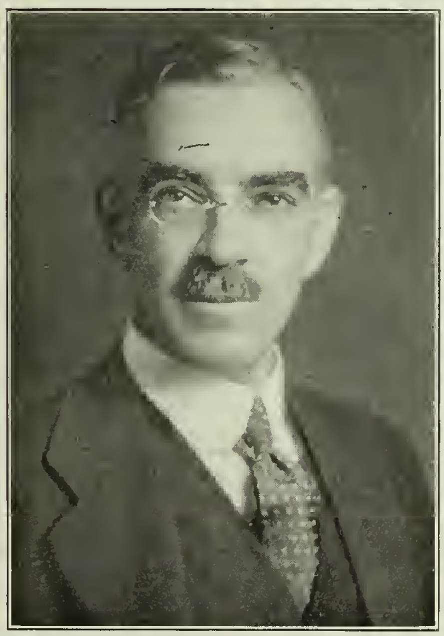
H. G. Thompson, A.M.E.I.C.,
F. S. B. Heward and Company, Ltd.,
Montreal.
Chairman of Publicity Committee.

C. M. McKergow, M.E.I.C.,
Professor of Mechanical Engineering,
McGill University, Montreal.
Chairman of
Smoker Committee.

J. L. Busfield, M.E.I.C.,
Busfield, McLeod, Ltd., Montreal.
Chairman of
Hotel Committee.

H. Massue, A.M.E.I.C.,
Assistant Engineer,
Shawinigan Water and Power Company,
Montreal.
Chairman of
Registration Committee.

F. Newell, M.E.I.C.,
Mechanical Engineer,
Dominion Bridge Company, Ltd.,
Montreal.
Chairman of
Committee in Charge of Visits to Plants.



P. E. Jarman, A.M.E.I.C.,
City Manager,
Westmount, Que.
Chairman of
Committee on Papers and Meetings.

W. McG. Gardner, A.M.E.I.C.,
Principal Assistant to Engineer of
Rapid Transit, Montreal Tramways
Company.
Chairman of
Ladies Committee.

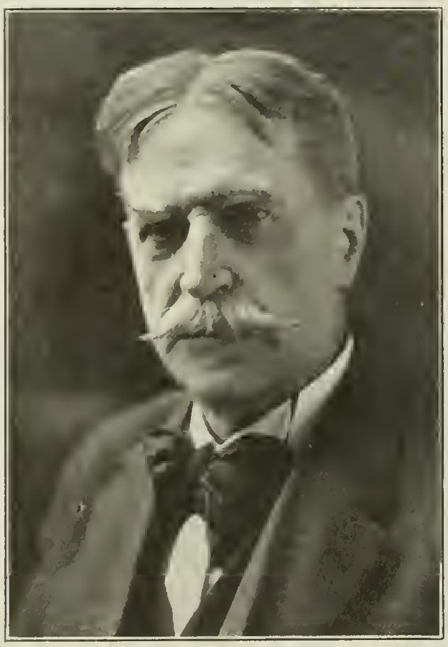
OBITUARIES

Charles Edwards Willoughby Dodwell, Hon.M.E.I.C.

On December 29th, 1930, The Institute lost by death one of its distinguished members, Charles Edwards Willoughby Dodwell, Hon.M.E.I.C., Supervising Engineer for the Maritime Provinces of the Department of Public Works of Canada.

The second son of the Rev. G. B. Dodwell, he was born October 17th, 1853, in Gloucestershire, England, and was educated at New College School, Oxford; Bishop's College School, Lennoxville, Que.; and at King's College, Windsor, N.S., where he graduated B.A. in 1873. Commencing his professional career in railway construction in Nova Scotia, he was assistant provincial engineer under Dr. Martin Murphy, M.E.I.C., until 1881, when he became connected with the work of the Canadian Pacific Railway, and in conjunction with G. H. Massey made the first plans and estimates for the bridge across the St. Lawrence at Lachine. From 1882 to 1885 he was employed on the construction of the line from Toronto to Smith's Falls.

His work was transferred to Montreal in 1885, when he took charge of the construction of the main line from Windsor street to Vaudreuil including the arched stone



C. E. W. DODWELL, Hon.M.E.I.C.

viaduct approach, and the bridges at Ste. Anne's, Stocker's Creek and Vaudreuil. His paper describing the "Foundations of the Ste. Anne's Bridge" appears in the second volume of the Proceedings of the Canadian Society of Civil Engineers.

The firm of Dodwell and Hogg was established in Montreal in 1889, where they carried on a general engineering practice till 1891, when Mr. Dodwell was appointed district engineer of the Department of Public Works of Canada at Halifax, N.S. He held this position till 1922, when he was promoted to supervising district engineer for the Maritime Provinces, an appointment which he retained up to the time of his death.

Associated with The Institute's activities from the very beginning, he was one of the first engineers to be elected Member of the Canadian Society of Civil Engineers on January 20th, 1887, and he continued to take an active and influential part in Institute affairs throughout his life. With Alan MacDougall he was among those who had canvassed the possibilities of the formation of such a Society in 1884-5. This interest he carried with him to Montreal, and was present at the organization meeting held there on March 4th, 1886, when a committee of nine, of which he was a member, was appointed to draft a constitution for the proposed body. This constitution, amended as a result of correspondence between Montreal, Toronto and Ottawa, formed the basis on which the Canadian Society of Civil Engineers was then founded, and as a result of the efforts of Mr. Dodwell and others, the Charter of the new organization received Royal Sanction on June 23rd, 1887.

Mr. Dodwell was a member of Council almost continuously from 1890 to 1910, was a Vice-President in 1904 and 1911, and was honoured by election as an Honorary Member in 1922. He took an active part in the formation of the Halifax Branch in 1918, and was its chairman for two years.

Throughout his connection with The Institute, his guiding principle was the maintenance and development of its status as a professional body, concerned with the high standing of its members, and promoting the interchange of professional knowledge among them. He was equally interested in the possibilities of legislation regulating professional practice, and as early as 1896 was instrumental in presenting a bill to establish engineering as a profession in the province of Nova Scotia, an effort which was almost successful, although perhaps somewhat ahead of the times.

Later, when in March, 1919, The Engineering Institute of Canada invited the various Branches to send delegates to a meeting at Montreal to devise means of creating Provincial Associations of Professional Engineers, Mr. Dodwell was elected chairman of the meeting, and after much intensive work a draft bill was prepared which formed the basis of the acts respecting the Engineering Profession, which have now become law in eight provinces of the Dominion.

Mr. Dodwell was the first President of the Nova Scotia Association of Professional Engineers, holding office for three years, and honoured by all its members for his efforts and the results obtained.

He was for nearly fifty years a corporate member of the Institution of Civil Engineers, having been elected an Associate Member of that body in 1881, and a Member in 1890. He was a member of the board of visitors of the Royal Military College from 1908 to 1911, and a member of the executive committee of the Halifax branch of the British Empire League. He was elected president of St. George's Society, Halifax, in 1908, serving until 1910, and was a vice-president of the Studley Quoit Club from 1909 to 1910 at Halifax.

With two or three others he represented the Dominion government at the twelfth meeting of the Permanent International Association of Navigation Congresses in Philadelphia in 1912, and in 1923 he was the sole representative of the Dominion government and The Engineering Institute of Canada at the thirteenth meeting held in London, England.

A man of wide reading and gifted with a remarkable intellect, his incisive comments on technical matters and questions of the day were always timely and conducive to discussion.

His many friends throughout Canada mourn the loss of a congenial companion, a patriotic citizen, and an outstanding representative of his profession.

Arthur Hutchinson Smith, M.E.I.C.

In the death of Arthur Hutchinson Smith, M.E.I.C., which occurred in his eighty-second year at his home in London, Ont., on October 3rd, 1930, The Institute loses one of its oldest members.

A. H. SMITH, M.E.I.C.

Mr. Smith was born at Shipley, Yorkshire, England, and was educated at Hippersholme school, graduating as a mechanical engineer. He came to this country in 1883 to fill the position of mechanical superintendent of the Grand Trunk Railway, with headquarters at Toronto. In 1885 Mr. Smith organized the first Red Cross train in Canada, one which was sent to the west to take care of men wounded in the Riel Rebellion. He went to London, Ont., in 1890 to take charge of the carshops in that city and of the locomotive shops at Stratford, Ont.

Mr. Smith took an active interest in Institute affairs and was a charter member of the London Branch. He was made a life member of The Institute in 1898.

Mr. Smith joined The Canadian Society of Civil Engineers as a Member of February 3rd, 1887.

PERSONALS

A. N. Ball, A.M.E.I.C., formerly with the McIntyre Porcupine Mines at Timmins, Ont., is now connected with the E. B. Eddy Company at Hull, Que.

W. J. Fuller, A.M.E.I.C., who has, since 1914, been district engineer for the Department of Public Works, Canada, at Sault Ste. Marie, Ont., has been appointed district engineer at Port Arthur, Ont., by the department.

F. A. Crawley, A.M.E.I.C., is at present connected with the Texas Power and Light Company, and is in charge of reconstruction of a hydro-electric plant at Llano, Texas. Mr. Crawley was formerly with the Compania Mexicana de Construccione, S.A., at Torreon, Voahuila, Mexico, as field engineer in charge of transmission line surveys.

A. W. Swan, A.M.E.I.C., has resigned his position as publicity manager of Evershed and Vignoles, Ltd., London, England, after seven years in that post, to accept the appointment of publicity manager of The Brush Electrical Engineering Company, Ltd., Loughborough, Leicestershire, England. From 1919 to 1922 Mr. Swan was assistant editor of The Engineering Journal.

Major L. T. Burwash, M.E.I.C., Exploratory engineer, Northwest Territories and Yukon Branch, Department of the Interior, Ottawa, arctic explorer and discoverer of the remains of the Franklin expedition, was the guest of honour, on December 26th last, at a civic luncheon at the St. Denis Club, Montreal.

F. H. Hibbard, A.M.E.I.C., has recently received the appointment of chief engineer of the Quebec Central Railway Company. Mr. Hibbard has had extensive experience on railway work, particularly with the construction of the National Transcontinental Railway and Saint John Valley Railway. He became connected with the Quebec Central Railway Company in 1913 as engineer in charge of construction, later becoming in turn assistant engineer, engineer maintenance of way, and engineer, holding the last-named office up to the present time.

J. G. Hall, A.M.E.I.C., Receives Appointment

J. G. Hall, A.M.E.I.C., has been appointed general manager of Combustion Engineering Corporation, Ltd. Mr. Hall, who has been with the Corporation since 1924, is a graduate of McGill University of the year 1921, and was for some time in charge of operations in the west. His previous engineering experience includes work with the Grand Trunk Railway, the United States Shipping Board and the Back River Power Company. Mr. Hall is a member of the Associations of Professional Engineers of Quebec and Manitoba.

H. M. LYSTER, A.M.E.I.C.

H. M. Lyster, A.M.E.I.C., has been appointed general manager of the Dominion Welding Engineering Company, Ltd., Lachine, Que. Following his graduation from McGill University in 1913 with the degree of B.Sc., Mr. Lyster was assistant engineer with the Canadian Pacific Railway Company at Bankhead, Alta. In 1915 Mr. Lyster went overseas where he was later attached to the Royal Engineers, and was awarded the Military Cross. He was for a time in charge of explosive railway transport in Yorkshire, England, for the Imperial Ministry of Munitions. He was demobilized in 1920, and returning to this country became salesman and estimating engineer for H. H. Robertson and Company, Ltd., Montreal. He was later connected with

A. C. TAGGE, M.E.I.C.

the Automotive Engineering Company and the Eastern Engineering Company until 1926, when he became Secretary of the Canadian Electrical Association, which position he has held until the present time.

A. C. TAGGE, M.E.I.C., RETIRES

A. C. Tagge, M.E.I.C., has retired from the presidency of the Canada Cement Company, Ltd., which office he has held since 1927. He will, however, remain on the board of directors of the company.

Mr. Tagge was born at Ann Arbor, Mich., in 1870, and received his early education in the public schools of Ann Arbor and his technical education at the University of Michigan, graduating from the latter institution in 1897 with the degree of B.Sc. In 1898 Mr. Tagge was draughtsman with the Link-Belt Machinery Company at Chicago, Ill., and two years later was employed by the Osborne Engineering Company, Cleveland, Ohio. In 1901 he was appointed erecting engineer and superintendent of the Peninsular Portland Cement Company, resigning that position in 1902 to come to Canada as engineer with the International Portland Cement Company at Ottawa. Mr. Tagge remained with this company until 1905 when he occupied a similar position with the Western Canada Cement and Coal Company. Two years later he returned to Ottawa as engineer and superintendent of the International Portland Cement Company, until he accepted the position of general superintendent with the Canada Cement Company at Montreal in the year 1909. He occupied this position until 1919 when he was made assistant general manager of the company.

J. D. JOHNSON, AFFIL.E.I.C.

J. D. JOHNSON, AFFIL.E.I.C., NEW PRESIDENT OF CANADA CEMENT CO., LTD.

J. D. Johnson, Affil.E.I.C., has been elected to the presidency of the Canada Cement Company, Ltd., succeeding A. C. Tagge, M.E.I.C. Mr. Johnson was born at Malagash, N.S., and received his early education at schools in Nova Scotia. In 1903 he joined the staff of the Canadian Portland Cement Company, Ltd., remaining with that company for one year, when he became connected with the Raven Lake Portland Cement Company, Ltd., filling at various times the positions of secretary-treasurer, superintendent and sales manager. In September, 1907, Mr. Johnson became sales manager of the Lehigh Portland Cement Company, Ltd., Toronto, which position he held until October, 1909, when he joined the staff of the Canada Cement Company Ltd., as sales manager of the company's Toronto office. In March, 1919, Mr. Johnson was appointed general sales manager at Montreal, which position he has held until the present time.

T. S. MORRISEY, A.M.E.I.C.

LIEUT.-COL. T. S. MORRISEY, A.M.E.I.C., ACCEPTS NEW POSITION

Lieut.-Colonel T. Sidney Morrisey, A.M.E.I.C., has resigned as vice-president and general manager of Combustion Engineering Corporation Ltd. to become vice-president of United Engineers and Constructors (Canada) Ltd. Lieut.-Colonel Morrisey is a native of Saint John, N.B., and graduated with honours from the Royal Military College, Kingston, in 1910. From that time until the outbreak of war Colonel Morrisey was engaged on the design and construction of various engineering projects. Joining the 13th Battalion the Royal Highlanders of Canada in 1914

GEO. R. MacLEOD, M.E.I.C.

he served continuously for three years in France and later in Siberia, being awarded the D.S.O., the Japanese Order of the Rising Sun and the Czecho-Slovak War Cross, and was demobilized in 1919 with the rank of lieutenant-colonel. Colonel Morrisey joined the staff of the Combustion Engineering Corporation of New York as field engineer during the construction of the steam stand-by plant for the Winnipeg Hydro. In 1926 he was appointed to the position with the Combustion Engineering Corporation Ltd. which he has recently resigned.

Geo. R. MacLeod, M.E.I.C., Receives Important Appointment

Geo. R. MacLeod, M.E.I.C., who was appointed assistant chief engineer of the city of Montreal in May, 1929, has now been entrusted with all questions relating to railways and tramways in that city. He will also supervise the construction of bridges, tunnels and viaducts. Mr. MacLeod thus becomes city railways engineer. This post assumes special importance by reason of the big railway terminal problems confronting Montreal, in connection with which Mr. MacLeod's railway experience prior to his becoming connected with the engineering department of the city of Montreal will be most valuable. From 1918 to 1929 Mr. MacLeod was engineer-in-charge of the Technical Service, a branch of the Public Works Department of the city of Montreal, which was organized in 1918 with the purpose of concentrating in one department all engineering work connected with every branch of the city public services excepting water supply and distribution.

It is also announced that J. G. Caron, A.M.E.I.C., engineer in charge of the Technical Service, will have charge of homolgations, expropriations, etc.

The Lincoln Electric Company of Canada, Ltd., manufacturers of "Linc-Weld" motors and "Stable-Arc" welders, announces a totally enclosed, fan-cooled, induction motor which embodies a number of new and unusual features. This new motor is so designed that its rise in temperature is considerably less than the allowable rise for motors of this type. The design of the motor also includes arc-welded steel construction, double-sealed ball bearings, and a removable cover which facilitates cleaning of the unusually large radiating surface. This new "Linc-Weld" motor has the same mounting dimensions as standard open type, horizontal motors of equal rating, and is manufactured in sizes from 1 to 50 h.p.

BOOK REVIEW

Diesel Engine Operation, Maintenance and Repair

By Charles H. Bushnell. John Wiley & Sons, New York, 1930, cloth, 6 x 9 in., 285 pp., figs., tables, $3.50.

The topics discussed include vapourizing, mixing and ignition systems, fuel injection, governors, indicators and indicator diagrams, lubrication, crankshafts and bearings, knocks, cylinders and pistons, air compressors, joints and packing. The descriptions are clear and concise and are accompanied by numerous drawings which appear to have been specially prepared for the text.

The book is well balanced, emphasis being placed on principles rather than on detailed rules or descriptions of particular machines, and there is a complete absence of padding and introduction of irrelevant material.

Designers and operators will find in this book much valuable information of a practical nature and many useful hints on the design, operation and maintenance of the Diesel and other oil engines.

Professor A. R. Roberts, A.M.E.I.C.,
Associate Professor,
Department of Mechanical Engineering,
McGill University, Montreal.

RECENT ADDITIONS TO THE LIBRARY

Proceedings. Transactions, etc.

Presented by the Societies:

The Institution of Civil Engineers: Minutes of Proceedings, vol. 229, Part 1, 1929-30.

The Institution of Mechanical Engineers: Proceedings, Vol. 1, Jan.-May, 1930.

The Institution of Engineers, Australia: Transactions, vol. 9, 1928.

North-East Coast Institution of Engineers and Shipbuilders: List of Members, August 1, 1930.

Second World Power Conference: Transactions, Vol. 1; Uses of Electricity.

American Society for Testing Materials: Index to A.S.T.M. Standards and Tentative Standards, as of September, 1930.

Reports, etc.

Dept. of the Interior, National Development Bureau, Canada:

Map of the Dominion of Canada, exclusive of Northern Regions, indicating Main Natural Resources, 1930.

Map of Northern Alberta, 1930.

Map of Southern Alberta, 1930.

Map of the Dominion of Canada, indicating Vegetation and Forest Cover, 1930.

Dept. of the Interior, Topographical Survey, Canada:

[Map of] Hudson, Ontario, [1930].

[Map of] Fitzgerald, Alberta, [1930].

Dept. of Mines, Mines Branch, Canada:

The Salt Industry of Canada.

Dominion Water Power and Hydrometric Bureau, Canada:

Hydro-Electric Progress in Canada in 1930.

Dominion Bureau of Statistics, Transportation and Public Utilities Branch, Canada:

The Highway and the Motor Vehicle in Canada, 1929.

Dept. of Trade and Commerce, Canada:

Review of Canadian Business and Industry for 1930, by Hon. H. H. Stevens.

Corporation of the City of Hamilton, Ont.:

Annual Report of the City Engineer for the Year 1929.

Bureau of Standards, United States:

Commercial Standard CS8-30: Plain and Thread Plug and Ring Gage Blanks.

Circular No. 385: Classification of Radio Subjects: An Extension of the Dewey Decimal System.

Public Health Service, United States:

Reprint No. 1405: Acute Response of Guinea Pigs to Vapours of Some New Commercial Organic Compounds: Part 5: Vinyl Chloride.

Reprint No. 1407: Acute Response of Guinea Pigs to Vapours of Some New Commercial Organic Compounds: Part 6: Dioxan.

Dept. of the Interior, United States:

Annual Report of the Director of the Geological Survey, June 30, 1930.

Geological Survey, United States:

Water-Supply Paper 623: Surface Water Supply of the United States, 1926: Part 3: Ohio River Basin.

Water-Supply Paper 628: Surface Water Supply of the United States, 1926: Part 8: Western Gulf of Mexico Basins.
Water-Supply Paper 646: Surface Water Supply of the United States, 1927: Part 6: Missouri River Basin.
Water-Supply Paper 647: Surface Water Supply of the United States, 1927: Part 7: Lower Mississippi River Basin.
Water-Supply Paper 648: Surface Water Supply of the United States, 1927: Part 8: Western Gulf of Mexico Basins.
Water-Supply Paper 655: Surface Water Supply of Hawaii, July 1, 1926, to June 30, 1927.
Bulletin 817: Boundaries, Areas, Geographic Centers, and Altitudes of the United States and the Several States, 2nd ed.
Bulletin 813-D: Notes on the Geology of Upper Nizina River, Alaska.
" 821-A: A Graphic History of Metal Mining in Idaho.
" 822-C: Bituminous Sandstone Near Vernal, Utah.
" 824-A: Mineral Industry of Alaska in 1929 and Administrative Report.
Professional Paper 100: The Coal Fields of the United States.
" " 160: Geological History of the Yosemite Valley.

Bureau of Mines, United States:
Technical Paper 479: A study of the Production of Activated Carbon from Various Coals and Other Raw Materials.
Bulletin 329: Agglomeration and Leaching of Slimes and Other Finely Divided Ores.

National Council of State Boards of Engineering Examiners, [United States]:
Proceedings of the Eleventh Annual Convention, Held at Richmond, Va., Oct. 20-21, 1930.

Municipal Administration Service, New York, N.Y.:
Publication No. 17: Standards for Modern Public Utility Franchises.

The Smithsonian Institution:
Annual Report of the Board of Regents, 1929.

National Electric Light Association:
Hydraulic Power Committee, Engineering National Section: Hydraulic Turbine Governors and Frequency Control.
Prime Movers Committee, Engineering National Section: Pulverized Fuel.
Prime Movers Committee, Engineering National Section: Power Station Chemistry.
Meter Committee, Engineering National Section: Watthour Meter Lubrication.
Fixed Capital Committee, Accounting National Section: Definition of a Unit of Fixed Capital.

Technical Books, etc.

Presented by H. H. Vaughan, m.e.i.c.:
American Engineer and Railroad Journal, Vols. 72-87, 1898-1913.

Presented by W. H. Breithaupt, m.e.i.c.:
The Railway and Locomotive Historical Society, Inc.: Bulletin No. 23, [containing paper by W. H. Breithaupt, m.e.i.c., on: "Outline of the History of the Grand Trunk Railway of Canada.]"

Presented by D. Van Nostrand Company:
The Airplane, by F. Bedell and T. E. Thompson.
Motor Vehicles and Their Engines, 4th ed., by E. S. Fraser and R. B. Jones.

Presented by Whiting Corporation:
Handbook of Crane Information, compiled by M. F. Beetham.

Presented by the International Nickel Company, Inc., New York:
Literature and Patent References to Nickel, Vol. 3, no. 16, Nov. 1930.

Presented by John Wiley & Sons:
The Principles of Coal Property Valuation, by A. W. Hesse.

Presented by Universal Oil Products Company, Chicago:
Booklet No. 84: Cracking Mexican Kerosene at 300 Pounds Pressure Makes Anti-Knock Gasoline.

Presented by Harper & Bros., New York, N.Y.:
Amber to Amperes: The Story of Electricity, by Ernest Greenwood.

Purchased:
Air-Screws: An Introduction to the Aerofoil Theory of Screw Propulsion, 1918 ed.

ELECTIONS AND TRANSFERS

At the meeting of Council held on January 20th, 1931, the following elections and transfers were effected:

Associate Members

MacLEOD, John Angus, designer, engrg. dept., Dominion Iron & Steel Co. Ltd., Sydney, N.S.

THOMPSON, Vincent Swire,(Associate, City and Guilds of London Institute's Technical College, Finsbury), designer, Hamilton Bridge Company, Ltd., Hamilton, Ont.

Transferred from the class of Associate Member to that of Member

CONNELL, Charles Herbert Newton, district engineer, Northern Ontario District (Central Region), C.N.R., North Bay, Ont.

FRIGON, Augustin, B.A.Sc., C.E., (Ecole Polytech.), Grad. E.E., (Ecole Supérieure d'Electricité de Paris), D.Sc., (Univ. of Paris), Director General of Technical Education for the Province of Quebec, Dean, Ecole Polytechnique de Montréal, Chairman, Electrical Commission of the City of Montreal, Montreal, Que.

HARKNESS, Harold Wilson, B.A., B.Sc., (Queen's Univ.), M.Sc., Ph.D., (McGill Univ.), Associate Professor of Physics, Acadia University, Wolfville, N.S.

PERRY, Brian Rhodes, B.Sc., (McGill Univ.), consulting engr., 561 New Birks Building, Montreal, Que.

Transferred from the class of Junior to that of Associate Member

BAILLIE, Edward Leonard, B.Sc., (N.S. Tech. Coll.), asphalt highways engineer, Imperial Oil Limited, Halifax, N.S.

BRICKENDEN, William Thomas, B.A.Sc., (Univ. of Toronto), mech'l. engr., Thorne, Mulholland, Howson & McPherson, Toronto, Ont.

HILL, George Rixon, municipal engr., rural municipalities of Wallace, Pipestone, Sifton, Woodworth, Archie and Miniota, P.O. Box 283, Virden, Man.

LEWIS, James Wentworth, (McGill Univ.), supt., American Concrete Marbelite Co., Chicago, Ill.

MURPHY, Alexander Gordon Silcox, B.Sc., (McGill Univ.), struct'l. engr., Dept. of Railways and Canals, Welland Ship Canal, St. Catharines, Ont.

Transferred from the class of Student to that of Associate Member

SUTHERLAND, George MacKenzie, B.Sc., (N.S. Tech. Coll.), dftsman and designer, engrg. dept., Canadian Ingersoll-Rand Co. Ltd., Sherbrooke, Que.

Transferred from the class of Student to that of Junior

COPPING, Bruce Gray, B.Sc., (McGill Univ.), plant engr., Copper Cliff works, Canadian Industries, Limited, Sudbury, Ont.

DONNELLY, James Henry L., B.Sc., (McGill Univ.), asst. engr., Canada Cement Company, Montreal East, Que.

Students Admitted

Undergraduates at McGill University, Montreal, Que.:
CRAIN, Reginald Albert, 3647 University St., Montreal, Que.
LEA, William Chester, Montreal, Que.
McBEATH, Ernest Harrison, 3592 University St., Montreal, Que.
SANCTON, Richard Arthur, 4643 Sherbrooke St. West, Westmount, Que.
WATIER, Arthur H., 4169 Dorchester St. West, Westmount, Que.

Undergraduates at Nova Scotia Technical College, Halifax, N.S.:
COFFEY, Laurence Edward, Halifax, N.S.
CURRIE, George James, 840 Robie St., Halifax, N.S.
GLOTZER, Samuel, Halifax, N.S.
MUIR, Clarke Bower, Halifax, N.S.
SPENCE, Earl Boyce, 209 South Park St., Halifax, N.S.
SPENCE, Graydon Dill, 209 South Park St., Halifax, N.S.
WEATHERBEE, Weston Ewart, 40 Queen St., Halifax, N.S.

* * *

HEIMBURGER, Boris, (Univ. of Toronto), 38 Classic Ave., Toronto, Ont.

JAQUAYS, Homer Morton, Jr., B.Sc., (McGill Univ.), 3457 Ontario Ave., Montreal, Que.

OLSEN, Arnold Mayne, (Univ. of Alta.), Edmonton, Alta.

SHEEHAN, John Barry, (St. Mary's College), Halifax, N.S.

SIMONS, Finlay William, (Univ. of Alta.), 11019-80th Ave., Edmonton, Alta.

A new departure in bronze valve design is now being presented by Jenkins Bros. Limited, makers of the well known line of "Diamond" trade marked valves.

This new standard bronze valve is one-piece bonnet construction—assuring unusual ease in removal. The manufacturers state that because of this new bonnet design the valve has a degree of extra strength that prevents springing or distortion even though the bonnet is removed and replaced repeatedly. The heavy proportions of the valve, apparent upon examination, would indicate that it is built for sturdy usage.

Another feature of interest is the slip-on, stay-on disc holder which reduces the matter of disc changing to the very simplest terms. By raising the spindle a turn or so the bonnet may be removed from the valve body without the disc holder slipping off the spindle. When it is desired to remove the disc holder, a turn or two in the opposite direction will cause it to slip off easily.

Jenkins Bros. Limited present these new Fig. 106-A valves for all standard services.

BRANCH NEWS

Calgary Branch

A. W. P. Lowrie, A.M.E.I.C., Secretary-Treasurer.
W. H. Broughton, A.M.E.I.C., Branch News Editor.

About forty members and friends met at the Board of Trade rooms on December 11th, 1930, with B. Russell, M.E.I.C., in the chair, to hear a report by the Branch Councillor, T. Lees, M.E.I.C., of the Plenary Session of Council held on September 22nd to 24th, followed by a paper on "Modern Trends in Steam Power Plant Practice" by W. H. Broughton, A.M.E.I.C., Chief Instructor in Steam Engineering at the Provincial Institute of Technology and Art, Calgary.

Mr. Lees gave a comprehensive report of the proceedings as reported fully in The Journal for November, he having supported the instructions of the Calgary Branch "that any general increase in dues is inopportune under the present depressed condition of industry."

S. J. Porter, M.E.I.C., was accorded a great reception as the official nominee as President for the ensuing year. After thanking the members Mr. Porter briefly reviewed the progress towards closer relationships with the various provincial professional organizations and expressed the hope that considerably more progress might be made during the coming year.

In introducing his subject, Mr. Broughton referred to the modern era as commencing with Savery or Newcomen in the seventeenth or eighteenth centuries relegating the engines of Hero, de Vinci and Branca to the ancient period. After sketching the improvements of Watt, Smeaton, Trethevick, Stevenson, Hornblower, Woolf, Symington, Fulton and Corliss during the eighteenth and nineteenth centuries the speaker projected a comparison of the gain in economy during that period, as follows:

Year	Prime Mover	lbs. of coal per K.W. hr.
1720	Newcomen, condensing beam engine	30
1782	Watt, Double-acting expansion engine	11
1880	Modern Double-acting expansion engine	3
1900	Multiple Expansion, Marine Type	2
1920	Steam Turbine	1.4
1925	Steam Turbine	1.0
1930	Steam Turbine	.86

This shows an almost uniform gain in economy during the past century which apparently has not yet ceased, although we think, as we have thought at each succeeding stage, that finality had about been reached, thus:

From 1880-1900 ..... 33 1/3%
1900-1920 ..... 30%
1920-1930 ..... 38%

These comparisons are for the best prime movers of their respective dates, and tabulations by various eminent authorities were thrown onto the screen supporting them, together with operating figures from individual plants showing that these economies have been realized in small as well as in large plants.

The speaker went on briefly to specify the various improvements that have contributed to the gain during the past ten years. Greater efficiency of combustion because of: improved stokers that will burn coal more economically and burn a wider range of fuels on the same grate; the use of powdered fuel which is economical in itself and has stimulated stoker improvements; zoning of air preventing streamlining in the furnace; increased furnace volume and length of gas travel which has given more time for the completion of the combustion reaction and higher furnace temperatures which increased the speed of reaction; increased turbulence by improved arching and baffling which has increased the intimacy of contact of the combining elements and reduced stack losses by reducing the excess air required. Efficiency gains due to the better collection of the heat generated during combustion by: the use of water-walled furnaces and exposure of boiler tubes to direct radiation thus leaving less heat to be collected from the gases by convection; placing superheaters in positions where they tend to keep the economy curve flat over a wide range of loads; the extraction of a maximum of the heat from the gases by economizers and combustion air preheaters.

Gains in economy in the turbine and auxiliaries by: the use of higher initial pressures and superheats and lower vacua; limiting the moisture in the turbine due to adiabatic heat drop by reheating the steam whenever the moisture reaches 10 per cent; recovery of a maximum of heat rather than power from the steam by bleeding the turbine to heat the feedwater at suitable stages.

History is repeating itself for, as progress during the nineteenth century was delayed by lack of suitable materials and of accurate machining methods, today it is retarded from want of refractories that will stand up to the very high furnace temperature now being developed and of suitable materials for parts of boilers, superheaters, pipe work and turbine blades before still higher steam pressures and temperatures can be used.

Operating technique is responsible for gains due to: keeping the plant more nearly at its initial efficiency by systematic elimination of losses due to such items as dirty tubes in condensers and boilers; the intelligent use of indicating and recording appliances which reflect instantaneous conditions and also allow of comparison with past performance.

The gains, the speaker said, had not accrued without expense. Feed water which was satisfactory at pressures of 200 pounds required treatment for use in boilers at 450 pounds pressure and upwards; larger quantities of condensate must be pumped to obtain the lower vacua and higher wages be paid the higher grade of operator necessary in these modern plants.

The speaker pointed out, however, that these economies have been gained without any, or with very little, increase in first cost of the plant and have been the means of greatly reducing operating costs.

In conclusion the speaker quoted the Vice-President of the Southern California Edison Co. that "With low fuel values the question of efficiency is not so important, but efficiencies have risen so very greatly that the steam plant is much less sensitive to changes in fuel prices than ever before. Under present conditions the cost of steam power is less at all usable load factors than the cost from the cheapest remaining undeveloped hydro-project available to Southern California, not ignoring the results expected from the Boulder dam project," and the Vice-President of the Pacific Gas and Electric Co. who said on the same occasion "By reason of the cheapness of steam-electric power few hydro-electric projects are economically justifiable."

F. N. Rhodes, A.M.E.I.C., moved a vote of thanks to Mr. Broughton for his interesting address, which was heartily accorded by the members and visitors present.

Cape Breton Branch

S. C. Mifflen, M.E.I.C., Secretary-Treasurer.
Louis Frost, Branch Affiliate, Branch News Editor.

The tenth annual meeting of the Branch was celebrated by a banquet at the Isle Royale hotel, Sydney, on the evening of December 16th, 1930. A. L. Hay, M.E.I.C., Branch chairman, presided. The banquet was well attended, over fifty being present.

Following the toast to the King, the chairman appointed scrutineers to count the ballot for the election of officers, and called upon the Secretary to read the minutes of the last regular meeting and the financial report for the preceeding year. The report showed the finances and the membership of the Branch to be in a very healthy condition.

The retiring chairman briefly reviewed the activities of the Branch during the preceding year, paying tribute to the Mining Society of Nova Scotia, jointly with which many of the Branch meetings had been held, and who were equally responsible for the high standard of the papers read during the year.

The scrutineers having presented their report, the retiring chairman introduced A. P. Theuerkauf, M.E.I.C., the newly-elected chairman, to the meeting.

J. R. Morrison, A.M.E.I.C., and W. L. Stuewe, A.M.E.I.C., were elected members of the executive council for the ensuing year.

The toast to sister societies was proposed by Joseph Kalbhenn, A.M.E.I.C., and responded to by T. L. McCall, M.E.I.C. In proposing the toast Mr. Kalbhenn pointed out that the goal striven for by all is happiness. This could only be attained by rational activity in a life free from hypocrisy or formalism and strictly in accordance with principles of pure humanity. The engineer leaving the university sets out to conquer, but soon finds that this is an illusion, and instead of conquering finds himself conquered. He then turns to the technical societies and institutes for guidance, and it is through these institutions that he receives his post-graduate education, fitting him for a more rational acceptance of an engineering future.

This was followed by the main address of the evening on "Sydney—Its place in the Industrial Development of Eastern Canada," by J. W. Madden, Esq., K.C.

Mr. Madden stated that it was wise, at such a period of industrial despondence, to speculate upon the future of Sydney and the province of Nova Scotia. Today, as in times past, Nova Scotia is exploring provincial and federal avenues for the amelioration of its economic burden. Avenues that in perspective appear good, do not, when analyzed, afford the permanent structure upon which the future of Sydney and the province can be built.

Many commissions have investigated the problems that confront us and have passed their recommendations. All that has remained is the agreement or disagreement, whether these recommendations have been implemented. Nova Scotia, and Sydney in particular, have been looking to the west to develop reciprocal markets. Development of the St. Lawrence waterways has been mooted as the channel through which this can be accomplished. Such a channel would also give our competitors to the south equal opportunity to outreach us in economic range. Cheaper rail rates may help to alleviate the situation, but cannot be considered a permanent basis upon which the future prosperity of Sydney can be founded.

Future economic development can only be attained by developing the mineral and other natural resources of the Maritimes, and by looking across the Atlantic to the east, and to the south for reciprocal economic treaties. If, Mr. Madden said, we can persuade the makers of agricultural implements such as the Massey-Harris company, or the larger automobile manufacturers to look over the map of the world and see for themselves our geographical location with regard to South America and the east, and to see how in regard to this we are favoured over the rest of Canada, it would be but a short time before branches would be established right in the province, where steel, coal and timber are available to meet the needs of these industries in the manufacture of their commodities, for which markets are readily available to the east and to the south. Develop the Argentinian, the Australian, and the European markets, and in return obtain leather, and also solve the feed problem in Nova Scotia.

The toast to steel and coal was proposed by Mr. P. J. Lynch, who discussed the present depression in these industries and gave it as his opinion that the local situation could be alleviated by the establishment of finishing mills here to turn out the finished product. This he contended would eliminate the sending of semi-finished products to Upper Canada, there to have them finished and returned to Cape Breton. Such mills as he advocated would do much to relieve the unemployment situation here.

Responding for the coal and steel industry, F. W. Gray, M.E.I.C., reviewed the development of these industries in Cape Breton. Sydney, he declared, is an ideal position for a steel plant, situated as it is close to iron ore deposits and coal mines. The local steel plant is now equipped to roll the largest rails ever made in Canada. Better coke and better steel are now being produced than at any time in the history of the plant.

A new power plant, one of the finest of its kind, has been installed, also new machinery. New mechanized methods of mining are now in use and greater depths have been reached. As a result and despite this time of unparalleled depression, when plants throughout the world are reducing their production, the local plant has worked fairly steadily, and its output compares favourably with the large steel plants of the United States and Europe.

Following several other speakers, the evening's programme was wound up in good style by M. Dwyer, A.M.E.I.C., who gave an address in his inimitable and humorous style.

W. S. Wilson, A.M.E.I.C., was at the piano.

Halifax Branch

R. R. Murray, A.M.E.I.C., Secretary-Treasurer.

The regular meeting of the Halifax Branch was held on the evening of November 19th, in the Nova Scotian hotel, at 6.30 p.m. Professor W. P. Copp, M.E.I.C., presided and there were 32 members present, the meeting being preceded by a supper.

The first business of the meeting was a report from the Nominating committee who gave out their slate of candidates for the various Branch offices. This report was adopted and names ordered placed on the official ballot.

Secretary R. R. Murray stated that he had a message from J. L. Busfield, M.E.I.C., Montreal, to the effect that he expected to be in Halifax and would like to speak before the Branch on the 24th of the month. It was decided to hold a supper meeting on that evening to hear Mr. Busfield on the subject of "Classification and Remuneration of Engineers."

Mr. C. H. Wright, M.E.I.C., president of Halifax Board of Trade, invited all the members to attend a Board meeting on the 25th, to hear a discussion on the "St. Lawrence Waterways" question from the Maritime viewpoint.

Several visiting engineers were welcomed to the meeting.

It was decided to have the executive arrange the details for the annual meeting, which will be held on the third Thursday in December. The chairman was requested to name the scrutineers of the ballots.

The meeting was then adjourned to another room where a very interesting and instructive address was delivered by F. H. Peters, M.E.I.C., Surveyor General of the Department of the Interior, Ottawa. The subject was "Aerial Surveying and Mapping in Canada."

Mr. Peters stated in his opening remarks that he was very pleased to be in Halifax, after which he gave a detailed description of the methods employed in aerial surveying and mapping illustrated by slides of graphs which gave those present an outline of the large amount of work done by the department. It was shown that surveys from photographs were not sufficient in themselves for an accurate map of any territory as it was necessary to lay out control points on the ground. The photographs made in the first instance were skeleton and were afterwards corrected and the details filled in. Old and new types of mapping instruments were also described in detail.

Mr. Peters said that two types of photographs were obtained—oblique and vertical. The oblique method of photography was used over country of low relief and for small scale maps of outlying country where extreme accuracy of detail is not very important. The vertical method is employed where the country presents various types of relief, and for large scale maps. The system used in plotting these aerial surveys was next described, many of the details of which had been developed within the organization itself to suit the particular needs of the area surveyed. To show the value of aerial photography the speaker as an example showed a map having a scale of 4 miles to the inch, an area which was originally very sketchy in detail, a total of nearly 5,000 lakes and more than 6,000 islands, 90 per cent of which were not shown on any previous maps.

Mr. Peters stated that the figures for the work done during 1930-31 were, of course, not available yet but those for 1929-1930 showed that about 125,000 photographs were made, to gather data covering 106,000 square miles of territory. There are in the Index Bureau, at Ottawa, some 300,000 of these photographs of which about 90,000 were secured and completed during the past year. During 1929-30 the field operations were carried into all the provinces, including the Yukon and Northwest Territory. Eighteen separate parties were employed in addition to three survey engineers who acted as navigating officers and technical advisors using planes of the Royal Canadian Air Force. This large complement of men were all engaged in the work of photographing and mapping already referred to. In this work the planes are flown at a sustained altitude of 5,000 feet.

Altogether the address was of great interest, and in conjunction with three reels of films, gave an idea of the magnitude of the work.

W. A. Winfield, M.E.I.C., general plant superintendent of the Maritime Telegraph & Telephone Co., who said that his company had in mind an aerial survey of their transmission lines but no plane was available, moved that a hearty vote of thanks be tendered Mr. Peters.

Mr. C. H. Wright, M.E.I.C., seconded the motion, which was unanimously accorded the speaker.

A special supper meeting of the Halifax Branch of The Institute was held on the evening of November 24th, 1930, at the Nova Scotian hotel. The meeting was presided over by Professor W. P. Copp, M.E.I.C., chairman of the Branch.

Forty or more members were present to greet J. L. Busfield, M.E.I.C., chairman of The Institute committee on Classification and Remuneration, who addressed them on the work of the committee and the conclusion reached in the report to be submitted to the Annual Meeting of The Institute in February.

Mr. Busfield was introduced to the members by Professor F. R. Faulkner, M.E.I.C.

K. L. Dawson, M.E.I.C., congratulated the committee on the vast amount of work done and data compiled, pointing out how well the classification had been worked out. He thought 30 per cent gave a good cross section of members' opinions, but did not feel that personal ability necessarily indicated ability to do; it might refer to ability to organize. However, he did think the average salary as stated to be a good one.

J. H. Winfield, M.E.I.C., also congratulated the speaker on his address, pointing out that such a report is timely because of a feeling among engineers that the remuneration received is not commensurate with the services rendered. He further remarked that personal ability needs opportunity to be able to advance to its proper sphere of usefulness.

Professor R. L. Nixon, A.M.E.I.C., moved that a vote of thanks be tendered Mr. Busfield for his timely address, expressing his own satisfaction and that of members present. J. B. Hayes, A.M.E.I.C., seconded the motion, which passed unanimously.

Mr. Busfield in his reply gave some information regarding the application of averages to salaries paid which do not always indicate the true average. He thanked members for their attention and hoped that the report would be of some value to all, incidentally remarking that he hoped to visit the city again and meet the Branch members.

The annual meeting of the Halifax Branch of The Institute was held on Thursday, December 18th, at the Nova Scotian hotel. Professor W. P. Copp, M.E.I.C., chairman of the Branch, presided and more than 40 members were present.

The meeting was preceded by a supper during which the chairman extended a welcome to those who attended from out of the city and read a telegram from H. F. Bennett, A.M.E.I.C., who has recently been transferred to Sault Ste. Marie, extending his good wishes for a successful year in 1931.

Secretary Murray then read the minutes of the past annual meeting and of the several recent meetings.

The matter of a joint banquet with the Nova Scotia Professional Association was discussed and it was decided to take part. A committee, consisting of J. B. Hayes, A.M.E.I.C., J. D. Fraser, S.E.I.C., and R. R. Murray, A.M.E.I.C., was appointed to represent the Branch in the arrangements.

The Secretary read his report, also the financial report, which was very satisfactory.

J. St.C. Wilson, A.M.E.I.C., chairman of the Papers committee, presented a report reviewing the work of the past year and stated that he expected to have, in the near future, an address on "Gypsum and Allied Products" by a representative from the Canadian Gypsum Co.

J. Lorne Allan, M.E.I.C., chairman of the Membership committee, presented the report from that committee, reviewing the work of the past year and offering valuable suggestions.

W. J. De Wolfe, A.M.E.I.C., chairman of the Publicity committee, reported on the work done during the year, and stated that he hoped for better results next year.

Professor F. R. Faulkner, M.E.I.C., reported, as chairman, for the Prize committee, and some very valuable suggestions were made on making prize competitions more successful and productive, the feeling of his committee being that much good can be accomplished in this manner.

All the above reports were received with enthusiasm and finally adopted.

Professor Faulkner also gave a report on the work of the plenary meeting of Council held in September last. This report was of some length and went into detail on all matters discussed there as affecting the welfare of The Institute generally. The suggestions contained, if taken to heart, could not fail to be of great benefit to all members.

C. H. Wright, M.E.I.C., commended the report for its value and moved a vote of thanks to the committee. This was seconded by J. B. Hayes, A.M.E.I.C., and accepted.

H. W. L. Doane, M.E.I.C., presented a report on behalf of the joint committee on Co-ordination of The Institute and Professional Associations. This was a résumé of the conclusions and work of The Institute committee in that connection. Since the full report of that committee will appear in The Journal it is considered sufficient to state that Mr. Doane was of the opinion that real progress was being made and that the Halifax Branch was not lagging in the effort to find a solution to the question.

The present Branch representatives were asked to continue to function, which they agreed to do.

W. H. Noonan, A.M.E.I.C., for the scrutineers, reported the results of the ballot for Executive for coming year:—

Chairman.......................... J. L. Allan, M.E.I.C.
Council........................... A. F. Dyer, M.E.I.C.
J. D. Fraser, S.E.I.C.
S. L. Fultz, A.M.E.I.C.
J. D. Clarke, A.M.E.I.C.
W. J. De Wolfe, A.M.E.I.C.

Professor Copp, M.E.I.C., next delivered his retiring address as chairman of the Branch for 1930. He thanked all for the honour which had been done him and referred with some feeling to the loss sustained by the deaths of the late Professor W. F. McKnight, A.M.E.I.C., and W. G. Matheson, M.E.I.C., during the year. Efforts had been made to have a Maritime meeting but this could not be carried through. However he hoped for better results during the next year, the probable location being Saint John, N.B. He referred also to the suggested closing of the Technical College in Halifax, and said that, while no definite action had been taken, he was of the opinion that such a retrograde step will not likely be made, at least for some time to come. His opinion was that the earlier meetings of the year had not been as well attended as they might have been but he had noted with pleasure that the later ones had been much better. He suggested greater activity in the affairs of the city and province and looked forward to hearty support of the members to the new executive and to a successful year.

At the conclusion of the chairman's address J. L. Allan, M.E.I.C., was invited to take up his new office.

Mr. Allan was very appreciative of his selection for the office and stated that he would try to make the next year a banner one.

Professor F. R. Faulkner, M.E.I.C., and Professor C. H. Burchell, M.E.I.C., were appointed auditors. H. W. L. Doane, M.E.I.C. was appointed Branch representative on the General Nominating committee.

A letter from Brig.-General C. H. Mitchell, M.E.I.C., re members, was referred to the new executive.

On motion, it was voted that the Secretary receive an honorarium of $50.

A discussion arose as to the best way to stimulate interest in the Students' Prize essays. Various ways and means were thrashed out but no final result was recorded and the matter was given over to the executive to consider several suggestions offered, among which was the offer by Karl Whitman, A.M.E.I.C., to donate the sum of $15 as a first prize open to all students of engineering in the colleges of Nova Scotia.

On motion of G. S. Stairs, M.E.I.C., and Professor W. P. Copp, M.E.I.C., a vote of thanks was tendered to the retiring executive. Thus was brought to a close a very successful year for the Branch.

Hamilton Branch

J. R. Dunbar, A.M.E.I.C., Secretary-Treasurer.
J. A. M. Galilee, Affiliate E.I.C., Branch News Editor.

Executive Committee Meeting, November 21st

A luncheon meeting of the executive committee was held on Friday, November 21st, in the Wentworth Arms.

W. L. McFaul, M.E.I.C., was appointed the branch representative of The Institute Nominating Committee for 1931.

The following branch committees were also appointed.

The branch prize committee:

L. W. Gill, M.E.I.C.
J. C. Nash, A.M.E.I.C.
F. P. Adams, A.M.E.I.C.,

together with the branch chairman and branch secretary.

Scrutineers for branch elections:

J. C. Nash, A.M.E.I.C.,
G. W. Arnold, A.M.E.I.C.

After sundry other details had been discussed and dealt with, the meeting then adjourned.

Branch Meeting, December 10th, 1930
(Reported by J. T. Thwaites, Jr.E.I.C.)

The December meeting of the Hamilton Branch, under the chairmanship of W. F. McLaren, M.E.I.C., was held on the evening of December 10th in the ball room of the Royal Connaught hotel.

Mr. McLaren asked Mr. Knight, engineer of the Bell Telephone Company of Canada, to introduce Mr. Dancey, also of the Bell Telephone Company, the speaker of the evening. Mr. Knight stated that Mr. Dancey had been responsible for a number of engineering developments and was equally at home with explaining the dial system, cable teletype and carrier telephony. He said that Hamilton was the first place in the world to have a telephone exchange, the first to utilize a toll cable, and the first to install the carrier system, namely, between Hamilton and Windsor.

The Carrier System of Telephony

Mr. Dancey, in introducing his subject, explained that he would treat it from a non-mathematical standpoint, even though it is essentially mathematical. He would merely state the assumption and come to a conclusion as a definite fact.

Carrier current consists essentially of substituting one frequency of electric waves for each frequency of sound waves which it is desired to transmit. In ordinary telephony these electric and sound waves have the same frequency, but in the carrier system the electric wave is of a much higher frequency.

Normal speech may be transmitted with commercial clarity if a band 200 cycles per second to 3,000 cycles per second be transmitted. If an oscillatory circuit is set up and made to generate a frequency of 10,000 c.p.s. and this frequency be superimposed on voice currents in a suitable vacuum tube modulator, two bands of frequency are formed, one above and one below the 10,000 c.p.s. frequency. By means of suitable filters the carrier and the lower side band are suppressed.

In this new band of frequency there is an 11,000 c.p.s. current which represents 1,000 c.p.s. in the original, an 11,500 c.p.s. frequency which represents 1,500 c.p.s. in the original, and so on. Thus each frequency in the original has been replaced by a frequency 10,000 c.p.s. higher. Thus speech is transmitted by transmitting a band 10,000 c.p.s. to 13,000 c.p.s. Similarly speech may be transmitted on any band 3,000 c.p.s. wide.

Interference troubles have limited the lower band limit to 6,000 c.p.s. and the upper band limit to 30,000 c.p.s. which allows six bands 3,000 c.p.s. wide with 1,000 c.p.s. spacing between them. These may be sent out over the same wire and sorted out by suitable filter circuits. As sending and receiving must be kept separate, due to the amplifiers being unidirectional, there are only three talking channels.

At the receiving end, these signals, after being sorted by filters, are demodulated by reintroducing the carrier which brings back the original frequencies and these are then intelligible as ordinary speech in the telephone.

Carrier current telephony has given rise to many problems in connection with line transposition and so it is not always possible to make full use of a line already built without considerable expense. Also for carrier telephony there is very expensive terminal apparatus, but for long distances of 200 miles or more, it is to be recommended.

The first commercial carrier current line in Canada was from Hamilton to Windsor and has given complete satisfaction. There are now 17,000 miles of carrier line in Canada and 10,000 more miles are projected for early construction.

At the conclusion of the address, general discussion took place, which elucidated many points.

A hearty vote of thanks was tendered to the speaker by the chairman.

Attendance was 55, a number of engineers from the Bell Telephone Company being present as well as a contingent from Toronto.

The regular monthly meeting of the Hamilton Branch of The Institute took place in the Royal Connaught hotel on January 13th.

After the reading of the minutes J. J. McKay, M.E.I.C., nominated the following for the Nominating committee for the Annual Meeting:

W. L. McFaul, M.E.I.C.
L. W. Gill, M.E.I.C.
H. Lumsden, A.M.E.I.C.
E. M. Coles, A.M.E.I.C.
G. A. Colhoun, A.M.E.I.C.
Branch Chairman
Branch Secretary

The speaker of the evening was W. R. Smith, A.M.E.I.C., of London, Ontario.

Railway Construction Through the Yellowhead Pass

Mr. Smith, at the outset of his lecture, reminded his audience that the pioneer of exploration and surveying of the Rocky Mountains was David Thompson, a man of whom little is known, but through J. B. Tyrrell many interesting facts have come to light.

David Thompson came to Canada when a boy and was apprenticed to the Hudson's Bay Company at York Factory. In 1807 he left for

Western Districts and in 1810 he was at Cumberland House. He travelled up the Saskatchewan river to Fort Augustus (Edmonton) experiencing considerable opposition from the Piegan Indians.

In 1811 he crossed the Athabaska pass and through observations made by J. B. Tyrrell at a later date it was found that a remarkable accuracy was maintained by Thompson, the exception being the altitudes, which were invariably out. Thompson's men mutinied before he reached the coast, but he was able to complete his journey with the aid of a faithful servant, by descending the Columbia river to the Pacific.

At his death he had plotted more Canadian country than any man before or since. It is notable that no memorial has yet been erected to his memory, while his body lies in an unmarked grave in Mount Royal cemetery in Montreal.

The speaker's experience of railway construction occupied a period of ten years and in November, 1909, he was sent out as a resident engineer with eight men to survey a district known as Mile 80 of the Mountain Division.

Mr. Smith gave a good account of the vicissitudes of a resident engineer's life. The conditions of life, though rough, were those experienced in ordinary outdoor life. Accuracy of work was essential: the line was to be constructed on a maximum grade of 4/10 of 1 per cent with a maximum curvature of 6 degrees or a radius of approximately 955 feet. The grade was remarkably low when one considers that around Hamilton grades of 1 per cent are quite common. 0.02 was allowed for grade compensation per degree of curve so that the grade on a maximum curve would be only 0.28 per cent. Searle's spirals were used as easements on all curves over 2 degrees. Embankments were 16 feet in width up to 18 feet, and cuttings 22 feet, allowing for shallow ditches 3 feet in width by 1 foot deep at each side. Rock cuttings were 20 feet in width. Earth slopes were calculated at 1½ to 1, while rock quantities were figured at ¼ to 1 slope.

The duty of the resident engineer was to see that the right-of-way was cleared and then to run check levels and establish bench marks, then pick up the location centre line and re-run the alignment according to the location map supplied. Curves had to close at the tangent points to 3/10 of 1 foot, otherwise they had to be re-run and the errors found and corrected.

In cross-sectioning, the slope was often as steep as 60 degrees, the method adopted for arriving at the horizontal distances was by calculating them from the measured distances along the slope by the medium of the trigonometrical functions of the vertical angles obtained by the use of an Abney hand level. To obtain these measured distances the rodman had sometimes to be lowered by a rope. In many cases the work was done above boiling rapids, where a slip would be fatal. In spite of these hazards, as well as others, the speaker reported that there were no fatalities in his party.

It was the practice to erect temporary trestles, wherever needed, one of the largest being at Big Eddy, where something like five million f.b.m. were used.

As a rule, streams discharge into valleys at the highest parts. This fact made it often necessary to divert mountain streams by means of rock-filled cribs and these diversions were sometimes a cause of much anxiety to the engineer.

Through a certain amount of carelessness typhoid fever attacked the camp in 1910. The Railway Company were very considerate and gave sufferers passes to their homes and full pay during absence.

Considerable trouble through the use of horses in these districts with various diseases was experienced, but it was found that the Missouri mules were practically immune. They were, therefore, used in large numbers towards the end.

An interesting story was told concerning the practice of subletting contracts. A particularly large neck of land, approximately 175 feet deep, had to be moved. Indications pointed to the fact that there was a large amount of rock in this and spectators looked on with amusement when a party of Swedes undertook the job. On digging down, however, the Swedes discovered that the hillside was pure sand and it was an easy matter to tunnel through and operate gravity dump cars and let nature do the work. This good proposition netted the contractors about $1,000 apiece to the 24 men in a little over three weeks.

Hardships encountered at Brûlé Lake district, through blowing sand, caused abandonment of a constructed line. It was impossible to keep the right-of-way clear and fences soon disappeared from sight.

One of the most interesting features of the railway construction in such places was the constant battle against the forces of nature. Human difficulties, through the long distance from the base, the discomforts of living and the monotony of companionship and general isolation were by no means inconsiderable and it is a tribute to those who came through, when they did so, with such cheerfulness.

The party worked all through the winter and temperatures of 40 degrees below zero were often encountered, and contrasting this with a summer temperature of 80 degrees it will be noted how important it was to take temperature into account when using the steel tape. In re-running curves it was possible that very considerable inaccuracies might be encountered.

The speaker recalled seeing a stump on which marks made by Sir Sandford Fleming were discernible. It was found that the elevation of 3,418 feet at this point, made in 1873, differed by only 10 feet, from that of the speaker's measurements. This is a fine tribute to the early surveyors.

At the conclusion of the lecture a number of very fine slides were shown through the courtesy of the Canadian National Railways. These included views of Jasper park and of various trails and mountains and other wild prospects. These slides were beautifully coloured and proved to be a most delightful part of the evening's enjoyment.

At the conclusion H. A. Lumsden, M.E.I.C., made the suggestion that schools should tell their pupils far more about the early discoverers and explorers in Canada so that their exploits might be commemorated.

R. K. Palmer, M.E.I.C., moved a hearty vote of thanks to the speaker for his most interesting and instructing lecture, which was carried with applause.

Lethbridge Branch

Wm. Meldrum, A.M.E.I.C., Secretary-Treasurer.

The Lethbridge Branch held its first regular meeting of the new year on January 10th in the private dining room of the Marquis hotel. The Branch was especially favoured by a visit from Dean C. J. Mackenzie, M.E.I.C., Vice-President of The Engineering Institute of Canada, and sincerely hopes more such visits can be arranged in the future. During the afternoon, Dean Mackenzie attended a meeting of the Branch executive which was concluded in time to attend the usual dinner at 6.30 p.m., the latter being enlivened by Mr. Brown and his orchestra. After dinner, there followed the customary community singing, together with much appreciated vocal solos by Miss Allison and Mr. N. B. Peat. The speaker was then introduced by G. N. Houston, M.E.I.C. Dean Mackenzie took as his subject, his own research work, namely

"URBAN GROWTH IN WESTERN CANADA"

In many cases of civil engineering work in cities, it is necessary to make, as closely as possible, an estimate of the population at some future date. Dean Mackenzie being faced with this problem in regard to some of the cities in Saskatchewan, has made a thorough study of this statistical problem. In the past, many methods of estimating future increase of population have been used, some of these being based on the following methods:

1. Arithmetical progression.
2. Geometrical progression.
3. Second order parabolas.
4. Logarithmic graph.
5. By producing uniformly the curve of the past.

These, however, and all other methods in customary use, fail completely when an attempt is made to apply them to western Canada whose population increase has been so fluctuating that it is impossible to arrive at any reasonable estimate of the future population by any of the past methods in use. Nor, in any of the above cases, are these methods reasonable, because if carried far enough they will continue indefinitely, indicating eventually a limitless population. An engineer's estimate must be based on reason.

Professor Pearl carried out numerous experiments in an attempt to arrive at a solution to the problem. He put two flies in a bottle kept at a suitable temperature and containing an adequate amount of food, i.e. the conditions were ideal for a natural rate of growth of the flies in the bottle. He closely observed their increase and repeated the experiment several times. From the data thus obtained, Professor Pearl was able to plot the population of the flies against time and obtained, in every case, a smooth curve.

This curve belongs to the family of curves expressed by the equation:

$$y = \frac{b}{e^{-ax} + c}$$

Where y = Population
x = Time
e = Natural Base
a, b, c = Constants

Note that there comes a time when an upper limit or asymptote is reached, i.e.

Death Rate = Birth Rate

Then the astounding discovery was made by Professor Pearl that this curve was followed almost identically when he plotted curves for various groups of the states and a number of countries.

When, however, Dean Mackenzie attempted to use these results in western Canada and various places in the United States, he found that there was a discrepancy. However some reasonable basis of estimating the future population had to be found. Professor Mackenzie, after experimenting and studying the problem from all angles, finally discovered the fact that, while the total population of our western provinces followed no apparent mathematical laws, if he divided the population into rural and urban and plotted each separately, they both followed very definite curves. He took as his division point 2,500; that is, cities of 2,500 or over were classed as urban population and all the rest as rural population. On applying the above to numerous states, he was able to show that for rural population an almost exact replica of the "fly curve" was obtained in each case and that for urban population a straight line curve was obtained. He also found that for cities and states in the United States, comparable geographically and economically to cities and provinces in western Canada, that the form of curves obtained were almost identical with each other. In each case the urban population curve showed a decided lag and did not start properly until the rural population curve had reached its upper asymtote and does not start at all until the inflection upwards of the rural population curve begins.

Applying this method to several states it was found that the lag in the urban curve becomes greater and the slope becomes progressively less, as each westward move was made; but the regularity of the curves is most remarkable.

Professor Mackenzie gave as the reason of the lag of the urban curve, the fact that the first people arriving in a new country are homesteaders whose wants and needs are few, hence the needlessness of towns and cities, but once the rural districts begin to fill up, there comes a time when towns and then cities are required with the attending rush of banks and distributors. The urban growth, then, is brought about by the increase in the wealth of the country, and not by industrial production, where the latter is concerned chiefly with production for local consumption.

In all such problems it is necessary to have some secondary proofs. Professor Mackenzie took the records of older cities, especially selected as being similar in type, and compared their records with his estimates for western Canada; taking the per cent of urban to rural population of each and found these percentages not at all unreasonable with his estimates.

A second check was arrived at by taking these comparable cities and plotting their populations on logarithmic graph paper both before and after the population had reached 50,000, using this figure as a common starting point.

Dean Mackenzie illustrated, by lantern slides, all his points and calculations by graphs of numerous cities and states.

Among the conclusions which he drew from his studies, the following are of interest:

By 1955 the urban population of Saskatchewan will be about 300,000 of which 75-80 per cent will be in Regina, Saskatoon and Moose Jaw. Alberta in 1955 should have an urban population of 340,000, about 90 per cent of which will be distributed about evenly between Calgary and Edmonton, each of these cities, therefore, having a population of about 150,000.

A formal vote of thanks was moved by H. W. Meech, A.M.E.I.C., and tendered to Professor Mackenzie through the chairman, C. S. Clendening, A.M.E.I.C. The notable meeting closed at about 11 o'clock p.m. with the singing of the national anthem.

London Branch

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

John R. Rostron, A.M.E.I.C., Branch News Editor.

The regular monthly meeting was held on Wednesday, December 17th, in the board room of the Board of Education, W. G. Ure, M.E.I.C., chairman of the Branch, presiding.

The speaker was Archie B. Crealock, B.A.Sc., A.M.E.I.C., consulting engineer, Toronto, and his subject "Highway Bridges."

The paper was illustrated by many lantern slides of different types of bridges and details of construction.

Mr. Crealock first explained that although he was now in private practice as a consulting engineer he was formerly engaged for a period of eight or nine years as assistant engineer to the Hon. G. S. Henry, then Minister of Highways, and his remarks were compiled from his experiences during that time. The district covered concerned bridges on the provincial highways of southern Ontario extending from Windsor on the west to the boundary of Quebec province on the east and as far north as Ottawa, the district activities being taken care of by resident engineers stationed at various points.

The old bridges are inadequate for present-day loading and hence the necessity for renewal. The new bridges were mostly built for class "C" loading under the Ontario Highways Specification which provides for 20-ton motor traffic and 40-ton street railway cars. The widths of the bridges were such as to accommodate roadways of from 20 to 24 feet but this had lately been increased to 30 feet in many cases. In and around the large cities the width again increased to 48 and 50 feet roadway accommodation.

Owing to a condition of high flood water which obtained in nearly all the rivers of Ontario, it was necessary in many cases to keep the depth of construction below road level as small as possible and this explained the adoption of the reinforced concrete bowstring arch type of bridge in certain locations. A fine example of this type of bridge exists at Bowmanville and this was shown on the screen—views were shown of many other bridges on the provincial highways and short descriptions given by the speaker. Amongst these were the bridges at Caledonia and Sixteen Mile creek, the prevailing types of bridges being the concrete arch before-mentioned and the steel truss deck bridge. Of the latter type was a bridge on the highway east of Toronto which is built to a 5 per cent grade. This was made necessary by the new bridge being built on a different site from the old bridge in order to do away with the dangerous sharp reverse curves of the roadway at each end of it.

Wherever possible dangerous curves were eliminated, and grade separation adopted to do away with as many level railway crossings as possible. Very considerable expense had been entailed by this work and further improvements along these lines were still being prosecuted.

The steel hog back truss bridge over the north branch of the river Thames at Broughdale in London township has the distinction of being, up to the present, the longest span (194 feet) steel bridge in Ontario. The speaker described the bridge over Hogg's Hollow, North Toronto, in detail and showed many slides of the work in progress. The writer cannot do better than refer the reader to a fully illustrated article written by Mr. Crealock in the Canadian Engineer of December 11th, 1928, for a full description of this work. However, special mention might be made of the difficulty experienced in the foundations of two of the piers where fine sand was encountered. Borings were taken and these showed that the sand extended in some places to a depth of 70 feet before hard ground was reached. This difficulty was met and overcome by the use of Raymond concrete piles, their penetration being 20 feet and the maximum pressure on one pile 39 tons.

The speaker then outlined the supervision necessary to ensure proper maintenance of bridges—under this head he dealt with painting, the cleaning out of bearings, periodical examination of abutments and piers, and scour of the water, etc.

Regarding the first of these—painting—he strongly urged that steelwork should receive at least one coat of paint in time to prevent the necessity of chipping off the rust. As a rule a coat of paint was necessary every two or at most three years and this would be found cheaper than allowing the work to go so long that it would require chipping. He also recommended the use of aluminum paint as it was not much more expensive than the ordinary paint and it stood up better, lasted longer and was desirable from an æsthetic standpoint.

He also stressed the necessity of seeing that men cleaning the roads did not throw the sweepings, etc., over the rails of the bridges as a good deal of this refuse then lodged on the steel and caused corrosion.

The speaker concluded his remarks by giving an outline of prospective work by the department and in this connection the bridge at Paris might be mentioned. This, he understood, was to be of steel arch design rendered more difficult by the fact that it will be on the skew.

A hearty vote of thanks to the speaker was proposed by John R. Rostron, A.M.E.I.C., city bridge engineer, who called attention to many points of similarity between the floor construction of Hogg's Hollow bridge and those of the Victoria and Kensington bridges lately erected in this city. The vote was seconded by W. R. Smith, A.M.E.I.C., vice-chairman of the Branch, and unanimously carried.

There was an attendance of 25 and an instructive discussion was engaged in, many practical questions being asked and answered.

Moncton Branch

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

The aerial photographic methods employed in mapping the vast territories of the Dominion, was the subject of an extremely interesting address delivered before a supper meeting of the branch on November 18th, by F. H. Peters, M.E.I.C., Surveyor General, Department of the Interior, Ottawa. Mr. Peters' address was illustrated throughout by lantern slides, and followed by motion pictures showing the actual taking of photographs from one of the flying boats of the Royal Canadian Air Force.

L. H. Robinson, M.E.I.C., chairman of the Branch, presided.

A feature of the evening was the rendition of several vocal selections by Mr. H. S. Austin, all of which were well received and heartily encored.

Aerial Photographic Surveys

Mr. Peters prefaced his remarks by stating that the system of aerial surveying developed by his department was believed to be the best suited to the needs of this country, although other methods had been devised and were in use in other parts of the world.

Two types of photographs are used, the vertical and oblique. The former is preferable for large scale maps and where there is considerable variety of relief. Knowing the elevation of the plane and the focal length of the camera lens, it is possible to scale distances directly from a vertical photograph. The oblique photograph has the advantage of covering a much greater area and is the one most generally employed. By a most ingenious method of superimposing a perspective grid upon the print, distances can be readily scaled off and plotted. The speaker described, in detail, the system of plotting and of determining compass directions from photographs. He also referred to the technique of the plotting of contours.

The motion pictures showing the daily routine of an aerial survey party, were followed with considerable interest. The planes used are of the pusher type and permit the photographer an unobstructed view ahead. It is usual to fly at an elevation of 2,000 feet and to follow parallel lines about 6 miles apart over the area to be mapped. The personnel of the party consists of three,—the surveyor, in charge, the pilot and the photographer. The two first named sit in comparative comfort in the cockpit of the machine, but the photographer occupies a much more exposed position in the bow and finds it necessary to clothe himself somewhat after the manner of a popular conception of a denizen of Mars, in order that he may withstand the rigours of his breezy perch. Travelling at 80 miles per hour, photographs must be taken every two minutes. Three exposures are made in quick succession—a right, left and centre. The camera is mounted on a curved rail. It is a bulky affair but easily moved about at the will of the operator.

At the conclusion of Mr. Peters' address an argument arose concerning the horizontal grid line which is superimposed upon the horizon of an oblique photograph. A member of the branch contended that this line should not be straight but curved. The natural horizon comprises a circle, and consequently a line made to coincide with this circle or any part of it, must of necessity be curved. The speaker took an opposite view, and although the discussion was prolonged, no satisfactory conclusion was reached.

A vote of thanks moved by Professor F. L. West, M.E.I.C., and seconded by C. S. G. Rogers, A.M.E.I.C., was tendered Mr. Peters by the chairman.

The engineering features of the Allenby campaign in Palestine and the exploits of Colonel Lawrence in Arabia, was the subject of an illustrated address of unusual interest delivered before the Branch, on January 13th, by Major H. W. L. Doane, B.Sc., M.E.I.C., of Halifax. The meeting was open to the public and the attendance was most gratifying. The large audience taxed the combined capacity of the city council chamber and court room and a number were compelled to remain standing. L. H. Robinson, M.E.I.C., chairman of the Branch, presided and introduced the speaker.

In his opening remarks Major Doane stated that owing to the large attendance on the part of the public he would as far as possible avoid technical details. He would say, however, that the final advance against the Turks was really an engineering problem involving the transport of men and supplies. In following up the victorious armies, engineers built a railway on the desert sands at the rate of a mile a day, also an 8-inch water pipe line 147 miles long, with booster stations at intervals to keep up the pressure. With such minor difficulties to contend with as scorpions and centipedes, and with the temperature at 120 in the shade (and by the way there was no shade) the work accomplished by the engineers was truly remarkable. An innovation in the science of road building was introduced when it was discovered that chicken wire netting pegged down to the sand would support guns, tractors, motor cars, etc., and really excellent military highways were built of this material, large quantities of which had been brought out from England for use in trench construction.

It is interesting to note that Major Geo. A. Walkem, M.E.I.C., a past-president of The Engineering Institute of Canada, had charge of the railway work in Palestine.

Turkey was persuaded to enter the war on the promise of the Central Powers that she would get Egypt, Palestine and other adjoining countries in Asia and Africa. At first Britain did not take the Turks seriously as it was believed the great Sinai desert was sufficient barrier to any Turkish advance. However, one of the most amazing feats of the war was the crossing of this desert by the Turks and finally an attack on the Suez canal with an army of 16,000 men.

In 1917, operations having reached a stalemate in France, it was decided to wage a decisive campaign in Palestine, and Allenby was placed in command. This officer had under him troops of seventeen nationalities. One of the most interesting units was the camel brigade, comprising 60,000 camels. Major Doane described in detail the brilliant tactics which resulted in driving the Turks out of Palestine, but which unfortunately was accompanied by heavy loss of life.

Coincident with Allenby's campaign in Palestine, Colonel Lawrence was sent to organize the Arabs, who had revolted against the Turks. In describing the Arab, the speaker declared that he was a magnificient fighter, but generous to a fault in dealing with his friends In war he never harmed women, or children too young to fight. Furthermore, property that could not be carried away was left uninjured. The Arab had a keen sense of humour. During the campaign an Arab king sent the following telegram to King George: "Our troops are victorious everywhere. The truth follows by post."

Lawrence at first did not attempt to drive the Turks out of Arabia, but was content with harassing his lines of communication, thus keeping enemy forces engaged that might otherwise have been used against Allenby in Palestine.

At the conclusion of the address, which was followed throughout with intense interest, a hearty vote of thanks, moved by F. O. Condon, M.E.I.C., was tendered the speaker by the presiding chairman.

Montreal Branch

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

The Montreal Branch spent a most interesting evening on December 4th at McGill University studying and observing the research problems which are being undertaken in the Faculty of Applied Science and Engineering.

Professor Ernest A. Brown, M.E.I.C., Acting Dean of the Faculty, welcomed the visiting members in a short address, during the course of which he paid tribute to the late Dean Mackay through whose efforts the visit of the Branch had been arranged. Professor Brown also outlined the various researches in the different departments after which the members divided into groups. Short descriptive talks were given by various members of the staff, dealing with the particular problems in which they were respectively engaged.

Professor C. V. Christie, M.E.I.C., head of the Electrical Department, arranged for demonstrations of the work in electrical engineering which included acoustic shock absorbers on telephone lines and high voltage testing.

Professor C. M. McKergow, M.E.I.C., and Professor Patten dealt with the work in the Mechanical Department, which included tests of the thermal conductivity of insulating materials as well as heat transfer from radiators.

In the Department of Civil Engineering Professor Brown outlined the study of secondary stresses in riveted trusses, joints and eccentrically connected members as well as the work done by the late Dean Mackay on welded joints in association with A. M. Bain, Jr.E.I.C.

All of the laboratories were open for inspection and proved a source of very great interest to the members who spent considerable time examining the more modern pieces of equipment.

R. S. Eadie, A.M.E.I.C., of the Dominion Bridge Company, moved a vote of thanks to the McGill University authorities and the Faculty of Applied Science for the privileges which had been extended by them.

Two papers were presented before the Montreal Branch on December 11th by students at McGill University.

The first, by P. E. Savage, S.E.I.C., dealt with the construction of a new highway bridge at Rapides Blancs, P.Q. This bridge was built by the Dominion Bridge Company for the Shawinigan Power Company. The location is about 20 miles north of La Tuque in a very rough section of country and over a very rapid stretch of water. Owing to the impossibility of delivering materials on both sides of the river a cantilever design was used which permitted of all erection being carried out from one side only and this feature combined with the fact that erection was completed in the short space of three weeks, made the subject a particularly interesting one. Mr. Savage showed a series of slides covering the various stages in the work of erection.

The second paper was by Mr. C. B. Charlewood on the subject of "Steam Distribution and Control in Paper Machine Dryers." A number of slides were shown illustrating the various arrangements of equipment used in regulating the steam flow in and drainage from the dryer cylinders.

Votes of thanks were moved to the two speakers by F. P. Shearwood, M.E.I.C., and W. McG. Gardner, A.M.E.I.C., respectively, and H. W. Lea, Jr.E.I.C., occupied the chair.

On December 18th Mr. D. Marples presented a paper before members of the Montreal Branch, prepared by Mr. John Avery, of the Brown Boveri Company, on the subject of "Turbo Blowers and Compressors."

Mr. Marples told of the development of the original centrifugal or turbo-compressor by Professor Rateau in 1905 as a machine for compressing air along the same principle as the centrifugal pump. The tests on the first machine were so favourable that in the following year several European firms took up the manufacture under Professor Rateau's patents.

The earliest machines built were for operating pneumatic tools in mines and steel works and, therefore, were for fairly high pressures, i.e., 70 to 100 pounds. These had as many as 20 or more wheels or stages and were usually cooled by water jackets. Later, it was found that a machine built on the same principle but for lower pressures of from 15 to 30 pounds formed an ideal blowing engine for iron blast furnaces. These units were called turbo-blowers as distinct from units for higher pressures. The use of these machines was gradually extended to other uses until the present time, when they are generally used wherever large volumes of air or gas have to be handled under pressure.

In the 25 years which have elapsed since their original conception many changes have been made, mostly along the line of lighter and stronger parts, higher speeds, etc.

Details of the construction of the machines were illustrated and described by the speaker, as well as the theory of operation and an explanation of the phenomenon of "pumping" given. Mention was made of various differences of opinion in connection with minor points of design and also of cooling and regulation.

The speaker finally summarized the advantages of turbo-blowers and compressors over other types of equipment and instanced some points to be guarded against when comparing capacities and efficiencies. Particulars of a number of interesting or outstanding blower installations in Canada as well as other parts of the world were given, two of the largest being the 78,000 c.f.m. unit at 120 pounds for the Victoria Falls and Transvaal Power Company Ltd. and the 130,000 c.f.m. unit at 21 pounds for the Alfred Hutte plant of the Krupp Company in Rheinhausen. In conclusion, Mr. Marples referred to some of the latest fields of application such as supercharging for Diesel and aeroplane engines.

Following the paper a number of interesting points were keenly discussed by several members of the audience, including Messrs. F. S. Winslow, A.M.E.I.C., and J. L. Busfield, M.E.I.C. J. T. Farmer, M.E.I.C., occupied the chair.

Niagara Peninsula Branch

C. G. Moon, A.M.E.I.C., Branch News Editor.

Under the able chairmanship of Walter Jackson, M.E.I.C., the Branch held a dinner meeting on Wednesday, January 14th, 1931, at Niagara Falls.

The guest speaker was Captain A. F. Ingram, Manager of Canadian Airways Limited, and until lately Adjutant at the Camp Borden flying field, consequently numerous members of the local flying club swelled the attendance and assisted the engineers in assimilating facts and disentegrating aero technicalities. Mainly, however, the address was couched in everyday language that could be followed by any layman.

Commercial Flying in Canada

Captain Ingram commenced by referring briefly to the history of his company, of which Mr. James Richardson of Winnipeg is president. The company is an amalgamation of several independent lines which started up soon after the war and served various districts under the stimulus of mail contracts. Western Canada Airways served the prairie country between Winnipeg and Calgary; Canadian Airways had the single route from Montreal to Toronto; other lines ran from Montreal to Moncton, from Edmonton north to Ketchekan and still others had short but dangerous routes to various northern mining camps. All these lines are now under the one management with headquarters in Montreal and have recently received substantial backing from Canada's two great railway systems, thus allowing Sir Henry Thornton, M.E.I.C., and Mr. Beattie to become vice-presidents of the Flying Company; Sir Herbert Holt is also on the board of directors, so that the future promises important developments. Very shortly, continued Captain Ingram, we can promise a trans-Canada quick service, flying by day and reposing more or less restfully during the night in one of the magnificent Pullmans hauled along prosaic rails by an obsolete locomotive. By the way, this is not an exact quotation, as Captain Ingram still has a vast respect for engines and railway companies.

During the War, 62 per cent of the Imperial Air Service was composed of Canadian flyers. This statement somewhat startled the audience, but Captain Ingram explained it by saying that the majority of young Britons had already trained in other branches of the Army and their services were too valuable to allow of any great change while the war was in progress. On the other hand, the Canadian boys were untrained and formed the very best material for this new branch, consequently they were snapped up and given important positions as the Air Service expanded. After the war, from about 1921 to 1926, aviation in Canada was at a standstill. Only about 5 per cent of the returned fliers stayed with the game and earned a precarious livelihood with minor flying units or as forest patrols. Today, there are plenty of pilots available in Canada—the Canadian Airways has a waiting list of fifty names, all eager to take over new routes as soon as they can be opened up. There is a good future ahead for aviators and groundsmen. The Canadian Airways find that it is good policy to pay well for competent pilots; they have fewer mishaps and consequently not only are insurance rates lowered but the public is gradually gaining confidence and using this means of travel to an ever-increasing extent. At present, pilots get a retainer of about $200 to $250 a month plus a flying bonus of 5c. a mile, which amounts to a respectable figure at the end of the year. One thousand to fifteen hundred flying hours is, however, considered low and most of the passenger plane pilots must have more than 2,000 hours to their credit.

Ground crews, naturally, are not paid on such an extravagant scale; air engineers get $150 to $175, mechanics about $100. There are also recorders, radio operators, weather reporters, and many other positions, which are being opened up continuously; also airport engineers have a professional field which has hardly been touched.

Airways in Canada have, so far, had an uphill fight—the Post Office Department has saved the day by means of air mail subsidies but even this has not meant unalloyed bliss. Pressure is continually being brought to bear for uninterrupted service combined with shorter flight timing. On the other hand, insurance companies and the Department of Civil Aviation, combine in insisting upon "Safety First." A hundred successful flights may implant courage into one hesitant traveller but one bad accident will deter many more than a hundred would-be fliers.

Despite these handicaps, aviation in Canada has progressed—the 340-mile air route between Toronto and Montreal was originally flown by Captain Peck in 1918 and his time was about six hours and forty minutes. At present the regular service is three hours.

Accidents are rare: in the last two years there have been 94 forced landings, of which 85 were caused by weather conditions and only 9 due to engine trouble. Forced landing fields are spaced about 30 miles apart where possible; of course, in many of the farmed lands a forced landing can be made almost anywhere but routes such as the one between Montreal and Moncton offer great difficulties on account of its heavily wooded nature. Along this route pilots have orders to fly as close to the Canadian Pacific Railway right-of-way as possible.

The signal service plays a most important part in aviation. Teletype machines are at present employed at all ports between Montreal and Windsor and from Montreal to Halifax ground signals are still in use but these will shortly give way to radio thus allowing the pilot to be in constant communication with both the points of departure and destination.

During the last year Canadian Airways have flown 5,000 passengers in the prairie districts and 1,000 in eastern Canada at rates which are about equal to railway fare plus the cost of a lower sleeper. In eastern Canada the rates are slightly higher than in the west and amount to 5c. a mile. Flying rates in the United States are about double this last figure.

One of the most important of Canadian Airways activities is the mail route to Rimouski and the Island of Anticosti, meeting or overtaking the trans-Atlantic steamers, thus saving some 12 hours' time over the New York service. This route is to be extended another 400 miles to the Straits of Belle Isle with a consequent saving of another 12 hours. Eventually the intention is to extend still farther northward up the coast of Labrador to a junction with the trans-Atlantic service of the Imperial Airways which is even now in process of being established via Greenland. The greatest water-hop is not more than 500 miles and Captain Ingram believes that the next few years will see this project completed and in operation.

In conclusion, Captain Ingram spoke of some of the technical difficulties encountered in flying. Fog is the worst hazard; it is not, at present, possible to complete an entire flight in fog; landing in a ground fog, however, has been proved practicable. The landing field has to be marked by a captive balloon which must be higher than the fog bank; the pilot marks his position and comes down through the muck not knowing just when he is going to strike the ground. However, about 5 feet beneath his plane there dangles a weight carrying an electric contact to a red light on his dashboard. As soon as this weight touches the ground the contact is made and, at the flash of red, he pulls back hard on the stick and lands—very often this gives a smoother landing than with perfect vision because it is automatic and adjusted exactly for every plane. Aquaplanes frequently use this device on glassy water when the distance is almost impossible to judge exactly.

Snow storms do not materially cut down time but they may be very unpleasant to fly in. The present company regulations call for a forced landing whenever the ceiling becomes less than 800 feet and the visibility is less than half a mile. Then the pilot goes forward, or back, to the nearest forced landing field marked on his chart.

Parachutes are going out of use in commercial flying except when pilots are flying at night in single seater planes. Most modern planes are so constructed that it is safer to stay with the plane than risk the jump into the air and the later danger of landing. The bodies or cabins are the strongest part and will resist a crash and protect the passengers when all other parts have crumpled and borne the brunt of the shock.

Following his address, Captain Ingram showed some very good lantern slides of various types of aeroplanes and a motion film sponsored by the N.A.T. lines in the States.

Ottawa Branch

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

The Wolfe Cove Tunnel

Lieut.-Col. D. Hillman, M.E.I.C., engineer of construction for the Canadian Pacific Railway, was the speaker at the noon luncheon held at the Chateau Laurier on Thursday, December 18th, his subject being "The Wolfe Cove Tunnel, Quebec." John McLeish, M.E.I.C., chairman of the local branch, presided and other guests at the head table included Major W. E. Blue, A.M.E.I.C., J. E. St. Laurent, M.E.I.C., Dr. J. A. Amyot, Deputy Minister of Pensions and National Health, F. H. Peters, M.E.I.C., Surveyor General, B. R. Riggs, Secretary of United States Legation, C. R. Coutlee, M.E.I.C., Honourable Dr. R. J. Manion, Minister of Railways and Canals, Honourable T. G. Murphy, Minister of the Interior, J. E. Noulan Cauchon, A.M.E.I.C., Irving N. Linnell, United States Consul General, G. J. Desbarats, C.M.G., M.E.I.C., Deputy Minister, Department of National Defence, A. E. MacRae, A.M.E.I.C., and Dr. R. M. Stewart, M.E.I.C.

The Wolfe Cove tunnel now being built by the Canadian Pacific Railway is part of a project relating to the construction of harbour terminal facilities at Wolfe Cove. The systematic waterfront development known as the Wolfe Cove terminal has been brought forward as a result of long and extensive study by the port of Quebec authorities. This project covers the river frontage of the city proper for a distance of about 2 miles, giving a total wharfage of 26,000 linear feet. It consists of a quay wall for the entire length, placed far enough out from the present shore to allow ample trackage together with piers 2,300 feet long and 425 feet wide extending into the river at appropriate intervals. A section of the terminals under construction at the present time consists of 4,300 feet of the above mentioned quay wall and completes the eastern portion of the development.

The tunnel itself when constructed will facilitate the handling of traffic between the new terminal and the Canadian Pacific main line along the St. Charles river. It leaves from a point on the main line about 2½ miles west of the Palais station at Quebec, and passes directly under the ridge which lies between the valley of the St. Charles and St. Lawrence rivers. In its course through the ridge it passes slightly west of the Plains of Abraham and comes out on the St. Lawrence a little to the east of the historic site of Wolfe Landing, the centre line being directly under Belvedere Avenue. The grade on the branch line varies from nearly level at the north portal to a maximum of 0.8 per cent in the tunnel itself. There will be no grade crossings of streets on the branch line. To obviate a grade crossing at Champlain street alongside the St. Lawrence a diversion of the street will be constructed in order to carry it over the tunnel lining which will be extended past the face of the cliff a sufficient distance to accommodate it. The selection of the location of the branch line was influenced by the topographical features, the expected geological formation and the desire to avoid interference with the existing appearance and conditions of the terrain at the historic site of Wolfe Landing. The formation varied from shale to Quebec city limestone, both rocks being quite soft and weathering on exposure. The former has to be supported immediately with timbers while the latter is self-supporting.

The speaker mentioned in some detail the methods used to insure accuracy in the tunnel alignment and also the means taken to hold points of reference both for line and grade.

The location plan, profile and book of reference were approved by the Board of Railway Commissioners July 2, 1930, and the contractor was advised at once to proceed with the work. The time for completion was specified as June, 1931, that is, eleven months only were allowed for the construction of this 1½ mile branch line with one mile of it in tunnel. The date set for the completion will fit in with the date set as the time when the new Canadian Pacific steamship "Empress of Britain" should reach Quebec on her maiden trip, the first steamer to use the Wolfe Cove terminal.

The tunnel is for single track with a clear inside width of 16 feet and a clear height above base of rail on the centre line of 22 feet 6 inches. The side walls are vertical and the top is formed by a semi-circular arch of a radius of 8 feet. The tunnel will be lined with concrete the type and quantity of which will vary according to the class of material through which the bore passes. At three locations in the west wall at equal distances apart refuge bays will be constructed to provide places for the section gang and other workmen to get clear of the trains. In the east wall there will be three conduits for carrying signal and telegraph wires.

The tunnel is being constructed from both portals at the same time and at the time of the address the speaker stated there was still about one-third of the distance to be bored through. Electric power is used for all the plant equipment and lighting on the job and is supplied by the Quebec Power Company. For excavating the tunnel the bottom heading method is used. The heading being driven from each end is taken out about 12 feet high and 14 feet wide. The drilling for this heading consists of about 24 holes 8 feet to 10 feet deep. The work is carried on in two shifts over the 24 hours and each shift generally drill and shoot one round. The shot is arranged in seven delayed actions, the central holes being fired first. About three pounds of powder per cubic yard is used per shot. The advance in each heading averages about 100 feet per week. Further details were given by the speaker with regard to the methods used for handling the muck, the whole operation being very efficiently carried out and running very low in maintenance cost as well as having a low first cost.

After a shot is fired the drillers have been able up to the present time to get back to the heading in about twenty minutes without suffering any ill effects from gas or dust although it is expected that before long blowers for clearing the gasses from the tunnel will have to be put in operation. The spray is turned on the muck heaps after each shot and this tends to expel the gasses and to permit of earlier re-occupation of the heading.

The rock in the tunnel drills easily and shoots small. Many falls of rocks have occurred, fortunately as yet without serious results. These falls have been in the shale only and generally where boulders of foreign rock are imbedded in the shale. No warning, such as small pieces of rock dropping off, occurs prior to such falls and it has only been by careful inspection and from the prompt placing of timbers that serious accidents have been avoided. Where there is an indication of foreign boulders in the shale, breakdown timbers are placed at once.

For the placing of concrete the plant on each end consists of a one-yard mixer with pneumatic placer and necessary pipe. The concrete is mixed in the ordinary way and deposited in a hopper and thence in the pneumatic placer after which a plate is set over it. When the air is turned on, it is caused to flow through a 6-inch pipe and delivered behind the form at the top of the tunnel lining. The placing of concrete will be carried out from the north end and from the south end and from three intermediate stations. At the three intermediate stations within the tunnel the concrete will be delivered through holes that are being drilled from the surface. The placing of concrete will be carried out at the north end and south end on alternate days giving daily progress of about 20 feet at each end.

The rate of progress since this work has started would indicate that the breaking through of the heading will take place in the last half of February. It is expected that the full section excavation will be completed about six weeks later and the concrete lining a month after the full section is completed.

The annual meeting of the Ottawa Branch of The Engineering Institute of Canada was held at the Chateau Laurier on the evening of January 8th. About ninety members were present. John McLeish, M.E.I.C., chairman of the local branch, presided.

The meeting commenced with the reading of the notice of meeting by F. C. C. Lynch, A.M.E.I.C., Secretary-Treasurer. The minutes of the last annual meeting together with reports of the various committee chairmen had, previous to the meeting, been prepared in multigraph form so that a copy could be handed to each of the members present. This facilitated the progress of the meeting and on this account a number of the reports were taken as read, thereby allowing a greater length of time to be taken up in discussion.

In the chairman's address, presented by Mr. McLeish, tribute was paid to those who had assisted in carrying out the various duties of the Branch. Reference was also made to various points, most of which were more fully elaborated upon by the committee reports presented later, namely to the extent of membership, the state of the finances, a proposal for the formation of radio and aviation sections, a suggestion for the awarding of prizes to stimulate education in the Ottawa Technical School, and the branch activities in general.

Reports presented at the meeting included that of the Managing committee by E. W. Stedman, M.E.I.C., chairman; the Secretary-Treasurer's report by F. C. C. Lynch; the report of the Proceedings committee by L. L. Bolton, M.E.I.C.; of the Membership committee by J. E. St. Laurent, M.E.I.C.; of the Rooms and Library committee by W. L. Cassells, A.M.E.I.C.; of the committee on Advertising by J. R. Akins, M.E.I.C.; of the Branch By-Laws committee by W. F. M. Bryce, A.M.E.I.C.; of the Reception committee by F. H. Peters, M.E.I.C.; and of the special committee to look after the 44th Annual Meeting of The Institute held at Ottawa on February 12th, 13th and 14th, 1930, by J. L. Rannie, M.E.I.C.

Although the membership of the local branch had fallen off during the year prospects for an increase in 1931 were favourable. There were 393 resident members and 68 non-resident members of the local Branch. The financial statement, according to the Secretary-Treasurer showed that the assets of the Branch were $1,968.67. The cash balance was $1,642.41. The outstanding event of the year had been the 44th Annual Meeting of The Engineering Institute of Canada held under the auspices of the local Branch last February.

The Managing committee's report contained details of a recommendation to the effect that it would be advisable to form professional sections of The Institute; as examples, aviation and radio sections were named. In the discussion which followed, Group-Captain Stedman said that everything was in readiness to proceed with the formation of a local section for aviation. He also said that he understood Colonel W. A. Steel, A.M.E.I.C., who was not present at the meeting, was prepared to organize a radio section.

The report of the Proceedings committee elicited the information that during the year there were 14 luncheons and 4 evening meetings held, with an average attendance of 112 for the luncheons and 154 for the evening meetings. This report contained a recommendation that the local papers the *Journal*, the *Citizen* and *Le Droit*, be communicated with and expressions of appreciation from the Branch sent them for the excellent write-ups which they had given to the luncheon addresses and evening meetings.

With regard to the suggestion put forward that the Branch undertake to donate prizes to pupils of the Ottawa Technical School, the meeting was entirely in accord. In the discussion upon this subject, it was brought out that the prizes should be awarded to both day and night classes. For the latter, particularly, it was considered that the awarding of prizes would afford a stimulus toward the completion of the courses undertaken by those who of necessity had to obtain their technical education in the evenings.

The election of officers for 1931 resulted as follows:—chairman, G. J. Desbarats, C.M.G., M.E.I.C., Deputy Minister of the Department of National Defence; secretary-treasurer, F. C. C. Lynch, A.M.E.I.C., Director of the National Development Bureau of the Department of the Interior; managing committee, R. F. Howard, M.E.I.C., of the Gatineau Power Company, Group-Captain E. W. Stedman, M.E.I.C., of the R.C.A.F., Department of National Defence, C. E. White, A.M.E.I.C., of the Canadian National Railways, J. R. Akins, M.E.I.C., of the Topographical Survey of Canada, and J. E. St. Laurent, M.E.I.C., of the Department of Public Works; the two last named having still one more year to serve in order to complete their term. Ex-officio members of the committee are J. E. Noulan Cauchon, A.M.E.I.C., F. H. Peters, M.E.I.C., and John McLeish, M.E.I.C.

Following the election of officers Mr. McLeish, who had presided up to that time, gave over the chair to Mr. Desbarats, who made a short address.

During the course of the meeting and afterward entertainment was provided by Mr. Roy Wright of Ottawa who contributed several songs and performed a number of sleight-of-hand tricks. Two short moving pictures supplied through the courtesy of B. E. Norrish, A.M.E.I.C., Manager and Director, Associated Screen News, of Montreal, were shown. At the close of the meeting refreshments were served.

Peterborough Branch

F. G. A. Tarr, S.E.I.C., Secretary.
B. Ottewell, A.M.E.I.C., Branch News Editor.

TWELFTH ANNUAL DINNER

The Peterborough Branch held its annual dinner on November 25, 1930, at the Empress hotel, Peterborough, with its usual success, nearly one hundred members and guests being present. Among the prominent guests who honoured the Branch with their presence were A. J. Grant, M.E.I.C., President of The Institute, Colonel R. E. Smythe, A.M.E.I.C., Director of the Technical Service Council, Toronto, R. J. Durley, M.E.I.C., General Secretary, C. E. Sisson, M.E.I.C., Vice-President for Canada of the A.I.E.E., E. G. Cameron, A.M.E.I.C., assistant engineer, Welland Canal, Colonel VanScoyoc, Portland Cement Association, E. A. Peck, M.P., Alderman MacDonald, representatives of the Montreal, Toronto and Kingston Branches and also delegates from the local medical, ministerial and teachers associations.

As a centre piece at the head table a working model of one of the Welland Canal lift bridges paid delicate compliment to our President and several of his engineers who were present.

Chairman W. E. Ross, A.M.E.I.C., proved a capable master of ceremonies and following the banquet he introduced the programme by a brief address in which he reviewed the aims of the Peterborough Branch of The Institute and the possibilities it holds for the profession. The customary programme of toasts followed and addresses were given by a number of guests.

In response to the toast to The Institute, President Grant stressed the necessity for new members and also for closer co-operation between The Engineering Institute and the various Provincial Associations of Professional Engineers.

R. J. Durley in optimistic tone outlined the progress of the work being done towards confederation of these various Associations. Speeches were also given by E. G. Cameron, A.M.E.I.C., Niagara Peninsula Branch, D. C. Tennant, M.E.I.C., Montreal Branch, Colonel E. J. C. Schmidlin, M.E.I.C., Kingston Branch, and J. J. Trail, M.E.I.C., Toronto Branch, and also by members of the sister professions and others.

In deploring the exodus to the United States of a large percentage of the graduates of Canada's universities, which has been checked appreciably by the activities of the Technical Service Council, of which he is a director, Colonel R. E. Smythe, D.S.O., explained that in the past fifty years this exodus from one university alone was approximately 17 per cent. After the War and up to the year 1928, the percentage rose as high as 24 per cent. At that time the Technical Service Council was formed with the intention of increasing the use for technically trained men in Canada and to influence the supply and demand in all branches of the profession; also to establish a clearing house that men of ability could find some opening, where their talents may be used for the good of their own country.

In 1929, 97 per cent of the graduates of Ontario universities put their efforts into Canadian enterprises, in 1930 the percentage rose to 98. "This country needs her engineers," he declared, in making it quite plain that the organization of which he spoke, was in no way antagonistic to the United States. "In 1931," he said, "there will be 38 engineers graduating in Canada for every one million of the population, while in the United States next year, there will be 82 graduates for every million of the populace.

"I believe that in the near future the engineers of Canada are to play a larger part in the wealth of the country than they have done in the past. We still see the demand for engineers, which has kept constant despite the slight depression in most other industries and professions."

The speaker thought The Institute was due for an increase in membership and an increase in influence and strength, and that the quickest way to accomplish such an end was for the A.I.E.E., the Technical Service Council and other kindred organizations to get into harness and pull together, then the engineer of the Dominion would occupy a new status, and commence to play a greater part in the leadership of this country.

Commenting on the immigration situation, Colonel Smythe, while realizing that Canada needs many men of the right stamp and calibre, was nevertheless of the opinion that in times of depression immigration on a large scale should not be encouraged. With this idea in mind the Council had written to the authorities in the preferred countries and had urged them to postpone their impending migration to Canada until trade conditions become more stabilized. The result of this action had been a large falling off in the number of immigrants to this country during the past year; more work for our own engineers and the assurance that these intending migrants, providing they are of the right type, will be needed very shortly.

The musical programme was contributed by an excellent orchestra of piano, violin and 'cello, also a solo by R. J. Cobbold, S.E.I.C. Community singing was led by Paul Manning, A.M.E.I.C., and a skit on the activities of certain prominent members of the Branch on the recent occasion of their visit to the Canada Cement works was entertainingly presented by Student and Junior members.

COPPER IN THE ELECTRICAL INDUSTRY

A well attended meeting of the Branch was held on December 11, 1930, at which an interesting address on the above subject was given by Mr. H. C. Jennison, Assistant Technical Superintendent and Assistant Metallurgist of the Anaconda American Brass Company. Chairman Ross Dobbin introduced the speaker who first showed two reels of moving pictures depicting the plant, equipment and processes of the Anaconda Company. Starting with the mining of the ore and following the progress of the material through crushing, screening, smelting, refining and rolling, the films clearly illustrated modern methods of production. Manufacture of copper sheet, rod and tube was also shown.

Remarking that the production of copper in the United States and Canada in 1929 totalled 1,160,000 tons, the speaker said that approximately half of this was used in the electrical industry, which requires the highest quality in conductivity. A purity of 99.90 per cent was guaranteed and the actual average was 99.95 per cent.

As an example of the ductility of copper mention was made of a 1-inch bar drawn down to .002 inch by special care but without annealing.

Mr. Jennison also dealt at length with copper alloys, of which there are some hundreds, many such as brass, manganese, phosphor bronze, everdur, etc., having valuable properties in the electrical industry.

Incidentally the speaker mentioned that all the Company's mills have been or are changing over to electric drive exclusively with resultant economies. Ninety per cent of the metal is now melted in electric furnaces of the arc, induction and high frequency types.

A very active discussion followed the address, many questions being answered by the speaker. On behalf of those present, H. R. Sills, Jr.E.I.C., moved a hearty vote of thanks.

An exceptionally popular meeting of the Peterborough Branch was held on Thursday, January 8th, 1931, at which Major L. T. Burwash, M.E.I.C., geologist, scientist and explorer, of the Yukon and Northwest Territories Branch of the Department of the Interior, gave an address on the subject of "Exploration in Northern Canada." This meeting was open to the general public and was held in the large auditorium of the Collegiate Institute, the attendance being approximately 800. W. E. Ross, A.M.E.I.C., Branch chairman, presided.

In introducing the subject, Major Burwash stated that the Northwest Territories comprised about one-third of the total area of Canada; He thanked the people for investing money in this and other expeditions. he hoped that further work would not prove too expensive.

The natural resources of this northerly district were pictured as being extensive. A great agricultural area, an extension of the Peace river belt and some of the most fertile land in Canada, stretches northward from the Northwest Territories boundary 300 miles, and east and west 500 miles. This excellent land, the speaker said, is at present very sparsely settled, but promises the sustenance of a large population in the future.

In the Mackenzie river district are extensive mineral and oil deposits. Valuable discoveries were made last year, and this area should become the wealthiest mining district in Canada. Copper ore has been found and this is accompanied by favourable geology. Radium ores, comparing very well with those found in the Belgian Congo, have been discovered, and may furnish Canada with a copious supply of that precious element.

Valuable products such as oil, leather, etc. are furnished by the abundant supply of sea mammals in these northern regions. The country provides good grazing lands for caribou and reindeer.

Eventually Canada will be abundantly repaid by the produce from the northlands, as a result of the investment in exploration and scientific expeditions.

Major Burwash then proceeded to recount the fascinating history of northern Canada, commencing with the discovery of Hudson bay by Henry Hudson in 1603, proceeding with the subsequent expedition of Fox, James and Frobisher, and giving in considerable detail an account of the tragic Sir John Franklin expedition.

The speaker then described his own expeditions and especially those of 1928 to 1930, culminating with a visit to the Franklin camp on King William island.

During these trips Major Burwash took observations of the north magnetic pole, noting a variation of some 7 degrees east and west each day.

Major Burwash's address was illustrated with a very fine series of still pictures and his later expeditions by aeroplane were shown in moving pictures.

At the conclusion of the address the appreciation and thanks of the large audience was ably expressed in a short speech by Judge Huycke.

Saskatchewan Branch

R. W. E. Loucks, A.M.E.I.C., Secretary-Treasurer.

The first regular meeting of the season was held at the Kitchener hotel, Regina, Sask., on October 24th, 1930, at which time Councillor D. A. R. McCannel, M.E.I.C., gave a report on the Plenary Meeting of Council held in Montreal on September 22nd, 23rd, and 24th. Mr. McCannel emphasized the need for additional funds to carry on the work of The Institute and told of the plans which are now under way to bring about closer relations between the various Professional Associations of Engineers and The Institute. He referred to the work of the committee on Publications, committee on Remuneration and Classification, Students Prizes and other matters dealt with at the meeting. He said it was expected that President Grant would make a visit to the western branches during the coming season. Vice-President C. J. Mackenzie, M.E.I.C., Dean of Engineering, University of Saskatchewan, was also present and contributed to the discussion on Institute matters. The meeting was preceded by a banquet held at 6.30 o'clock p.m. at which 40 members and guests were present. At 9.00 o'clock p.m. the meeting adjourned and was followed by a meeting of the Professional Association of Engineers of Saskatchewan, which the majority of the members attended.

Experiments in the Transmission of Speech and Music

At the November meeting of the Branch held at the Kitchener hotel, Regina, on November 21st, 1930, S. R. Muirhead, A.M.E.I.C., gave an address on "Experiments in the Transmission of Speech and Music." This address was illustrated by gramophone records. Mr. Muirhead discussed briefly the principles connected with the transmission of sound, explaining that in telephone work the atmospheric vibrations are transformed into electrical vibrations and vice versa. Due to the characteristics of the electrical circuits and apparatus involved it is impossible to transmit by wire all the frequencies originally present in the atmospheric vibrations but fortunately reasonable results can be obtained by transmitting certain fairly well defined ranges of frequencies. The ranges necessary for satisfactory transmission of speech and music are somewhat different, the requirements for music being more exacting. A number of the records that were played showed the harmful effects of eliminating certain frequency ranges both for speech and music. Other records showed the effect of overtones on the quality of the tones of different musical instruments and gave practical demonstrations of other matters of interest to telephone engineers.

Mr. Muirhead is engineer with the Saskatchewan Department of Telephones. At the conclusion of his address a hearty vote of thanks was tendered him on motion of R. N. Blackburn, M.E.I.C., and H. S. Carpenter, M.E.I.C.

Natural Gas for Saskatchewan Cities

At a largely attended meeting of the Branch held at the Kitchener hotel, Regina, on December 12th, 1930, preceded by a banquet, some 47 members and guests assembled to hear Mr. E. M. Moore, engineer, of the Tri-Cities Utilities Ltd., speak of the proposition which his company has recently submitted to Regina, Saskatoon and Moose Jaw for a natural gas supply.

Mr. Moore traced the development of the use of natural gas on this continent which began in New York in 1832. The first pipe line, having a length of 25 miles from Whitepine to Rochester, N.Y., cost $25,000,000 and was a complete failure.

Engineering schools of that time failed to recognize the value of natural gas and its development was left almost entirely to "wildcatters," who accepted the risks of financing and who are not given all the credit they deserve. Only in recent years has gas supply been recognized as a public utility and to-day we find many prominent engineers connected with the development of oil and gas.

Mr. Moore exhibited a map showing the extent of the development of natural gas in the United States. Within recent years this country has been covered with a net work of lines extending from one end of the nation to the other and the movement is now spreading into Canada.

An investigation of the sources of supply for central Saskatchewan including the cities of Regina, Moose Jaw and Saskatoon, indicates three main fields, Montana, Turner Valley in Alberta and the Kinsella-Wainwright district in Alberta. Mr. Moore stated his reasons for favouring the development of the latter field based on the report of Herbert R. Davis, gas expert of Buffalo, N.Y., recently employed by the cities of Regina and Saskatoon to report on this question. Briefly the Montana field is in shallow sand, under low pressure and it is doubtful whether a sufficient supply of gas could be developed at this point to meet the needs of Saskatchewan. The supply of gas from the Turner Valley field is rapidly being depleted by uncontrolled waste and the gas contains so much sulphur (as much as 700 grains per 100 cubic feet), that it would have to be scrubbed before being fit for domestic use.

The Kinsella-Wainwright field, while not yet fully investigated nor developed, is believed to be eminently satisfactory. Government reports state that wells in the field have from 10 to 30 million cubic feet open flow. The Kinsella well has an open flow of 25 million cubic feet. It is 2,500 feet in depth and has a pressure of 765 pounds per square inch. The Kinsella field has to-day 15 producing wells, including the Hudson Bay well, and the Viking field is only 12 miles from the former. It has been estimated that the Kinsella-Viking-Wainwright field has a sufficient supply of gas already developed to meet the requirements of central Saskatchewan for 11 years, with the probability that this supply can be considerably augmented by the end of that time, either by new wells in that district or by the development of wells in other portions of Saskatchewan.

Mr. Moore recommended the sympathetic support of his audience to the efforts now being made to find supplies of natural gas in Saskatchewan at such points as Simpson, Outlook, Biggar and Pilot Butte, thus encouraging the development of our local resources which in turn would benefit every industry in the province.

Mr. Moore stated that experience shows that not more than 10 per cent to 20 per cent of the open flow of gas wells should be utilized. He further stated that 75 million cubic feet of open flow can be developed from three good wells in the Kinsella field.

The speaker estimated the cost of the proposed development including pipe lines to be $14,000,000. Very few cities on this continent have tried public ownership of gas supply mainly because it embodies an element of speculation, particularly during the first five years of the development. Franchises for the supply of gas usually carry with them provision for control of rates so that the company obtaining a franchise is not allowed over a certain percentage of profit on their investment. These rates are usually adjusted from time to time and at all times the company is forced to maintain rates which can compete with the use of coal as a fuel.

Mr. Moore stated that if his company is granted a franchise, they will introduce a most modern plant and appliances, consisting of mixing chambers, ranges, furnaces, etc., and that a service department will be set up and efficiently manned at all times to advise and inspect the consumers appliances. Gas companies must of necessity give the best of service, since they are in competition at all times with coal and electricity.

Upon completion of the address a general discussion took place.

Sault St. Marie Branch

A. A. Rose, A.M.E.I.C., Secretary-Treasurer.

The annual meeting of the Sault Ste Marie Branch of The Institute was held in the Y.W.C.A. rooms, March street, following a dinner at the Savoury cafe, on December 19th, 1930, at 8 o'clock p.m.

C. H. E. Rounthwaite, A.M.E.I.C, chairman, called the meeting to order and the minutes of the last meeting were read by the secretary and adopted.

On motion of J. W. Le B. Ross, M.E.I.C., and F. Smallwood, M.E.I.C., bills to Cliffe Printing, Barnes Drug Co., and stenographer's salary were passed. An honorarium to the Secretary of $25.00 was passed.

W. S. Wilson, A.M.E.I.C., chairman of the Papers committee, reviewed the year's work and was able to pass on some suggestions to the 1931 committee, regarding prospects for a number of papers. His report was adopted on motion of A. H. Russell, A.M.E.I.C., and Frank H. Barnes, A.M.E.I.C.

In the absence of the chairman of the Membership committee, the Secretary read a summary of the Branch membership, showing a decline of nineteen members for the year. This report was adopted on motion of Messrs. Barnes and Smallwood.

Mr. Barnes reported for the Social committee their efforts to put on a dinner dance which failed to materialize on account of an insufficient number of members being able to be present. His report was adopted on motion of C. H. S. Dennison, Jr.E.I.C., and Mr. Ross.

The Secretary's report for 1930 was read and adopted on motion of Messrs. Russell and Dennison. It showed the Branch in a healthy financial condition. On motion of Messrs. Ross and Barnes, the auditors for 1930, Messrs. L. R. Brown, M.E.I.C., and A. E. Pickering, M.E.I.C., were reappointed for 1931.

As the result of a ballot which was taken, W. S. Wilson was appointed Branch representative on the Nominating committee of The Institute.

Mrs. W. Scott contributed a number of piano solos which were much appreciated by all present.

Mr. Barnes, chairman of Nominating committee, reported the result of the elections as follows:

Chairman: A. H. Russell, A.M.E.I.C.
Vice-Chairman: C. Stenbol, M.E.I.C.
Executive Committee: (2 years)
Resident: W. S. Wilson, A.M.E.I.C.
Non-Resident: C. H. N. Connell, A.M.E.I.C., North Bay.
Executive Committee: (1 year)
Resident: J. W. LeB. Ross, M.E.I.C.
Non-Resident: J. M. Silliman, A.M.E.I.C., Sudbury.
Secretary-Treasurer: A. A. Rose, A.M.E.I.C.

On motion of Messrs. Barnes and Rose, this report was adopted.

In vacating the chair to the new chairman, Mr. Rounthwaite reviewed the work of the year just closing and expressing his hope and faith in the future prospects of the Branch, solicited the support of all the members for the new executive.

In taking the chair Mr. Russell thanked the members for the honour conferred on him and asked the support of all in making 1931 a banner year.

A vote of thanks was tendered the Y.W.C.A. for the use of their room on motion of Messrs. Barnes and Rounthwaite.

The new chairman was instructed to see what arrangements could be made for holding meetings and dinners at the New Windsor hotel.

The meeting adjourned on motion of Messrs. Barnes and Rounthwaite.

Toronto Branch

J. J. Spence, A.M.E.I.C., Secretary-Treasurer.
A. B. Crealock, A.M.E.I.C., Branch News Editor.

The meeting of the Toronto Branch of The Institute held on Thursday December 11th, 1930, was well attended, the speaker being A. S. Wall, M.E.I.C., of the Dominion Bridge Company, Ltd., Montreal. The paper presented was "Arc Welding in Steel Fabrication," and was written from the standpoint of the structural fabricator who in addition to being a manufacturer is a merchant in business to sell fabricated steel, the manufacturer's interest in the sale of fabricated material of welded construction being dependent on whether the use of welding leads to more economical construction or provides means of better design. At the present time and in the near future at least his attitude being that he has a new and very useful tool or process available in addition to his older method; and that he will be prepared to use whichever of the methods that best satisfy the requirements of a particular job. The type of welding discussed was metal electrode arc welding. This process as regards structural steel may be considered as in the earlier stages of evolution, various construction schemes being tried, probably as many being discarded; but the science of welding developed amazingly during the past few years. When welding machines first made their appearance they were used principally on repair or salvage work, but their use grew so that to-day the question is not so much is welding safe but rather the establishment of its economical boundaries. The growth of the practice is evidenced by the fact that while Mr. Wall's company purchased their first single operator machine some ten years ago, to-day the parent plant has 23 manual machines and 2 automatic heads while a dozen or more machines are distributed throughout their various branch plants. Although during this period many types of structures have been fabricated by welding such as tanks, barges, buildings, bridges, etc., it cannot be said yet that the manufacturing of all such structures by welding process has become standard practice, however in some plants there are various structures which are fabricated by welding as a more or less accepted practice. Welding is also used daily for the building up of worn shafts or other parts as the regular or only means, while the formation of loop ends for hangers or bracing rods costs less by the welded process than by the forge method. Vessels built to contain gasoline, caustic liquids and other liquids difficult to hold in riveted tanks give practically no trouble in containers of welded construction, although in this class it is not necessarily a question of reduced cost but rather that welding is more suitable for the purpose.

The speaker described the use of welding for sluice gates, also its advantages for parts made of cast steel and its use in the making of manholes, cleanout doors, machinery bases and bridge pier members. The next part of the paper contained a detailed description of the use of welding in structural work such as trusses, columns, beams and on building work, one of the advantages on the latter being the freedom from noise which is of extreme importance especially in congested districts. Following this Mr. Wall described the development of a system of control for welding operations, so as to ensure the strength of the weld, the training and periodic testing of the operators, the supervision and inspection of the work in order to ensure uniformly reliable welds. The training of the draughting and designing staff and the use of standard instructions were dealt with. Following this Mr. Wall treated on the methods used to provide for general economy in the practice, touching on the use of welding in ordinary shop work and describing how the practice is being studied, stating however that it will be necessary to profit by the accumulated experiences of many companies before a structural steel welding practice can be definitely established.

Then the speaker described the work being done on fundamental research along the lines of stress distribution in welded joints, studies of welded metals under impact and fatigue tests, continuous connections, etc. The need for a method to control the welded structure from distortion under construction was discussed. One of the probable fields for welding is the repair and reinforcing of old structures to allow them to take heavier loadings, but study should precede its employment for this work to ensure that stresses induced by the strains from members subjected to welding will not cause trouble in some plane of weakness. However, because of the rapid development in the art of welded design and operation and the widespread research now in progress, there is good reason to expect that in a comparatively short time there may be a reasonably comprehensive structural steel welding practice paralleling in a measure the older structural steel riveting practice.

Following this Mr. Wall showed some 75 slides illustrating the points covered in his paper. An extensive discussion on the paper took place and the meeting adjourned after a very hearty vote of thanks had been tendered Mr. Wall for his excellent paper.

On the evenings of January 7th, 8th and 9th, the Toronto Branch of The Engineering Institute of Canada in conjunction with the University of Toronto and other engineering societies in the city were again privileged to hear "A Short Course in Concrete," by Mr. R. S. Phillips, of the Portland Cement Association of Chicago. These lectures were given in Toronto two years ago and the interest with which they were received was evidenced by the attendance this year, the lecture room in the Physics building of the University being practically full on each evening.

It is impossible in a review of this nature to treat Mr. Phillips' lectures in detail but the subject was covered in a most thorough and interesting manner. In mentioning some of the highlights of the lectures we might state that the water-cement ratio strength law was the basic theory in both times that Mr. Phillips spoke to Toronto audiences, but whereas two years ago the trend was to get a concrete of a definite strength, to-day the exposure to which the concrete is to be subjected and its durability should be considered. The effect of this in climates such as we have in this locality is that whereas a 2,000-pound concrete (obtained with approximately 6 imperial gallons per sack of cement) might meet our strength requirements the need of producing a concrete that would have the required durability would necessitate a concrete with only 4½ to 5 imperial gallons per sack of cement which would give a strength of 2,700 to 3,000 pounds per square inch. Mr. Phillips pointed out that in cases like this it would probably be better to re-design the work on a basis of using 3,000-pound concrete thus reducing the quantity of concrete needed and obtain a concrete that would meet not only the strength requirements but would provide the durability necessary.

Another point brought out by Mr. Phillips was that the design of a mixture by the calculation method is being superseded by the trial method. An example of the trial method was demonstrated by Mr. Phillips. The essential factors in control such as the selection of materials, effect of size and grading of aggregates, control tests and the placing and curing of the concrete were fully covered, special attention being given to the question of proper curing.

The lectures were of great interest and were thoroughly appreciated by all in attendance, who demonstrated their approval in no uncertain manner.

The Gage Avenue Pumping Station

The Gage avenue pumping station of the city of Hamilton, recognized as one of the outstanding units on the American continent for handling unscreened sewage, consists of four Smart-Turner vertical wood trash pumps, each capable of discharging 15,000,000 Imperial gallons in twenty-four hours (10,416 Imperial gallons per minute) against a head varying from 35 to 49 feet, also one Smart-Turner vertical wood trash pump handling ten million Imperial gallons in twenty-four hours (6,944 Imperial gallons per minute) against a head of 35 to 37 feet.

These vertical pumps are equipped with 16-inch suction and 16-inch discharge, capable of passing a 12-inch sphere, and are installed in the basement, direct connected to motors by flexible couplings and vertical extension shafts to vertical motors mounted on the main floor of the building.

The four larger pumps are driven by 125 h.p. 25-cycle, 3-phase, 550-volt, 360 r.p.m. vertical motors while a 100 h.p. 3-phase, 25-cycle, 550-volt, 360 r.p.m. motor is used for the other unit.

In order to be prepared at all times should electric power not be available, two standby units have been installed, consisting of two horizontal Smart-Turner double suction wood trash pumps, direct connected by flexible coupling through reduction gear to 250 h.p. 8-cylinder gasoline engines.

These pumps are of the horizontal split case type, double suction, capable of discharging 37,500,000 Imperial gallons in twenty-four hours (26,041 Imperial gallons per minute) against a head of 16 feet and each equipped with two 28-inch suction pipes and 36-inch discharge. The speed of each unit is 220 r.p.m. and a sphere 9 inches in diameter will pass through the pump.

The Hamilton Gear and Machine Company, Ltd., Toronto, Ont. have published booklet No. 104, being the fourth of a series of parts of a section catalogue, the three previous parts covering the following subjects: Worm Gear Speed Reducers, Herringbone Gear Reducers and Industrial Cut Gears. The latest part of the catalogue is a twelve-page booklet entitled "Flexible Couplings," containing information regarding, and photographs of, various types of flexible couplings, to enable the engineer to select the correct size and type of coupling for a given service.

The Power Corporation of Canada, Ltd., Montreal, has published a sixteen-page booklet entitled "Power," illustrating and describing briefly some of the activities of the company's engineering, construction and industrial divisions. Among these may be mentioned the Seven Sisters hydro-electric power development of the Winnipeg Electric Company, the Back River power development of the Montreal Island Power Company Ltd., the Upper Notch development of the Northern Ontario Power Company, Ltd., and the Chats Falls Power development of the Ottawa Valley Power Company and the Hydro-Electric Power Commission of Ontario. Copies of this booklet may be secured from the company's offices, 355 St. James street, Montreal.

The Canada Cement Company, Ltd., has recently published two circulars, one of which gives specifications for the use of calcium chloride as an accelerator in concrete and the other gives the results of tests on concrete showing the high early strength when it is so prepared.

Preliminary Notice

of Applications for Admission and for Transfer

January 19th, 1931.

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, 1931.

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

COONEY—RICHARD THOMPSON, Jr., of Newcastle Creek, N.B., Born at Hoboken, N.J., Feb. 7th, 1892; Educ., I.C.S.; A.M., A.I.E.E.; 1909-10, elect'l. helper, Continental Electric Co., Washington, D.C.; 1910-11, elect'n., small power installns., Columbia Pump & Well Co., Washington; 1911-13, elect'l. inspr., Washington & Old Dominion Rly.; 1913-14, supt. of constrn., small power house, Merchant & Evans Co., Philadelphia, Pa.; 1914-16, supt. of constrn., trolley line, North Beach Rly. Co.; 1916-17, asst. operating engr., industrial plant, Baldwin Locomotive Works, Eddystone, Pa.; 1917-18, gen. foreman, shipyard, Amer. International Shiphldg. Co., Hog Island, Pa.; 1918-24, owner, Progressive Electric Co., Maple Shade, N.Y., engaged in house wiring and small power installn. work, contractor and builder on small dwellings; 1924-25, elect'l. foreman, large power plant, Dwight P. Robinson Corpn.; 1926-27, elect'l. supt., large power plant, United Engineers & Constructors Inc.; 1925-26, elect'l. foreman, Byllshy Engineering & Management Corpn., San Diego, Calif.; 1927-28, elect'l. supt., sulphur mining plant, J. G. White Company, New York, N.Y.; 1928-30, elect'l. supt., large power plant, etc., Penn. Rld. for United Engineers & Constructors Ltd.; 1930 to date, elect'l. supt., small power plant for United Engineers & Constructors (Canada) Limited, at Newcastle Creek, N.B.

References: S. R. Weston, G. A. Vandervoort, J. Stephens, J. N. Flood, R. M. Legate.

FITZROY—ROBERT HENRY, of Montreal, Que., Born at Wicklow, Ireland, Jan. 12th, 1896; Educ., 1909-11, Wicklow Technical Schools, evening classes, specializing in Diesel engrg.; 1911-18, ap'ticeship as engr. at Harland & Wolff's Shipyard, Belfast, attending night classes in prac. mechs., machine constrn. and drawing; 1916-20, Royal Naval Reserve; 1917-18, acting engr. sub.-lieut., in charge of repair base at Salonica; 1918-20, headquarters, Senior Naval Officer's Staff, Constantinople, eng. officer in charge of H.M.S. "Jessie"; demobilized 1921 as acting engr.-lieut.; 1923-24, chief engr., motorship "Arran Firth"; 1924-27, sales and installn. engr., Crude Oil Engine Co., personally supervised constrn. of vessels at the Davie Shipbuilding Co., Quebec; 1927-28, supt. engr., laid out Diesel engine power houses and loading wharf, for Brown Corpn., Bersimis, Que.; 1928-29, boiler and machy. inspr., Royal Insurance Company; 1929-30, chief engr., S.S. "Foundation Jupiter," Foundation Company; 1930, with Sun Oil Co. Ltd.; at present, sales engr., Diesel engine dept., Mussen's Ltd., Montreal, Que.

References: W. Lambert, C. M. McKergow, R. O. Sweezey, R. E. Chadwick, A. A. Bowman, C. Stephen.

GARNETT—CHARLES ERNEST, of 10344-132nd St., Edmonton, Alta., Born at Manchester, England, Apr. 21st, 1887; Educ., 1902-07, Manchester College of Technology; 1902-06, ap'tice, Manchester Electricity Works; 1906-07, improver, British Thomson Houston Co.; 1907-08, erector, British Westinghouse Co.; 1908-10, shift engr., Manchester Electricity Works; 1910-11, inspr.; 1911-14, erecting engr., Canadian Westinghouse Co.; 1914-17, Can. Engrs.; 1917, erecting engr., Canadian Westinghouse Co.; 1917-19, Can. Mach. Gun Corps; 1919 to date, engr., and at present, vice-president, in charge of all engrg. sales and installations, Gorman's Ltd., Edmonton, Alta. (including erection of Diesel power plants, refrigerator plants and other work of similar nature).

References: J. Garrett, R. J. Gibb, A. W. Haddow, H. J. MacLeod, C. A. Robb.

GUDMUNDSON—AUGUST EVERT, of 2070 McGill College Avenue, Montreal, Born at Calgary, Alta. Apr. 23rd, 1899; Educ., B.Sc. (E.E.), Univ. of Alta., 1929; May 1929-May 1930, testman, and May to Nov. 1930, on design, Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

References: H. J. MacLeod, C. A. Robb, W. E. Ross, W. M. Cruthers, R. S. L. Wilson.

HARRISON—ALBERT DEX, of 48 Dufferin Road, Hampstead, Montreal, Born at Sheffield, England, June 17th, 1881; Educ., 1897-1902, Sheffield Univ., passed final exams. in engrg., with distinction; A.M.Inst.C.E., 1910; 1897-1901, engrg. ap'tice, Hallersley & Davidson; 1904-05, dftsman., Davy Bros., Sheffield; 1905-08 and 1911-14, dftsman., Fraser & Chalmers, Erith, Kent; 1910-11, mech'l. supt., Pepperill Paper Corpn.; 1914-16, i/c drawing office, D. Adamson & Co.; 1916-19, design of food factories, Ministry of Food, London; 1919-25, i/c turbine design, W. H. Allen, Bedford; 1925-27, mech'l. engr., H. S. Taylor, M.E.I.C., Montreal; 1927 to date, Mech'l. engr., The Harland Engineering Co. Ltd., Montreal.

References: H. S. Taylor, F. A. Combe, E. A. Ryan, E. B. Wardle, D. Anderson, A. Laurie, J. J. McNiven.

HOLGATE—WILLIAM THOMAS, of 313 Maitland Avenue, Peterborough, Ont., Born at Innisfail, Alta., Feb. 18th, 1904; Educ., B.Sc. (E.E.), Univ. of Alta., 1930; Summer work: 1927, chainman, 1928, rodman, 1929, instr'man., on survey party, constrn. and mtce. work, Edmonton Divn., C.N.R.; June 1930 to date, students' test course, Can. Gen. Elec. Co., Peterborough, Ont.

References: R. W. Ross, L. DeW. Magie, A. B. Gates, W. M. Cruthers, W. E. Ross, V. S. Foster, B. L. Barns.

KILKENNY—JOHN MURRAY, of Kenogami, Que., Born at Unionville, Ont., Feb. 2nd, 1902; Educ., 1922-24, Univ. of Toronto. Passed intermediate exam. for admission as an O.L.S.; 1918-22, 1923 (summer), chainman, rodman, instr'man., Queenston-Chippawa development, H.E.P.C. of Ontario; 1924-27, chief of party on explorations and surveys in connection with hydro-electric projects on Ogoki, Muskoka and Ottawa Rivers, for H.E.P.C. of Ontario; 1927 (fall), topg'r., Dom. Topog'l. Surveys; 1928 to date, field engr. on constrn. of dam and power house, Chute à Caron development on Saguenay River, Alcoa Power Co. Ltd., Kenogami, Que.

References: C. P. Dunn, T. H. Hogg, W. Jackson, G. O. Vogan.

McWILLIAM—ARCHIBALD, of 51 Hall Avenue, Windsor, Ont., Born at Glasgow, Scotland, Mar. 26th, 1891; Educ., 1908-14, Royal Technical College, Glasgow; 1914-15 and 1918-19, dftsman., with Home, Morton Ker & Gibson, Civil Engrs., Glasgow, Scotland; 1915-18, with Royal Engrs. in Egypt, Palestine and France; 1919-20, struct'l. designer, P. & W. McClelland Ltd., Scotland; 1920-24, struct'l. checker, Canadian Bridge Co. Ltd; 1924-26, struct'l checker, Whitehead & Kales Ltd., Detroit, Mich.; 1926-27, struct'l. designer, Donaldson & Mier, Archts.; 1928-29, struct'l. checker, Canadian Bridge Co. Ltd.; 1929-30, struct'l. designer, Canadian Steel Corpn. Ltd.; 1930 to date, struct'l. designer, Canadian Bridge Co. Ltd., Walkerville, Ont.

References: G. V. Davies, A. E. West, R. A. Spencer, P. E. Adams, D. Stevens, A. B. Richardson, R. C. Leslie.

PALMER—FREDERICK ERNEST, of 153 Cartier Avenue, Quebec, Que., Born at London, England, Jan. 28th, 1905; Educ., 1919-23, mech. engrg. course, West Kensington Tech. Coll., London, England; 1923-25, with Bell Telephone Company, Montreal, inventory and engrg. dept., on rate revision inquiry. Estimating, dfting, surveying on all property and equipment; 1925-26, Victor Talking Machine Co., design of orthophonic principle gramophone and radio cabinets. Layout boiler-house-dry kiln (steam heated). Survey and layout of spur track from C.P.R. lines to factory; layout woodwork machy. and ventilating system; 1926 to date, Price Bros. & Co. Ltd., dftsman. on Riverbend mill extension, Kenogami mill, Donnacona board and paper mills; gen engrg., surveying, bldg. layout, foundations for machy., paper machy. layout, etc., also gen. constrn. engrg. on Price House; recently transferred to Riverbend mills as engrg. dftsman. (After Feb. 1st, 1921).

References: A. A. MacDiarmid, W. G. Mitchell, J. B. Gough, R. H. Farnsworth, H. Cimon.

POUNDER—THOMAS JAMES, of Yorkton, Sask., Born at Tacoma, Wash., U.S.A., July 9th, 1902; Educ., B.Sc. (Engrg.), Univ. of Man., 1928; Prelim. Cert. D.L.S.; 1927 (summer), instr'man., Manitoba Power Co., and Man. Dept. Highways; 1927 (Aug.-Dec.), transitman, on location, Man. Dept. Highways; 1928 to 1930, res. engr., Man. Dept. Highways; April 1930 to date, asst. dist. engr., Sask. Dept. Highways, Yorkton, Sask.

References: H. R. MacKenzie, E. P. Fetherstonhaugh, W. H. Hunt, E. W. M. James, C. K. Brown.

ROSS—HUGH CAMPBELL, of Toronto, Ont., Born at Toronto, Dec. 21st, 1905; Educ., B.A.Sc., Univ. of Toronto, 1929; 1926-28 (summers), rodman with Toronto Terminals Rly. Co.; 1929 to date, asst. testing engr., H.E.P.C. of Ontario, Toronto, Ont.

References: R. B. Young, A. J. Grant, E. L. Cousins, C. R. Young, R. E. Smythe.

THOMSON—WILLIAM JOHN, of 858 Burlington St., Hamilton, Ont., Born at Orillia, Ont., Oct. 7th, 1902; Educ., B.Sc., Queen's Univ., 1927; Student course with Bethlehem Steel Co.; 1924 (summer), Standard Chemical Co.; 1925 (summer), sampler, International Nickel Co.; 1926 (summer), dftsman., chemist, Can. Electric Castings; 1927 (fall), Bethlehem Steel Heater; 1928-29, Treadwell Yukon Mine, Bradley, chief sampler in charge of underground sampling, records, asst'g. with underground surveys, constrn. and mapping, also surface surveys; 1929-30, American Cyanamid Co., Niagara Falls, chemist on analysis of raw materials; at present, chemist, Abrasive Company of Canada, Hamilton, Ont.

References: L. M. Arkley, D. S, Ellis, A. Jackson, A. Macphail, L. T. Rutledge.

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

MORRISEY—THOMAS SYDNEY, of 3275 Cedar Avenue, Montreal, Que., Born at Saint John, N.B., Aug. 30th, 1890; Educ., Grad. with Honours, R.M.C., 1910; 1911, topog'r., Boston & Maine Rly.; 1911-13, junior engr., Montreal Harbour Comm.; 1913-14, principal asst. to A. D. Swan, M.E.I.C., in Montreal and Antofagasta, Chile; 1914-19, overseas, Lt.-Col., D.S.O.; 1924, field engr., Combustion Engineering Corporation, New York, during constrn. at Winnipeg Hydro-Electric Steam Stand-by plant; 1926-30, vice-president and gen. mgr., Combustion Engineering Corporation, Ltd., in full responsible charge of steam plant equipment installed with 39 pulverized fuel units and 150 stoker fired units in Canada. Work ranging from design and installn. of simple stokers to complete plant including boilers, furnaces, burners, mills, air heaters, fans, pumps, etc.; at present, vice-president, United Engineers and Constructors (Canada) Ltd., Montreal, Que. (*S. 1910, Jr. 1913, A.M. 1924.*)

References: C. H. Mitchell, C. J. Armstrong, T. W. Harvie, F. M. Gaudet, J. Stadler, H. O. Keay, F. O. White.

WANG—SIGMUND, of Hawkesbury, Ont., Born at Oslo, Norway, July 7th, 1887; Educ., Chem. Engr., Coll. of Christiana; 1910-11, Univ. of Darmstadt, Germany; 3 years' ap'ticeship, Norwegian sulphite mill; 1912-14, chemist, Oxford Paper Co., Rumford, Me.; 1914-16, chemist, Riordon Pulp & Paper Company, and from 1916 to date, manager of laboratories, now Canadian International Paper Company, Hawkesbury, Ont. (*A.M. 1919.*)

References: C. B. Thorne, W. M. Ketchen, L. S. Dixon, B. Grav, A. K. Grimmer.

WOODYATT—JAMES BLAIN, of 3197 Westmount Blvd., Westmount, Que., Born at Brantford, Ont., July 2nd, 1886; Educ., B.Sc., McGill Univ., 1907; 1904, chainman, Niagara & Welland Power Co.; 1905, topog'r., Toronto and Hamilton Rly.; 1906-08, ap'tice, Can. Westinghouse Co.; 1908-09, investigation of ice conditions in Gulf and River St. Lawrence under Dr. Barnes, for Dom. Govt.; 1909-10, sales engr., Allis-Chalmers-Bullock Co.; 1910-13, supt., Sherbrooke Rly. & Power Co.; 1913 to date, with Southern Canada Power Co. as follows: 1913-16, gen. supt., 1916-20, gen. mgr., 1920-25, vice-pres. and gen. mgr., and 1925 to date, president and gen. mgr., and at present vice-president and gen. mgr., Power Corporation of Canada, Ltd., Montreal, Que. (*S. 1907, A. M. 1916.*)

References: R. J. Durley, J. C. Smith, C. V. Christie, J. M. Robertson, K. B. Thornton, O. O. Lefebvre, G. G. Gale.

FOR TRANSFER FROM THE CLASS OF JUNIOR TO A HIGHER CLASS

COMEAU—JULES, of 6660-a St. Denis St., Montreal, Que., Born at Montreal, March 16th, 1897; Educ., C.E. Ecole Polytech., Montreal, 1919; 1918, instr'man and dftsman., Price Bros. paper mill at Kenogami; 1919, Quebec Govt. Bridge Dept., asst. engr., surveys, designings and estimates for steel and concrete bridges; 1920, Chute aux Galets power development for Price Bros. i/c lines and grades, field works; 1921-29, asst. engr. for lines and levels, public works, Technical Service, City of Montreal, and from 1929 to date, asst. to engr. in charge of Technical Service, being in charge of lines and levels dept. (*S. 1918, Jr. 1921.*)

References: G. R. MacLeod, J. G. Caron, F. C. Laberge, A. Frigon, H. Cimon, H. A. Terreault, J. A. Lalonde, L. A. Ste. Marie.

FOWNES—FRED J., of 4549 Decarie Blvd., Montreal, Que., Born at Meadow, N.B., Nov. 9th, 1893; Educ., I.C.S.; 1912-15, rodman, dftsman., instr'man., C.N.R.; 1915-18, artillery observer, overseas; 1919-24, engr. in charge of surveys, constrn. of bridges, bldgs., sidings, etc., C.N.R., Moncton, N.B.; 1925-26, engr. in charge of drainage work at Sarasota, Florida; 1927 to date, engr. in charge of surveys, constrn. of roads, bldgs., bridges, etc., Canadian International Paper Co., Montreal, Que. (*Jr. 1921.*)

References: J. A. H. Henderson, E. G. Evans, F. O. Condon, W. M. MacKenzie, H. L. Currie, H. B. Titus.

HEATLEY—A. HAROLD, of Kitchener, Ont., Born at Brampton, Ont., Aug. 29th, 1897; Educ., B.A.Sc., 1922, M.A. 1923, Univ. of Toronto; 1923-26, chemist, research and production, Raessler & Hasslacher Chemical Co., Niagara Falls, N.Y.; 1926-27, various temporary positions; 1927 to date, chemist, research and factory control, John Walter & Sons, Limited, Kitchener, Ont. (*S. 1921, Jr. 1926.*)

References: W. A. Campbell, R. E. Smythe, W. D. Walcott, E. A. Allcut, W. H. Breithaupt.

JICKLING—ROBERT WILLIAM, of 16 Kenora Apts., Regina, Sask., Born at Morden, Man., Mar. 8th, 1897; Educ., B.Sc. (E.E.), Univ. of Man., 1920; 1919, topog'r., C.P.R. surveys; 1920-21, timekeeper, Pointe du Bois, Man.; 1920 to 1930, with the Winnipeg Hydro-Electric System, from Nov. 1921 in distribution dept., Winnipeg, testing distribution transformers for loading, preparation of complete set of feeder maps of the distribution system, investigation and correction of customers' complaints, etc.; in July 1926, appointed asst. to the distribution engr., responsible for office routine; May 1928 promoted to position of distribution engr., supervised and responsible for all estimates, re-arrangements of overhead and underground distribution systems due to overloaded substations, feeders, transformers, etc., etc.; April 1930 to date, transmission and distribution engr., with Saskatchewan Power Commission, responsible for standard specifications and drawings of Commission, layout of transmission line and distribution layouts for the towns, preparation of estimates covering constrn. and distribution changes, etc.

References: L. A. Thornton, S. R. Parker, R. H. Andrews, J. W. Sanger, C. A. Clendening, E. P. Fetherstonhaugh, N. M. Hall, E. V. Caton.

MILNE—OSWALD, of London, England, Born at South Shields, England, Jan. 13th, 1900; Educ., 1916-19, Barrow Technical College (4th year pass). Lectures at McGill and Columbia Univs., I.C.S. Diploma, Marine Engr.; 1916-19, premium engrg. ap'tice, Vickers Ltd., England; 1919-20, marine dftsman., British American Shipbldg. Co., Welland, Ont.; 1920-21, mtce. dftsman., Can. Steel Foundries, Welland, Ont.; 1921-22, chief dftsman., P. Payette & Co., Penetang, Ont.; 1922-23, designer, Waterous Engrg. Works, Brantford, Ont.; 1923-27, dftsman., design and estimating, Canadian Vickers, Ltd., Montreal; 1928-29, in charge of marine dept., Peabody Engineering Corpn., New York, N.Y., including charge of pioneer work on pulverized coal for ships and operation at sea; 1929 to date, chief engr., Peabody Ltd., London, England, in charge of manufacture, sales and service in Great Britain and Europe of equipment of Peabody Engineering Corpn., of New York. (*S. 1922, Jr. 1926.*)

References: R. Ramsay, G. Agar, P. F. Stokes, C. K. McLeod, M. W. Booth, F. W. Pennock, S. W. F. Johnston, F. Gaskill.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

BRIGGS—HERBERT LEE, Birkenhead Apts., Winnipeg, Man., Born at Killarney, Man., July 5th, 1903; Educ., B.Sc. (E.E.), Univ. of Man., 1928; 1926, instr'man., Man. Prov. Good Roads Dept.; 1927, elec. substation design and detailing, City of Winnipeg Hydro-Electric System; 1928, elect'l. design, Slave Falls-Winnipeg 132 k.v. transmission lines, and 1929 to date, relay engr. and asst. to chief operator for system, City of Winnipeg Hydro-Electric System.

References: J. W. Sanger, E. P. Fetherstonhaugh, N. M. Hall, C. T. Barnes, R. H. Andrews.

MacINNES—DONALD ALEXANDER, of 1625 Pine Avenue West, Montreal, Que., Born at Montreal, Nov. 7th, 1901; Educ., Diploma, R.M.C., 1921; B.Sc., McGill Univ., 1923; 1924 to date, with the Lake of the Woods Milling Company as follows: 1924-25, supervision of repairs to mach'y., at flour mills, at Keewatin; 1925, tests and analyses, chem. lab., Keewatin; 1925-26, grading and trading, grain dept., Winnipeg; 1926-30, sales and advertising, Montreal, and at present advertising manager, Montreal. (*S. 1922.*)

References: G. H. Duggan, J. M. R. Fairbairn, E. G. M. Cape, C. M. McKergow, A. R. Roberts, F. P. Shearwood.

Claude's Tropical-Seas Power Plant

There are men to whom Kipling's qualification applies most strikingly—

If you can trust your faith when all men doubt you,
Yet make allowance for their doubting too....
You'll own the earth, and what is more,
You'll be a man, my son.

Claude's life is full of instances where he did things that everyone considered to be next to impossible. The creation of the dissolved-acetylene industry was the first of his important achievements. Next came a new method of cryogenation by means of which gases such as oxygen and nitrogen were liquefied by an apparatus in which the energy of the gases was directly consumed in driving a piston. This was followed by the development of a method of producing synthetic ammonia by the use of enormous pressures, by his invention of the neon light, etc.

In all of this work Claude was never afraid of resorting to means beyond anything previously known or considered permissible. His new scheme of producing power by utilizing the comparatively slight difference between the temperature of the surface water of tropical seas and that of the water obtained from a considerable depth belongs to the same category of doing something in a way that no one dared attempt before on a sufficiently large scale.

That the process used by Claude can produce power is beyond doubt. In the first place, the principles lying at the foundation of the Claude development are well-known and recognized, and in the second place, Claude has actually generated power both in his experimental plant in France and in the larger plant on the Cuban coast. The only question that still remains to be solved is whether or not this power can be produced economically—in other words, whether the plant will pay on its investment. From this point of view quite elaborate calculations have been offered showing that it will not pay. The following, however, has to be borne in mind. Claude in addition to being an inventor is an engineer with an excellent mathematical and physical training. He is assisted by Boucherot, a man of recognized engineering ability. The elementary calculations which have been cited against the project are of a kind which Claude himself has certainly made, simply because he could not have laid out his units without some such previous calculations. If, on the face of these he decided to go ahead with an experiment, the cost of which will considerably exceed a million dollars, and when that million has come, not from the sale of stock to the general public, but from the proceeds of his own previous achievements, it behooves the engineering world to refrain from expressing doubt too actively. It is just the ability to see a possible way when every one else says there is no way at all, that distinguishes men like Claude who succeed from those who prove by arithmetical calculation that success is impossible.

Should Claude succeed, he may lay the foundation of an industrial and social revolution in tropical countries. It was only through the application of heat to houses that the temperate and cold zones became habitable, and we know now that with cheap power available the question of cooling houses is no more complicated than that of heating them—and cooled houses would make tropical countries freely accessible to extensive settlement by the white races. If Claude can provide cheap power without resorting to fuel, absent in most cases in the tropics, he may do for those regions what Prometheus of the legend did for the rest of the world.

—*Mechanical Engineering.*

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HEATING AND VENTILATING ENGINEER, for investigating and re-designing heating and ventilating system in industrial plant. Temporary position. Apply at once to Box No. 654-V.

MANAGING ENGINEER for construction company in Ontario. Executive business ability of prime importance and prepared to make some investment. Should be energetic young man of good education. University graduate desirable but not imperative. Apply to Box No. 666-V.

PLANT MAINTENANCE ENGINEER, technically trained as mechanical engineer, with at least four years experience in actual charge of gangs. English, speaking French fluently, about thirty years of age. Location, province of Quebec. Apply to Box No. 667-V.

DESIGNING ENGINEER, one familiar with concrete and steel design. Must have had considerable practical experience and also must be capable of meeting public in sales capacity. Permanent position. State salary expected and full details of qualifications. Apply to Box No. 671-V.

CIVIL ENGINEER, with sound technical education, preferably college graduate, with at least ten years experience on general construction work, five years of which has been spent with contractors on road construction as asst. and supt. Apply to Box No. 672-V.

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CIVIL ENGINEER, A.M.E.I.C., B.A.Sc. and C.E., University of Toronto, with twenty years experience, is open for engagement. Three years railroad construction, one year lake drainage and dam construction, nine years municipal engineering, including pavement and bridges, two years town management, one year paving contracting, and one year resident engineer of highway pavement construction. At present in Maritime Provinces. Apply to Box No. 216-W.

ELECTRICAL ENGINEER, B.Sc., McGill 1926. Five years experience in the design of switchboards, layouts and wiring diagrams. Considerable experience in high and low tension switchgear design. Fifteen months experience in switchboard estimating. At present employed; available on short notice. Correspondence wanted. Apply to Box No. 247-W.

CIVIL ENGINEER, A.M.E.I.C., of long field experience on reinforced concrete, water purification, steel buildings and bridges, seeks employment on supervision or inspection. Temporary or otherwise. Apply to Box No. 277-W.

CIVIL ENGINEER, A.M.E.I.C., Canadian, R.P.E., Nova Scotia, 21 years engineering experience, both field and office, in railway, highways, foundations, concrete structures, water power and conservation, electric transmission lines, etc., experience comprising both surveys and construction, desires employment. Single. Will go anywhere. Working knowledge of French and Spanish. Available immediately. Apply to Box No. 327-W.

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Situations Wanted

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CIVIL ENGINEER, A.M.E.I.C., R.P.E. (Ont.), graduate. Eighteen years experience in survey and construction, railway, hydro-electric and buildings. Experience comprises both office and outside work. Desires responsible position, would consider position with commercial or manufacturing firm. Available immediately. Apply to Box No. 425-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate of Nova Scotia Tech. with experience as plane table topographer, instrumentman and draughtsman and particularly interested in hydro-electric power development and reinforced concrete design, desires position. Willing to go to foreign fields. Available at a few weeks notice. Apply to Box No. 431-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (McGill Univ. '27), age 26. Fifteen months outside plant engineering with large public utility. Twenty months' sales engineering experience with electrical manufacturing company. Available on reasonable notice. Apply to Box No. 463-W.

ELECTRICAL ENGINEER, B.Sc., (McGill), Jr.E.I.C., age 28, graduate Canadian General Electric Company test course, with two years experience in the design of induction motors and direct current machines. Previous experience includes electrical installation in large paper mill, and assistant to engineer in charge of small utilities company. Married. Location immaterial. Apply to Box No. 466-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate. Experience as instrumentman on city and railroad construction, desires to enter structural or hydraulic field. Available at once. Will go anywhere. Apply to Box No. 467-W.

CIVIL ENGINEER, experienced in road construction, mine surveying, transmission line survey and construction; paper mill construction; age 27. Available on short notice. Apply to Box No. 468-W.

CIVIL ENGINEER, A.M.E.I.C., age 39, with wide experience on design and construction of reinforced concrete structures, desires position. Apply to Box No. 475-W.

DESIGNING ENGINEER, A.M.E.I.C., P.E.Q., with extensive experience in design and construction of power plants, industrial buildings and hydraulic structures, desires position as designing engineer or resident engineer on construction. Apply to Box No. 492-W.

ELECTRICAL ENGINEER, B.A.Sc. (Univ. Toronto '29), S.E.I.C., Can. Gen. Elec. Co. test course. Six months experience in the design of induction motors. Experience in electrical maintenance. Apply to Box No. 494-W.

MANAGING CIVIL ENGINEER, college graduate, A.M.E.I.C., C.P.E.Q., 18 years com-

Situations Wanted

prehensive experience in all lines of architectural engineering and contracting as designing, detailing, quantity surveying, cost estimating, superintending and general business management, desires to change and wants connection with Montreal firm, preferably with chance to share in business. At present in responsible position as engineer in charge and chief estimator, but available on few weeks notice. Apply to Box No. 495-W.

STRUCTURAL ENGINEER, 20 years experience in the design and construction of all types of steel and reinforced concrete buildings. Available shortly. Location Toronto. Apply to Box No. 501-W.

WEST INDIES, Engineer, A.M.E.I.C., etc. Experience with engineers and contractors, railway, harbour and concrete construction, desires position in West Indies. Apply to Box No. 518-W.

MECHANICAL ENGINEER, Jr. E.I.C., B.Sc., '26. Ten months experience in pulp and paper steam control. Four years experience in detail design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

CIVIL ENGINEER, B.A.Sc., '29, with experience in supervision of construction and general office engineering, desires permanent position with contractor or engineer. Available at once. Apply to Box No. 524-W.

MANAGER FOR PUBLIC UTILITIES COMPANY, OR INDUSTRIAL PLANT, Mechanical and electrical engineer with wide experience in investigations, reorganizing and improving operating conditions to reduce production costs and increase earnings. Apply to Box No. 525-W.

MECHANICAL, CONSTRUCTION, AND DESIGNING ENGINEER, with special training in hydro-electric power development, underground steam distribution systems, and the operation of large electrical machinery. Active work desired. Apply to Box No. 528-W.

SALES REPRESENTATIVE, civil and mechanical engineer, with office in Toronto, desires to hear from manufacturers of high-grade building materials or industrial equipment, with the view of representing their interests in the promotion and effecting of sales to architects, engineers and contractors. Excellent connection. Apply to Box No. 529-W.

For Sale

One Troughton and Simms theodolite with solar attachments and stiff legged tripod, $70.00; One James Foster Dumpy level with stiff legged tripod, $35.00; Two pairs field glasses, $3.00 each. Apply to Box No. 9-S.

Soft Solders

It is not always realized that of all the common alloys engineers must buy, solders are by far the most costly, and until recently it was no exaggeration to say that all too little work had been done to obtain an accurate knowledge of their properties. Of late years, however, much has been done to fill this gap in knowledge, and in particular the British Non-Ferrous Metals Research Association instituted in 1922 a comprehensive investigation into the jointing of metals. This investigation, which was planned and started in that year by Mr. S. J. Nightingale, included not only soft solders, but also brazing, silver soldering and some aspects of autogenous fusion. The bulk of the experimental work, however, was done on soft solders, partly because soft solder, while easier to work than hard solder, could serve equally well for the determination of principles common to both, but also because in its application to soldered joints it presented an almost untouched field. By the courtesy of Dr. R. H. Hutton, the Association's Director of Research, we are able to give an account of the report on soft solders and soldered joints which was lately issued to the members of the Association. An edition intended for use by practical men has also been prepared.

The base of all soft solders is a series of alloys of lead and tin. The freezing points of these metals when pure and molten are, respectively, 327 degrees C. and 232 degrees C., and the minimum freezing point of any of their alloys is 183 degrees C. At this temperature the eutectic alloy of about 63 per cent tin: 37 per cent lead, passes directly from the liquid to the solid condition, while the other alloys, which begin to freeze at higher temperatures in proportion to their composition, pass gradually from the liquid to the solid state by freezing out solid particles of alloy containing lead or tin as the case may be in excess of the eutectic ratio, until solidification is complete at the eutectic temperature. In the solidification of any of the alloys except the eutectic, there is therefore a plastic range during which the metal is easy to manipulate, and, as Mr. Nightingale points out, plumbers and other craftsmen who use solders have shown an extraordinary acumen in selecting from the infinite number of possible alloys of lead and tin, those few that were best suited to their purpose, and became what he calls the hereditary solders.

Long ago, however, it was found that the properties of solders could be modified by the addition of small quantities of antimony. Whether the modification was beneficial or mischievous appeared to turn very closely on the percentage used, but for the last half century almost all soft solders have contained some of it. In 1925, the British Engineering Standards Association standardized nine different grades of solder for as many different kinds of work, ranging from those, such as steel tube joints, that required a low melting point and used slightly more tin than corresponded with the eutectic composition, down to dipping baths, containing less than some 30 per cent of tin. In each of these alloys antimony was either prescribed or permitted, and it is with these alloys that the present report deals. In an introductory chapter, after showing the equilibrium diagram of the binary (lead and tin) and ternary (lead, tin and antimony) alloys in question, and pointing out their consequences, it indicates the position of the standard solders in the range of possible alloys, and reproduces the analytical limits for each grade defined in the 1925 specification. The grades which throughout the report are used generally for illustrating the application of the results obtained are the four known as A to D, with minimum tin contents ranging from 64 per cent to 29 per cent and minimum antimony from 0 per cent to 2.50 per cent.—*Engineering.*

Combustion Engineering Corporation, 260 Madison avenue, New York, N.Y., has published a new and revised edition of their General Condensed catalogue (GC-6). This 16-page catalogue illustrates and briefly describes the fuel burning and steam-generating equipment manufactured by this company. A complete list of products is included. Individual catalogues are also available on all Combustion Engineering products, and will be sent upon request.

The United States as an Engineering Market

The ties of blood between the United Kingdom and the United States of America are not now, of course, what they were at one time, but the blood is still there, while the common language and almost common weights and measures are appreciable advantages. As a competitor for the trade of the United States, Canada has advantages which we do not possess, but no foreign country has any racial or political advantage over the United Kingdom. Where then do we stand in relation to the American market?

The American engineering market is, without question, the largest and most important of the world. It is not merely that the population of the United States now exceeds 120,000,000, but the people, or a very large proportion at any rate, are the most highly "mechanized" people of the world; that is to say, they use machinery more than any other people. They use it not only in their manufacturing and agricultural industries, but also in their counting houses and in their homes to an extent of which few people on this side can have any conception. This market is not only the greatest of the world, but it is supplied from home sources to a greater extent than, probably, any other corresponding market. Hence, judged by the imports into the States of the engineering commodities with which we are here concerned, it appears only a small market. The grand total for 1928, the latest year for which the details are available, amounted to no more than 13,827,000*l.*; and there are many people who will be surprised that it amounted to so much. In the same year, the corresponding imports into the United Kingdom amounted to over 55,000,000*l.*; even the corresponding imports into British South Africa were double the value of those into the United States of America. This relatively small value of the American imports is due, of course, to the fact that America is one of the most highly protected countries of the world; her "tariff wall" is almost unclimbable. Still the market, as represented by imports, is not a negligible market; it will be noted that of the total of 13,800,000*l.*, iron and steel and manufactures of iron and steel and machinery account for 12,500,000*l.* The other two groups of commodities, electrical and vehicles, make but a small contribution to the total, the duties imposed upon these two classes being almost prohibitive.

Fiscal policy does not account for the fact that out of 354,000*l.* of cast-iron pipes imported by America in 1928 we contributed only 1,244*l.*, while France supplied 280,500*l.* and Belgium 63,000*l.* In other pipes and tubes, we make a rather better showing, with 127,000*l.* out of a total of 847,000*l.*, but even here Sweden beats us with 194,000*l.*, while Germany supplies 365,000*l.*, or 43 per cent. of the total. In round wire we supplied 72 per cent. of the total, but in flat wire and steel strip, out of a total of 363,755*l.*, Sweden supplied 247,850*l.*, while we supplied the rest.

Germany has long been in front of us in America with machinery, and, unfortunately, there are no signs of any recovery on our part. It will probably surprise many people to find that with all her great agricultural experience and her engineering resources, America imports a certain amount of agricultural machinery; she admits agricultural machinery free of duty. Naturally, Canada takes much the larger part of this particular trade, but the United Kingdom comes next, though a very long way behind.

In general machinery we are beaten in every class except textile. America's imports of textile machinery (power) in 1928 amounted to 483,000*l.*, the share of the United Kingdom being 248,000*l.*; of Germany, 132,000*l.*, and of France, 119,000*l.* While we thus had much the larger share of this business as a whole, Germany, for the first time, supplied in this year more cotton machinery to the States than we supplied. In embroidery machinery, the United Kingdom supplied 37,000*l.* out of a total of 38,200*l.*, but in hosiery-knitting machinery, Germany supplied practically the whole of a total of 518,800*l.*, the share of the United Kingdom being 500*l.*—*Engineering.*

SUN LIFE ASSURANCE COMPANY OF CANADA

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MONTREAL

January thirtieth
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The President and Members,

The Engineering Institute of Canada.

Dear Sirs:-

I have much pleasure in extending to you a cordial invitation to visit our new Head Office Building which stands as a monument to the skill of the Engineers, Architects and Artisans of our great Dominion.

Yours faithfully,

T. B. Macaulay

President.

THE

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The Alexander Power Development on the Nipigon River

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SUMMARY—The Alexander hydro-electric development came into service in October, 1930, and is the second constructed on the Nipigon river by the Hydro-Electric Power Commission of Ontario. It has a capacity of 54,000 h.p., and, with the existing plant at Cameron falls, supplies the cities of Fort William and Port Arthur, distant about 80 miles. Interesting features in this project include unusual variations in design and construction necessitated by foundation conditions and materials available, the dewatering of the dam site by a diversion channel, the method of closure of the diversion channel, the use of the diversion channel as a power canal in the completed plant, and the provision for distant operation of the plant by supervisory control.

The main dam is of the earth-filled type, this design being adopted owing to the presence of suitable and abundant material and the resulting lower cost. Its maximum height is about 90 feet.

The spillwall has a capacity of 30,000 cubic feet per second, and special construction methods were adopted at the junction of concrete and earth sections. Adequate fishways and log-slides have been provided. The three turbine units, each of 18,000 h.p., are Francis turbines of moderate specific speed, and the generators are of welded structural steel design, each rated at 15,000 kv.-a., 12,000-volt, 3-phase, 60-cycle, 100 r.p.m. Novel arrangements are made for synchronizing.

Power is transmitted by three 110-kv. lines connected direct to the existing transmission lines from the Nipigon station to Port Arthur. The entire switching at the Alexander development will eventually be handled by remote control. The relay protection for the Alexander station consists chiefly of zone protective systems, and special care has been taken to promote system stability.

The Alexander hydro-electric development, on the Nipigon river, came into service in October, 1930. This development is the second constructed on this river by the Hydro-Electric Power Commission of Ontario and, like the first, supplies power to the Commission's Thunder Bay system, the principal market for power being in and near the cities of Fort William and Port Arthur, distant about 80 miles from the generating stations. The new development has a capacity of 54,000 h.p., and the original plant at Cameron Falls 75,000 h.p.

There are certain salient features of this development that warrant the preparation of a descriptive paper thereon. Among these might be mentioned: the unusual variations in design and construction necessitated by the foundation conditions and materials which varied greatly and frequently in adjacent areas; the dewatering of the dam site by a diversion channel to which the configuration of the power site readily lent itself; the method by which the closure of the diversion channel was effected on the completion of construction work; the use of the diversion channel as a power canal in the completed plant; and the provision for operation of the plant by supervisory control from the Nipigon station. In addition to these features, there are a number of other items of interest to which, along with those mentioned, more detailed attention will be given later.

Historical and Geographical

In a description of the Alexander power development, it is desirable that some geographical and historical background be given, so that the reader may better visualize the situation and grasp the significance of the various steps taken. The Thunder Bay system of the Hydro-Electric Power Commission comprises the district in and around Fort William and Port Arthur, and the village of Nipigon. The power for this system is developed by the Commission at its plants on the Nipigon river, that is to say, the Nipigon and Alexander developments, whence it is transmitted by 110,000-volt lines to the Port Arthur and Fort William transformer stations. A map of the district extending from Lake Nipigon to Fort William is shown in Fig. 1.

The Nipigon river from Lake Nipigon to Lake Superior has a total fall of approximately 250 feet, varying with the relative stages of water level in the two lakes. Of this head, the Nipigon development at Cameron falls utilizes 78 feet, and the Alexander power development 60 feet. From the tailrace of the latter plant to the mouth of the river, a distance of 8 miles, there is a normal drop of about 4 feet, which cannot be economically utilized for the development of power. The remaining head of somewhat over 100 feet, between the headwater level of the Cameron falls plant and Lake Nipigon, is as yet undeveloped.

In 1926 the Commission built a control dam at Virgin falls at the outlet of Lake Nipigon, creating thereby the largest storage reservoir in existence, having a capacity of 6,700,000 acre-feet. This control dam consists of a concrete pier and stop-log structure across the main channel, and three concrete sluiceways, also stop-log controlled, in a diversion channel on the left bank. The latter channel, entirely in rock, was used to handle the discharge of the river during construction of the dam in the main channel. The sluiceways in the main and diversion channels have a combined discharge capacity of 10,000 cubic feet per second at minimum regulated lake level.

The catchment area of the Nipigon river above Virgin falls is 9,000 square miles, of which Lake Nipigon comprises 1,700 square miles. The natural run-off in the period of record has averaged 7,600 cubic feet per second, and the storage facilities are such that the whole of this may be made available for generation of power.

The Nipigon development has an installation of six 12,500 h.p. units, of which the first two were installed in 1919, the second two in 1924, and the last two in 1926.

Concurrently with the placing of the last two units in operation, the regulating dam at Virgin falls was constructed.

GENERAL PLAN OF DEVELOPMENT

The growth of load on the system and the prospective load, following the completion of the Cameron falls plant, made it necessary for the Commission to proceed with plans for additional generating capacity. A study of the sites available indicated the advisability of choosing the site at Alexander Landing, about one and one-half miles downstream from Cameron falls. At this location a number of alternative layouts were studied, and estimates prepared, as a result of which the arrangement shown in Fig. 2 was adopted as the most suitable to the site, and at the same time the most economical.

It will be noted that at the power site, two sharp bends in the river, with the resulting backwater pools and narrow peninsulas, form an ideal location for the development of power. By damming a narrow section of the river and diverting the water through a short diversion canal across the adjoining peninsula, it was possible to isolate the two main construction operations of dam and power house with considerable attendant advantage. The diversion canal for carrying the river flow past both structures during the construction period was excavated through the peninsula near the power house. The layout also afforded an opportunity to locate the spillwall well away from the earth dam and from the entrance to the power house. Relatively low dam sections join the spillwall with the main dam and form a cut-off between the power house and the high ground to the west of the plant.

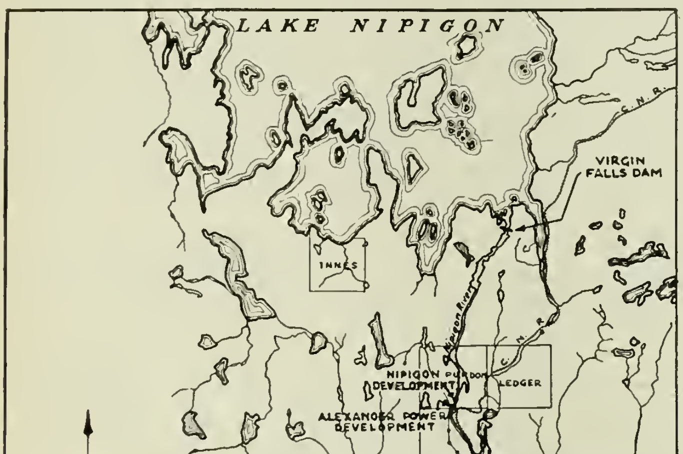


Fig. 1—Map of the District from Lake Nipigon to Fort William to show Location of Power Developments and Transmission Line.

In the preliminary studies, layouts were made in which the power house and dams were located in all the feasible locations available at the site. Comparative estimates of the cost of each layout were prepared, and the most economical arrangement was selected. In considering the economics of the problem, the practical difficulties to be encountered in construction were carefully studied.

In the general plan of the development it will be seen that the main dam extends from the high ground on the east bank of the river to the peninsula upon which the spillway, power house and other structures are located. The earth fill continues for about 400 feet, with a height of only 10 feet across the level ground at the easterly extremity of this peninsula to a junction with a concrete bulkhead section which in turn joined the spillwall. From this junction the spillwall continues for about 500 feet, where it crosses the diversion canal, immediately beyond which are the log slide, fishway and power house. A short concrete bulkhead section unites the northwesterly end of the power house with the auxiliary earth dam, which, although never more than 23 feet high, is 1,800 feet long.

SERVICE CONNECTIONS TO THE CANADIAN NATIONAL RAILWAYS

While the main line of the Canadian National Railways passes a short distance from the easterly end of the main dam on the opposite side of the river from the generating station, yet, in view of the existing connection from that railway to the Nipigon power house, less than a mile away, it seemed advisable to connect the Nipigon station with the Alexander station for convenience in the operation of both plants. Thus, the latter station has its service from the Canadian National Railways by way of Cameron falls.

This involved building two standard type plate girder bridges, designed for E-40 loading plus impact; the one over the Nipigon river a short distance below Cameron falls, and the second over Fraser creek, a small tributary flowing through a wide deep valley not far above the Alexander development.

The location proved of material value during the construction period, in giving access to sand and gravel pits, through which the line passed, and to the old yards of the Cameron falls development, as well as the stone quarry, near the latter plant, from which crushed stone for concrete aggregate and track ballast was obtained.

For permanent service to the new station, spurs have been built at two levels; one into the station at generator floor level, and the second at the level of headworks deck, giving access in the latter case for a locomotive crane to be used for handling head gates, racks, etc.

From the track at the lower level, a short spur serves the transformer station, and from this point to the power house the track is supported on concrete to guard against settlement when transferring the transformers into the power house for maintenance and repair work. The upper track where it joins the headworks is carried by a short girder span from the adjacent rock outcrop to the headworks deck. The maximum grade for the lower track does not exceed 2.5 per cent when corrected for curvature, and that for the upper line is less than 2.5 per cent with correction.

Permanent track throughout is built of 80 and 85 pound rail, with gravel and crushed stone ballast, with the exception of that portion from transformer station to power house referred to above.

Fig. 2—Plan showing Location of Dams and Power House in relation to the Nipigon Development and Transmission Line.

Dewatering by Means of Diversion Channel

The decision to build the main dam of earth, referred to later, necessitated the diversion of the river entirely from the dam site.

Running across the river at the location chosen for the dam, and approximately parallel to its axis, is a relatively narrow ridge of rock. Through a depression or fault in this barrier, the river has in former ages cut its way, and immediately below the dam site turns through almost 180 degrees, creating a narrow peninsula composed almost entirely of rock. This topography at once suggested an efficient method of dewatering, by diverting the river in an open channel cut across the peninsula upstream from the dam site. Here again, the natural conditions in the river, about 600 feet above the dam, were very favourable for a cofferdam location. A low flat point of land projects into the river, where the width of the stream is considerably reduced, creating conditions in which a large part of the cofferdam could be built on dry ground, and requiring a minimum of under-water work.

With the power house located at the downstream end of the cut across the point, the channel for diversion could be utilized for the greater part as the permanent feeder for the development. Thus the actual charges for dewatering were contained in the cost of the cofferdam and the additional depth of diversion channel, which depth was contingent on the height of the cofferdam; the economical balance in costs giving the relative heights and dimensions. The dewatering channel proper as it nears the headworks is diverted away from the feeder canal to the east, and passes through the line of the spillwall in a narrow rock cut. The closure works were located here, and the concrete for this structure ultimately formed the base for that section of the spillwall.

The discharge area actually required for diversion purposes was that necessary to provide for the water passing through the Nipigon station under full load, as the flood stages of run-off for the watershed may, with the flow required for that station, be fully conserved by the vast storage provided in Lake Nipigon by the regulating dam at Virgin falls at the outlet to the lake. Additional discharge capacity was, however, provided for unforeseen conditions of flow.

Where the river was diverted through the spillwall, two water passages were built, each 18 feet wide and 27 feet high, giving ample area with the water at the cofferdam safely below the top to take care of any reasonable contingency in river flow. (Fig. 4.) For closure, each of these areas was provided with checks to receive steel gates in three sections, each 10 feet 4 inches high.

Main Dam

The most suitable site for the main dam was at a point on the river about one and a half miles below the Nipigon development, where the flow passed in a narrow channel flanked by rock on either side. As previously stated, the river made a pronounced bend in its course immediately below the site, creating a point or peninsula, which provides a favourable location for the diversion channel and power canal.

While the sides of the channel at the site of the dam are of exposed rock formation, borings made in the river bed indicated that there was no rock at economic depth for a gravity concrete bulkhead section for the greater part of the length of the dam. This condition narrowed the choice of the type of dam to one of either a reinforced concrete bulkhead or earth section. The presence of suitable and abundant materials for earth fill at elevations well above

Fig. 3—Aerial View of Development under Construction. Nipigon Power House in Background.
(*Photo by Royal Canadian Air Force.*)

the top of the dam on the east side of the river indicated that the probable unit cost for an earth dam would be relatively less than usual, and this, with other considerations, proved the deciding factor in the choice for an earth fill dam.

A typical boring in the bed of the river at the site selected showed at the top, a layer of boulders underlain by a deep stratum of coarse sand, and thence alternate layers of boulders and sand. Soil bearing tests made at a number of points on the proposed site indicated that the bearing value of the soil was well within the margin of safe practice.

The rock walls at the shore ends of the dam were of a naturally rough formation, which, when cleared of all loose and weathered matter, revealed a vertically serrated surface providing a suitable seal for the core and abutments. These rock sides of the channel extended, the one on the east side above the high level of headwater, and the one on the west side almost to normal operating level. A typical section of the dam in Fig. 5 shows excavation for the core and that part of the base upstream from the core to be taken down deep enough to include the deposit of boulders, coarse sand and river silt; this material was used for making the upstream toe of the dam.

Before any earth fill was placed, a heavy rock dump was made forming the toe for the downstream side. This material was excavated from the rock section of the diversion channel and power house substructure. The facts that large quantities of rock had to be disposed of, and that the downstream toe of the dam proved to be quite suitable and economical as a disposal area, made it possible to provide a much more substantial support for the fill on the downstream side than it is usually economical to provide. At the same time, this rock fill provides ample drainage for any seepage through the core or the foundation material underneath the core.

The section chosen had a crest width of 20 feet with downstream slopes of 2.5 to 1 and 2 to 1, and upstream slopes 3 to 1 and 5 to 1. Its maximum height as built is about 90 feet. As the base of the dam is below tailwater level, extra precautions were taken to protect the toes of the slopes. (Fig. 5.)

The section as built is much larger than designed, this being brought about largely by the necessity of keeping dump tracks safely back from the edge of the segregation pool to prevent sliding. The tendency to slide was in turn caused by the very rapid rate of placing fill. The open season for this latitude is short, and the rate of fill was therefore necessarily accelerated.

The total yardage of the dam proper, exclusive of clay blanket upstream, is about 530,000 cubic yards, and from the time the season opened in May up to the end of August, there were 443,000 cubic yards placed in the dam, the rate being greatest in June, when about 159,000 cubic yards were placed. It will be of interest to note that the shrinkage in volume of material as between pit measurement and place measurement was less than 5 per cent.

The nature of the river bed upstream called for a protecting blanket of clay. This was sluiced in from materials on either side of the river to a depth ranging from 4 to 6 feet and extending upstream about 400 or 500 feet to the main cofferdam.

Construction Methods

The dam was built by the "semi-hydraulic" process, the materials being taken from selected borrow pits located on the east side of the river. Some of the borrow pits are in gravel and sand, while others are in pure clay, so that any mix determined to be desirable could be had by regulating the amount from each of the pits.

The output of the shovels in the pits was taken to the dam by trains, and dumped from trestles on either side of the segregation pool for the core, and the fineness of the core was varied at will by controlling the placing of train-loads of selected materials at points where it was sluiced into the pool with the proper grading. The width of the core was controlled by varying the width of the pool to suit.

The excavating plant consisted of five units; one steam-driven dragline with a 3 cubic yard bucket; one railroad type steam shovel with a 2 cubic yard dipper; one full revolving steam shovel on caterpillar tread, with a 1¼ cubic yard dipper; one gasoline-driven dragline on caterpillar tread with a 1¼ cubic yard bucket; and one steam shovel on caterpillar tread with a one cubic yard dipper. They were served by eight locomotives, each with five 16 cubic yard and twenty 20 cubic yard air dump cars. The locomotives ranged from 57 tons to 30 tons in weight. There were no grades against loaded traffic, and the train-weights were limited to the brake controlling capacity of

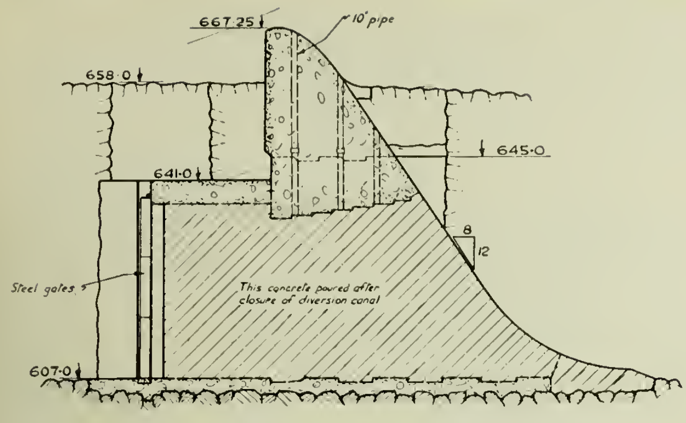


Fig. 4—Section through Sluiceways at Outlet of Diversion Channel.

the engines, as well as by the capacity of the engines to haul empties up the relatively steep grades on the return trip from the dam to the borrow pit.

Sluicing was done by two monitors, each placed on a float in the segregation pool. Pressure was supplied by centrifugal pumps direct-connected to electric motors. Electric power was supplied by special flexible submarine cable suspended on empty oil drums. The pumps were 6-inch by 6-inch two-stage units, equipped with nickel iron impellers to resist the heavy abrasive action of water carrying a large percentage of silt. The pressure at the discharge side of the pumps was 160 pounds per square inch, and the nozzle diameter of the monitor was 2 inches. Each motor was rated at 100 h.p.

Spillwall

The spillwall, as finally located, is 523 feet between abutments, and varies in height from 1 foot to 18 feet, with an average of 7 feet. These heights do not include the depth of section where the diversion channel sluiceways are located. The crest level provides for a maximum discharge head of 6 feet and, according to Bazin's formula for flow over a sharp-crested weir, as modified for this shape and depth, the discharge capacity is 30,000 cubic feet per second. The shape of the crest is shown in Fig. 6, and approximates very closely the parabolic form. Under maximum discharge conditions, the underside of the nappe lies theoretically below the surface of the concrete, so that under no conditions of flow there will be any tendency to produce vacuum. It is not expected that under operating conditions, with the total load for the system proportionately divided between the two plants, there will be any appreciable waste over the spillwall. Only under abnormal operating conditions will there be any overflow, and the possibility of maximum discharge is most remote. With the regulation provided at Virgin falls dam there is little or no waste at week-ends, the pondage of the lake above the Cameron falls plant being ample to balance the fluctuations; this lake providing daily, and to some extent weekly, pondage for both plants.

In constructing the spillwall, the surface of the rock foundation was only roughened, as, with the tilted formation of the beds, ordinary blasting opens seams that would extend to indefinite depths. The natural surface of the rock was for the most part fortunately sloped upwards in the downstream direction, providing a natural resistance against sliding. Dowels were generously provided in those smaller areas where the foundation was not so favourably tilted.

The section of all gravity walls, including spillwall and bulkhead sections, was designed to give ample factors of safety against overturning, sliding and ice action.

Tie Between Earth and Concrete Sections

At the junction of concrete and earth sections for both auxiliary and main dams, specially designed abutments are built in a similar manner to that for a bridge abutment sustaining an earth fill approach. Fig. 7 shows plan, elevation and sections of these. The two wing walls at each abutment are not, however, built to conform to the outer earth slope, but are confined to the core area and are completely enveloped by the less pervious fill which is carried 3 feet higher than the top of the concrete abutment. The sides adjacent to the core are constructed with a batter of 5:12, with the object of compensating for vertical shrinkage in the core material, and the tendency for the core to shrink away from a vertical face. The arrangement provided maintains at all times a tight contact between the earth and concrete. Five vertically placed timbers are embedded to half their depth in the faces of the abutments, to break the seepage plane between the core material and concrete, and these, together with the earth fill completely surrounding the wing walls and extending in front and behind the concrete section of dam, give reasonable assurance against destructive leakage.

The main line of the construction railway serving the mixer plant, boiler house and forebay area had of necessity to be located crossing the line of the auxiliary dam, and, in consequence, a gap through the concrete section was left to permit operation of trains until the last few days before the closure of the sluiceways. The concrete to close this gap was placed about a week before the closure was made, and was sufficiently set to sustain the head of water after the pool had reached its normal level.

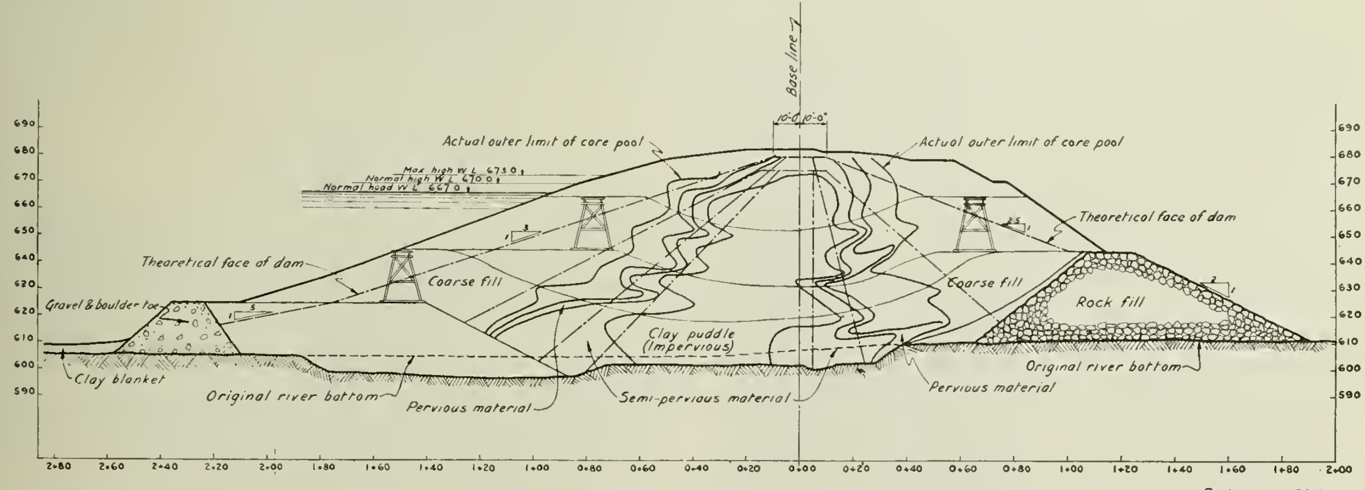
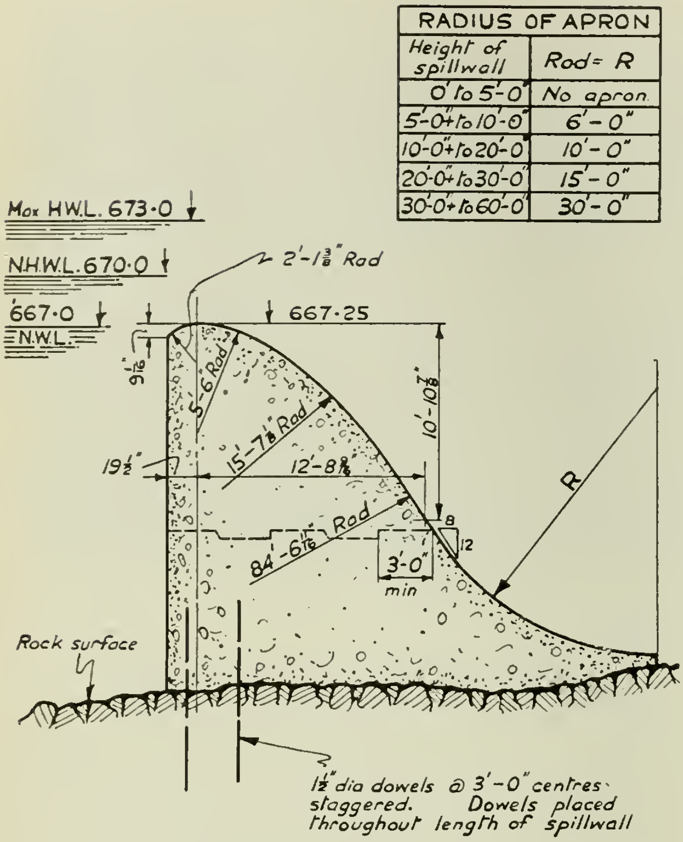


Fig. 5—Typical Section of Main Dam.



RADIUS OF APRON	
Height of spillwall	Rad = R
0' to 5'-0"	No apron
5'-0" to 10'-0"	6'-0"
10'-0" to 20'-0"	10'-0"
20'-0" to 30'-0"	15'-0"
30'-0" to 60'-0"	30'-0"

Fig. 6—Spillwall.

Auxiliary Dam

The auxiliary dam, running west from the power house was made up of a concrete section tied into an earth dyke. The concrete bulkhead portion of this dam (Fig. 8) is the conventional type, having a 3-foot top width and a batter of 8:12 on the downstream side, and a maximum height of 25 feet.

The earth section of the auxiliary dam was constructed as shown in the accompanying cross section (Fig. 9), having a central clay core supported on either side by pervious material. The central core, it will be noted, was carried to a depth of approximately 5 feet below the base of the dam, and from this point down to impervious material or to the rock, as the case may be, a 5-foot trench was dug between timber sheeting, and back-filled with puddle clay. To date, this dam has proved to be absolutely watertight and satisfactory in every respect.

Power Canal

As previously mentioned, during the construction period the whole of the river was diverted through a channel excavated through the peninsula formed on the right bank by the course of the river. This channel, in rock, is 50 feet in width and about 33 feet deep. The course is straight for about 500 feet, and then deflected to the left through 19 degrees toward the temporary sluiceways used during construction. Downstream from the point at which the course of the diversion channel deflects, and to the right of the channel, the earth overburden was removed to form a forebay. This, and a small amount of rock excavation immediately in front of the headworks, constituted the only additional excavation required for the power canal that was not removed for the diversion channel.

To the left of the power canal, excavation was carried down over the whole of the remaining area to elevation 660, in order to assure free access of floodwater to the whole of the spillway crest, which is at elevation 667.25. To the right of the canal, the original surface is practically all submerged up to the auxiliary dam, so that, under operating conditions, there appears a large headpond having an extreme width of over half a mile, completely submerging the original channels of the Nipigon river, Fraser creek and the diversion canal.

Headworks

Usually, in the design of headworks for a power development in a northern latitude, it has been considered necessary, and until recent years has become customary, to provide a superstructure with travelling crane for handling stop-logs, racks and headgates. A structure of this kind adds materially to the capital cost, as well as the consequential maintenance and operating charges which are of course, reflected in the power costs. In order to eliminate as far as possible this added expense, it was decided to design the headworks without a superstructure.

However, in consequence of the extremes of low temperature and heavy snowfalls prevailing during the long winter periods, certain protective measures had to be incorporated to guard against formation of ice in the rack and gate checks and to protect the headgate hoisting mechanism.

To raise and lower headgates during normal operation, there are provided motors and hoists enclosed in a low-roofed passageway running parallel with the centre line of units, which is about 7 feet high, or sufficient to conveniently house and operate this equipment. Each unit has two gates operated by one motor through disengaging clutches on the main line shaft.

The placing and removal of stop-logs, racks and headgates is done by a locomotive crane operating on a standard gauge track on the headworks deck. The locomotive crane may be used not only for this purpose, but for innumerable other operations in connection with the two developments, including such items as loading and unloading cars in the yards, minor switching service, and the handling of miscellaneous outdoor equipment. Since, in ordinary operation, the headgates are operated by hoists provided for the purpose, any unit may be shut down in an emergency without calling on the locomotive crane, thus permitting the crane to be kept in more or less continuous use, and even at considerable distances from the generating station.

To remove a headgate for repairs or renewal, it is only necessary to hoist the gate with the motor hoist to a height where it may be conveniently transferred to the locomotive crane. The width of the upper portion of the headgate checks is such that when the gate is raised for removal, it may be moved upstream, attached to the locomotive crane, and hoisted clear of the outer wall of the hoist housing. The passageway roof has hatchways, covered with removable concrete slabs made watertight with mastic joints.

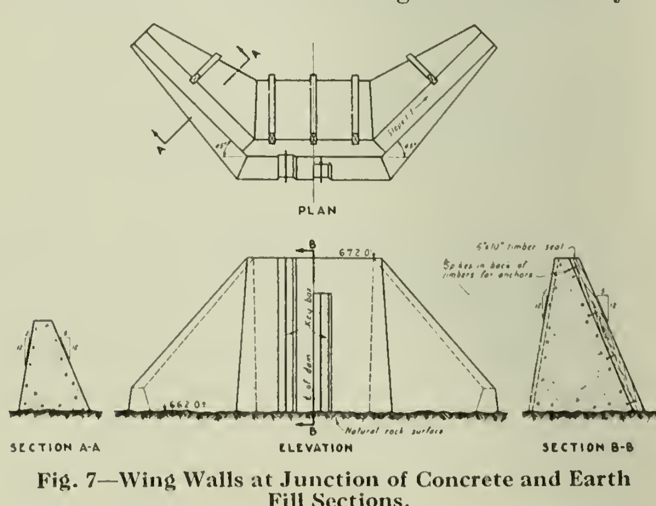


Fig. 7—Wing Walls at Junction of Concrete and Earth Fill Sections.

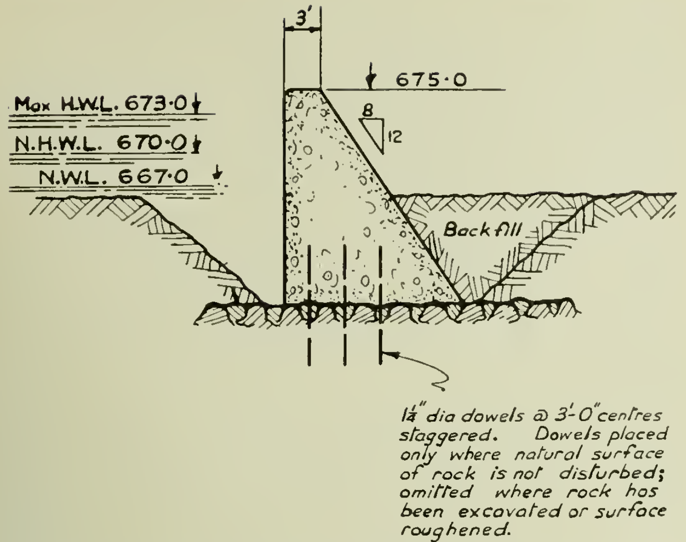


Fig. 8—Typical Section of Concrete Bulkheads uniting Headworks with Auxiliary Dam between Spillwall and Main Dam.

With these various openings available, the removal or replacement of motors and hoists is readily and conveniently effected with the locomotive crane. Removable deck beams carry the entire intake covering and crane tracks.

All openings over the stop-log and rack checks have matched plank covers made in sections fitted for quick handling; so that with the concrete curtain walls extending below low headwater level for each intake, the guide checks are well protected. In addition to this measure of protection, openings are provided immediately behind the guide checks for the headgates, through which heated air has free passage from the generator room. Provision has also been made for the installation of electric heaters, if found necessary.

For storage of the steel stop-log gate sections, two pockets are provided at the west end immediately upstream from the erection bay. These pockets are entirely below the deck level of the headworks, and are also protected with wooden hatch covers. Stop-log gate sections for one unit only are provided at the present time, but when unit No. 4 is installed, and the headgates in place for this unit, there will be released an additional set of stop-log gates, which are now serving as bulkheads in the headworks of this unit.

Racks and Stop-log Gates

The clear width of each of the two intake openings for one unit is 18 feet, and in each one there are three sections of rack panels, 11 feet 8 inches high, with bars 3 inches by

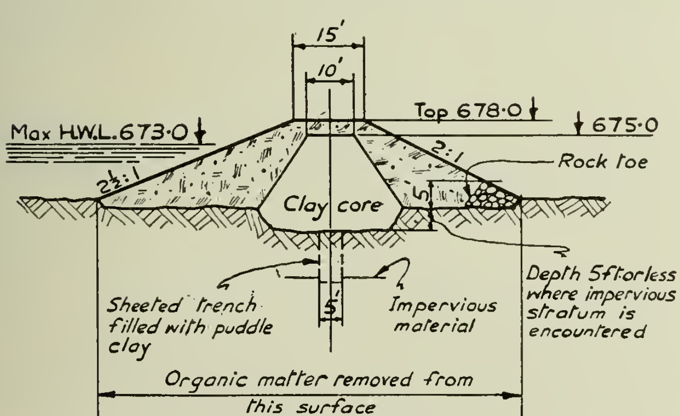


Fig. 9—Auxiliary Earth Fill Dam.

5/16 inch spaced 5⅞ inches centre to centre. The sections are all removable, and, in order that they may be placed in proper vertical alignment, the upstream sides of each section have oak guides fastened full length to the vertical side members of the frame, which ride against the upstream side of the guide check. The total width of I-beam and oak guide is one inch less than the width of the guide check.

The top rack section for each intake opening has a horizontal baffle plate secured to the top beam of the frame and extending upstream nearly to the curtain wall to prevent floating material from passing over the top of the rack, which is below headwater level. The rack sections are designed for a differential head of 10 feet, to allow for the accumulation of ice or debris.

The racks are placed in the checks immediately ahead of the steel stop-logs, and no provision is made for cleaning them in place, except by diver, such a provision having been found unnecessary in the operation of the Cameron falls plant.

To remove the racks, a follower is employed, with hooks near each end, which engage the top member of the rack sections through slots provided for the purpose. The

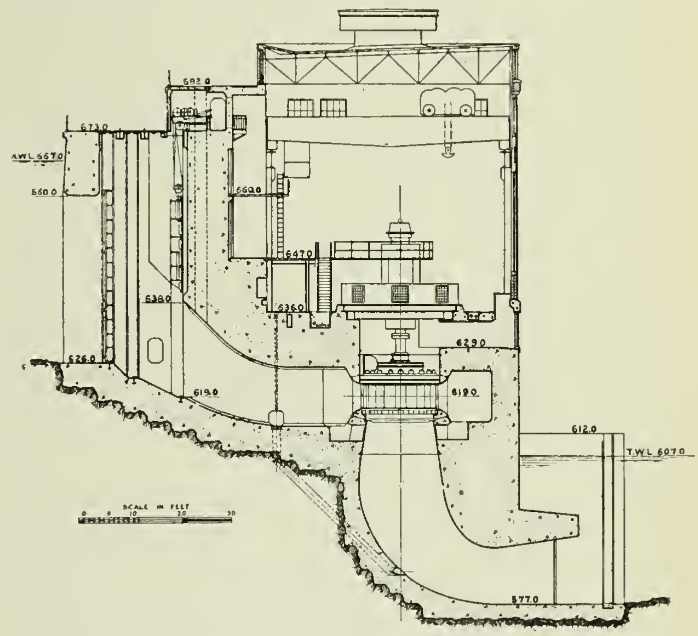


Fig. 10—Section through Power House.

follower is designed to engage or release its load by a line leading to the deck level, and is fitted with two end rollers at either end, to insure freedom from jamming in the checks.

The full depth of an opening to be closed by the stop-log gates is 47 feet, and its width is 18 feet in the clear. The gates for this purpose are in four sections, each 11 feet 9 inches deep, and are made of I-beams covered by ⅜-inch skin plates. The maximum size of I-beams in the lowest gate section is 20 inches at 65 pounds, and the closest spacing is 15 inches. The gross weight of the bottom section is about 18,000 pounds. The top three sections of the gates are adapted for use in the tailrace stop-log checks for unwatering the draft tubes. The same follower is used for handling both stop-log gate sections and the racks.

Fishway and Log Slide

In all the developments on the Nipigon river, present and prospective fishways are essential. Lake Nipigon is a large body of clear fresh water with an established fishing industry. It also lies in a vast area well covered by pulpwood and other timber of commercial value, as a consequence of which it was necessary to provide a log slide at the Alexander plant.

Fig. 11—General View of Forebay and Power House Headworks. Diversion Channel in left Foreground.

In order that fish may have free passage between Lakes Nipigon and Superior by way of the Nipigon river, fishways at both the Cameron falls and Alexander plants have been built according to the requirements of the Department of Game and Fisheries of the Province of Ontario. These are of the ladder type, with the passageways at the intake end spaced to suit varying levels of headwater. This type of fish ladder is very economical in the use of water, the ports supplying the flow being under a head of not more than 18 inches at any time. The velocity through these ports does not exceed 10 feet per second, as this is considered the maximum velocity against with the fish will migrate.

The pulp and paper industry in this district has already grown to considerable dimensions, and is becoming of greater importance, increasingly large quantities of pulpwood passing down the Nipigon to Lake Superior each year. To this end, the shape of the log slide at the Alexander plant is made to give the maximum log transporting capacity for the water used. The trough is "V" shaped, and constructed of timber supported on concrete piers and timber cribs, heavy cribbing having been used at the lower end as protection against ice action.

Hydraulic Equipment

The hydraulic equipment consists of three vertical shaft Francis turbines, placed in reinforced concrete scroll casings. Each is rated at 18,000 h.p. at 100 r.p.m. under a normal operating head of 60 feet. The turbines were manufactured by the S. Morgan Smith-Inglis Company, Ltd., of Toronto. The oil pressure governors and oil pumping equipment were furnished by the Woodward Company of Rockford, Ill. through the turbine contractor. This equipment was placed on order in the year 1927, and, while at that time a number of propeller turbines were in operation under 60-foot head (which, if employed in this case would have reduced equipment cost), the general performance at that time was such that the Commission's engineers did not think it advisable to select propeller turbines for this development. The Francis turbine of moderate specific speed was given preference, and in view of the fact that acceptable part-gate efficiency was anticipated by all competing manufacturers, it was decided to install the above described units.

Fig. 12—View of Power House from Downsteam Side. All River flow Passing over Spillwall.

Furthermore, in view of the fact that improved elbow draft tubes were simple in construction, and as such types showed equally good results compared with other types, decision was given in favour of the elbow draft tubes.

The casings and intake conduits are of reinforced concrete and conventional type and construction, needing no further comment.

The successful bidder of the water wheel contract preferred to furnish the solid type speed ring. This type differs from present-day practice, inasmuch as the stay vanes are integrally cast with upper and lower stay rings. This construction provided a rather simple method of taking care of hydrostatic pressures in the turbine casing, a simple and effective method of connecting reinforcing rods into the stay rings being incorporated in the casing.

Fig. 13—View looking along Main Dam toward Power House.

In general, the turbine consists of a cast iron runner wheel weighing about 95,000 pounds, with fifteen blades cast integrally between hub and crown. It is fastened to the shaft by means of tapered fit and retaining ring. A set of twenty cast steel gates are installed to regulate the flow of water. These gates are cast integrally with the gate stems, which are connected by links and pins to the cast steel regulating ring. This ring, in turn, is connected through adjustable rods to the two servomotors, which are operated through oil pressure. The link connection is of the tension-shearing type, providing protection against distortion of the gate shaft or breaking of gate arms in case of foreign material lodging between the gates.

In order to enable regular inspection of the turbine runner and to repair damaged blades, access is provided through pits and inspection covers placed in the upper draft tube, which is lined with steel plate.

The coupling between the turbine and generator is forged integrally with the shaft. The main guide bearing is of the adjustable water lubricated type, and is bolted direct to the turbine head cover.

Governor System

Each unit is equipped with a governor actuator, sump tank, pressure tank and oil pressure pump.

The governor actuator contains the electric motor driven flyballs, the pilot and main distributing valves, the gate limit device, the restoring mechanism, and the synchronizing gear, which can be operated remotely by electric motor or by hand. The whole governor setting is so arranged as to be compact and yet of easy access to all working parts. The actuator is of the well-known Woodward type, designed so that all parts are enclosed in a dust and oil-proof housing. The operating device consists of one hand wheel placed near the gauges and gate indicators. With this one hand wheel, it is possible to start the unit and bring it into operation, and an immediate shutdown can also be effected at any time.

As a novel feature for synchronizing an automatic speed matcher is furnished, which takes the place of the ordinary synchronizing motor. This speed matcher consists of two special 3-phase electric motors, one of which is connected to the unit which is to be synchronized; the other motor is connected to the bus. These two motors rotate in the opposite direction, and are directly connected to a differential gear which is placed on the synchronizing gear shaft, which, in turn, lowers or raises the pilot valve stem, thus opening or closing the turbine gates as required. When the frequency of the unit and bus is alike, both motors will be operating at the same speed, and the shaft of the differential mechanism will stand still, under which condition the circuit breaker can be closed.

While the oncoming machine is connected to the power system, it is at any time possible to either raise or lower the speed by operating the bus-connected motor. Such procedure will cause loading or unloading of unit.

In addition to all automatic features for synchronizing, a further advantage is introduced by operating the pendulum through a direct-connected electric motor. Such an arrangement eliminates the belt or gear drive, which is necessarily complicated and cumbersome in vertical machines. The current for this flyball or pendulum motor is obtained direct from a pilot exciter mounted on the upper end of the generator shaft. A special protection device is installed to shut down the unit to any predetermined gate or load in case of defect in the connecting wires.

The actuator housing contains the main distributing valves, gate valves and restoring devices, while, as an additional security, a hydraulic hand control is attached. With the hand control, it is possible to start the unit in case no oil pressure or outside current for the pump motors is available.

The oil pressure system is placed on the downstream side of the power house, and so arranged as to enable dismantling of main generating unit without interference with the sump tank, pressure tank or pump.

Construction Joints and Waterproofing

As an aid to the construction forces, detail plans were prepared for their guidance in the placing of concrete. These plans indicated the location and extent of the various classes of concrete going into the structure and the position of the construction joints. There were also shown the necessary cut-off or key trenches and copper bellows where waterproofing conditions indicated the need. With the receipt of weekly and monthly reports of work done, the progress is readily visualized by reference to these joints in the reports.

The location of the construction joints was largely controlled by the capacity of mixing and placing equipment and the restriction in height governed by the strength of forms for green concrete. It is also necessary to place certain joints at definite points where the stresses in the structure may be properly safeguarded and transferred. Wherever joints extend through a comparatively thin wall or pier against which there will be a pressure of water from either side special precaution is taken to waterproof the joint and to place a copper bellows.

The control of the concrete mixing and placing is an important factor in the construction of waterproof walls in that the density, which is a measure of resistance to penetration, may be fixed by the mix, provided it is properly placed in the forms.

To guard against the possibility of seepage damaging the plaster finish on the control room walls subject to water pressure on the upstream side as well as corresponding walls along the upstream side of the power house, a waterproof brick curtain wall was constructed leaving a space of 5 inches between concrete and brick. This space was provided with offtake drains.

Power House Superstructure

The power house superstructure is 52 feet in width and 203 feet in length by 55 feet high, constructed of steel frame with hollow tile walls faced with brick on the exterior and with plaster on the interior. The main generator room is divided into eight bays each 25 feet long, two of which are required for each unit and the two westerly bays for the erection room and control room. Below the erection room is a basement wherein the oil, water and air supply systems for the generators and transformers are located.

The power house is equipped with a four-motor, electrically-operated crane, having a rated capacity of 95 tons on the main hook and 20 tons on the auxiliary hook.

The heat from the generators is utilized for heating the station during the winter months. Five hundred and fifty-volt, 3-phase, electric heaters are provided to heat the control room and certain other sections of the control bay. Provision has been made for the installation of electric heaters in the headworks section should they be required; normally, the warm air from the generating room will be carried into the headworks section.

For cooling each generator a supply of 55,000 cubic feet of air per minute will be required. By a system of dampers, air from the outside may be drawn in through air ducts to the generators and expelled through monitors in the roof, or, if desired, the air may be circulated through the generators from the generator room or partially from outside.

The passages supplying air to the generators are designed for air velocity of 750 lineal feet per minute while the monitors in the roof are designed for an air outlet velocity of 570 lineal feet per minute. There is one monitor for each generator.

Generators

The three generators were purchased from the Canadian General Electric Company and are rated 15,000-kv.-a., 12,000-volt, 3-phase, 60-cycle, 100 r.p.m., 85 per cent power factor. They are of welded structural steel design, only the guide bearings and bearing housings being cast. The generators are complete with spring type thrust bearing and main and pilot exciters designed to give high speed excitation. The thrust collar of the thrust bearing also acts as a guide bearing so that this bearing can be considered as a combined thrust and upper guide bearing. The lower guide bearing is of the usual design, oil lubricated.

A 3-phase tap has been taken from the armature of the pilot exciter of each generator and run direct to supply the governor flyball motor. This eliminates the necessity of step-down potential transformers and connections to supply the flyball motors and supplies a potential direct to the flyball motor as soon as the generator is rotated, whether the 12-kv. connections are connected to the generator or not.

Thermocouples are embedded at different points around the stator windings, also in the upper and lower guide bearings. The leads of these thermocouples are connected to a selector switch which transfers any thermocouple to the temperature indicator or temperature recorder. There is also a Bristol recording thermometer connected to record the temperature of the thrust bearing.

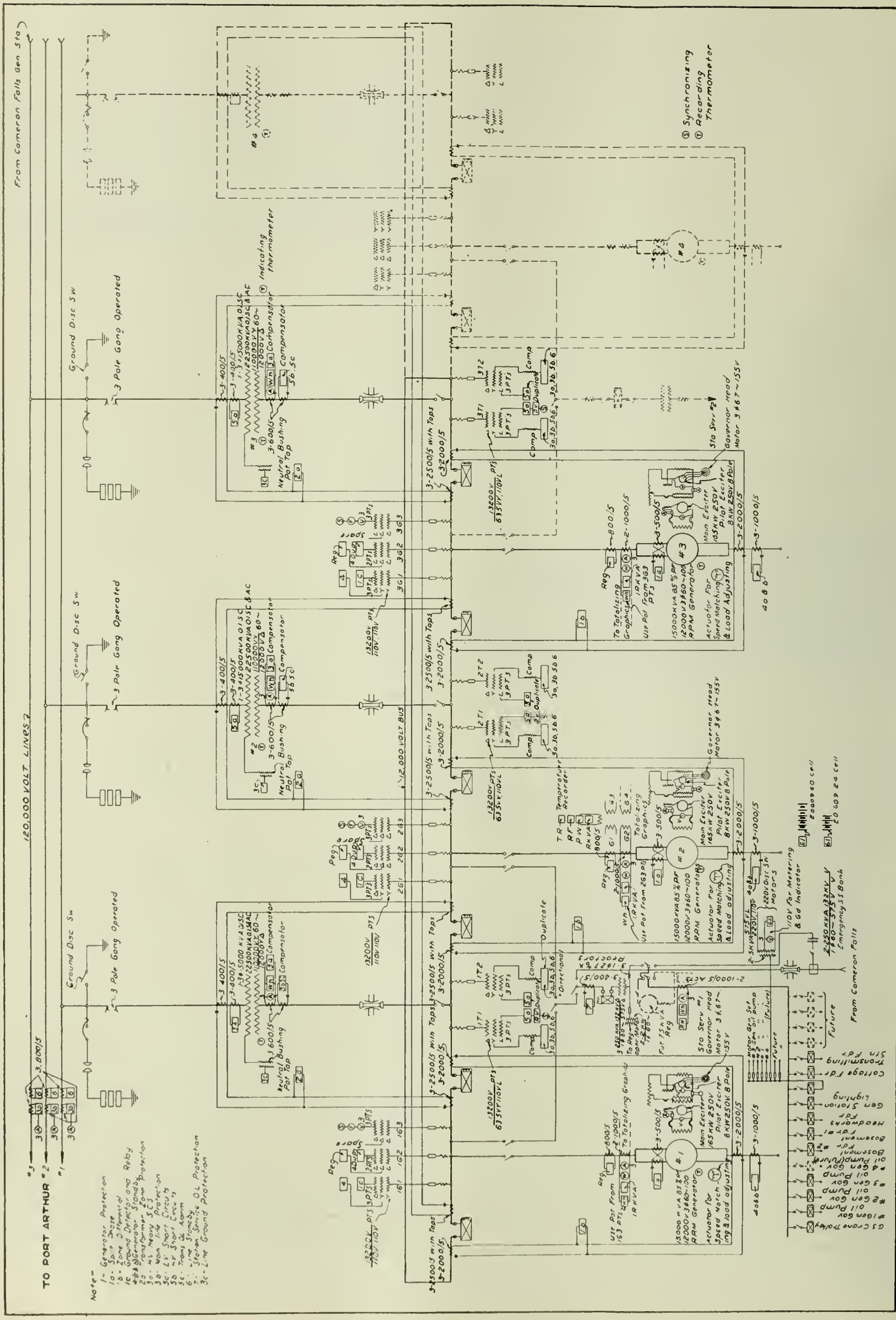


Fig. 14—Line Diagram of Electrical System.

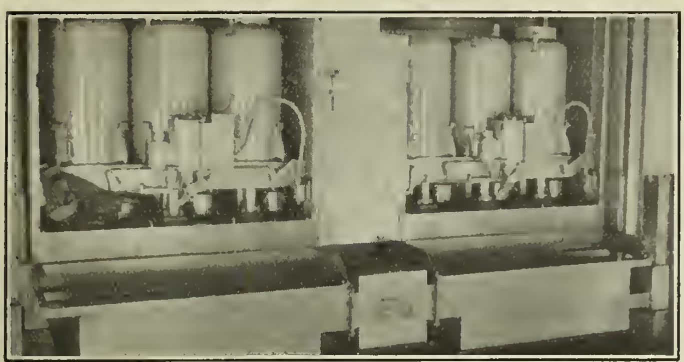


Fig. 15—Metal-clad Circuit Breakers.

Transformers

The power transformers consist of three outdoor, 15,000 kv.-a., radiator type, oil-insulated, self-cooled, 22,500 kv-a. forced air cooled, 80 per cent power factor, 3-phase, 110/12 kv., 60 cycle, 55 degrees rise with four 5 per cent high voltage full capacity taps above 63.5 kv., connected to manually-operated tap changers. The total weight of each transformer is 98 tons.

The transformers are connected 63.5 kv. star 12 kv. delta. The high voltage neutral lead is brought out of the transformer through a 110-kv. bushing of same design as the phase bushings, except that it is equipped with a potential tap device from which potential is obtained for operation of the relays on the ground protection system. This device eliminates the necessity of 63.5 kv. potential transformers.

Ring type current transformers are installed inside the delta in each transformer, also on the high voltage bushings of the transformers for use in conjunction with the protective relay systems. The neutrals of the transformers are not grounded in any manner as will be dealt with more fully later.

No indicating thermometers are provided on these transformers; instead each transformer is equipped with "hot spot" temperature indicating equipment which can be checked by thermocouples whenever desired. The temperature indicators for these transformers are located in the control room so that the transformer temperatures are constantly under observation of the operators on duty.

Electrical Layout

The single line diagram in Fig. 14 indicates the main 110 and 12 kv. switching and connections of this development.

The entire 12-kv. switching and bus connections consist of metal-clad equipment of latest design, so constructed as to fit the various bays in the station and to form a ring bus system. The capacity of the 12-kv. main bus and all oil circuit breakers is 2,000 amps. All breakers are interchangeable and one spare breaker is provided so that a breaker can be removed from service in the ring for maintenance and the spare breaker inserted to keep the ring intact. The breakers are all electrically and mechanically interlocked with the disconnecting switches to guard against faulty operation.

The required ring type current transformers and 3-phase double secondary potential transformers with their primary resistances and protective fuses are all incorporated in the metal-clad structure.

In a bay 21 feet long by 16 feet wide and 12 feet high, a metal-clad switching unit is installed consisting of two electrically-operated, 15,000-volt, 2,000-amps., 3-pole, oil circuit breakers with 12 kv. bus sections, two 3-phase, motor-operated, oil-insulated, disconnecting switches, 12 ring-type current transformers and five sets of oil-insulated, three-phase, double secondary potential transformers with primary protective equipment; this will give some conception of the compactness of this equipment. The equipment is designed for a potential test of 60,000 volts for one minute. It is designed to control the three 15,000 kv.-a. three-phase transformers and station service transformer banks and may be extended at one end in future.

From the ring bus system, six 1,000,000-c.m., 12,000-volt, P.I.L.C. cables are run underground in fibre ducts to each of the outdoor, 3-phase transformers. The connections from the metal-clad service breaker to the outdoor station service transformers are also run underground.

Where the 4-inch ducts are run from below the generator room floor up to the metal-clad structures, a rise of 14 feet 4-inch rubber hose was used instead of fibre or metal conduits. This eliminated the difficulty of fitting fibre duct sections for a vertical spiral run 25 feet long or bending metal conduits to fit properly. The rubber hose was filled with fine sand, capped at both ends and placed in position to which it readily conformed and the concrete poured around it. After the concrete had set the sand was run out and rubber hose joined to the fibre ducts in the main horizontal duct run.

The three 15,000 kv.a., 3-phase transformers are located outdoors approximately 250 feet from the generating station and mounted on concrete foundations. The transformers can be transported between the erection room of the generating station and transformer station by means of a specially designed transfer truck which is run on a standard gauge railway, the rails of which are placed on concrete foundations.

The 110-kv. switching equipment consists of an electrically-operated, 3-pole air break disconnecting switch. There are no 110-kv. oil circuit breakers or bus connections. The arrangement whereby these are eliminated is explained later. The power transformer banks are considered as part of the 110-kv. line and all automatic clearances are cleared by the low voltage breakers in the ring bus system, except infeed faults, in which case the line breakers at the receiving stations operate also. This system of connections involves a considerable saving in the cost of 110-kv. switching and connections.

The three 110-kv. lines from this development are connected at a special line tap steel structure erected on the transmission line right-of-way direct to the three transmission lines running from the Commission's Nipigon development to the Port Arthur transformer station.

The design of this line tap structure is interesting in its simplicity as will be noted from the layout. The structure is designed to accommodate a future fourth line. On the arms of the structure, it will be noted three 110-kv., oil-insulated, double secondary, ring type, current transformers are mounted on each of the three outgoing lines.

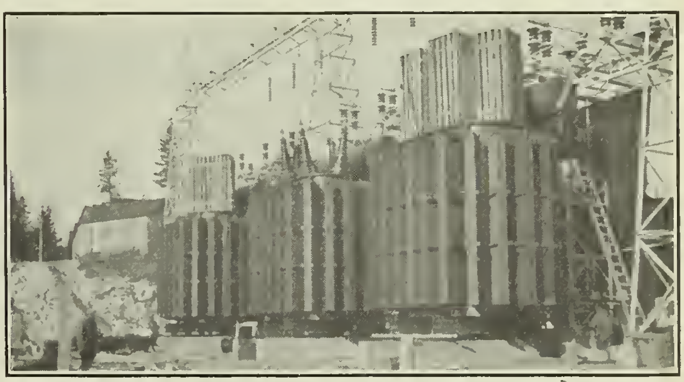


Fig. 16—Transformers.

These current transformers are required for the total line current indication and line protective relay systems.

The current transformers are constructed of two upper sections of oil-filled, 110-kv. porcelain transformer bushings bolted together by a flanged casting at the centre. At the flanged section the current transformers are located and covered with a weather-proof housing.

Control System

The entire station is controlled electrically from a central control desk located in the control room. The miniature type of control equipment is used on this desk, the top of which for the three present and one future unit measures 72 by 30 inches. The control switches are all of the standard telephone type. Forty-eight volts D.C. is used for the miniature control, which in turn connects in 125 volts D.C. for operation of the various switching units.

The synchronizing system consists of synchronizing across any of the 12-kv. breakers in the ring bus system. As there are potential transformers on both sides of each breaker, it is possible to synchronize across each breaker. Automatic synchronizing equipment is being provided, but in case of failure of the automatic equipment a manual synchronizing system is installed as a standby.

None of the 12-kv. oil circuit breakers in the ring bus system can be closed unless first synchronized. By operating a breaker key on the control desk to close a breaker, this key first connects in the speed matching motors of the generator to be connected to the bus, and at the same time selects the proper potential for the automatic synchronizing equipment; the automatic synchronizing equipment is then connected; this functions and when the proper synchronizing point has been established, energizes the control relays which close the breaker.

If a generator is already running and connected to the bus, and it is desired to close in the other breaker, thus completing the ring, the control is so interlocked that the synchronizing system will operate to close the breaker as usual, but the speed matching motors of the unit would not be energized, in such a case the automatic synchronizing equipment checks for voltage difference only and not for phase displacement.

The entire switching at the Alexander development will later be handled by remote control from the Nipigon station.

Protective Relay Systems

The Thunder Bay system has approximately 30 per cent of its connected load as synchronous motor load, which is very sensitive to voltage disturbances. The system is, therefore, being arranged as a series of 110 kv. lines metallically isolated from each other. These are connected to the generating and receiving station transformer banks. There is no essential oil breaker switching at 110 kv., only line disconnecting switches being required.

Parallel is held by the ring bus connections at generator voltage between the groups of units in each generating station and at the receiver station networks.

It is intended to promote stability by a layout of the system such that the effect of a fault on the system voltage will be localized and minimized. In other words, it is necessary to maintain at all times some tie between generators and the bulk of the synchronous load, which will retain some voltage to maintain synchronous torque. In addition, it is also necessary to provide an installation of switching and relaying which will enable any fault to be cleared from the system selectively and rapidly.

The relay protection for the Alexander station consists chiefly of zone protective systems, as will be noted from the single line diagram. The systems consist of the following:—

Generator Protection

Split Phase

This operates on unbalance between the halves of each winding and will operate on a single short circuited coil. This protection is also very sensitive to short circuits in field poles.

Zone Differential

This operates on any unbalance in the phases on any part of the generator circuit from generator neutral to bus side of the 12 kv. breakers in the ring bus.

Generator Ground Protection

(*1*) Heavy range—segregates units.
(*2*) Light range—alarm only.

Transformer Protection

Zone Differential

Covers bank from the H.V. bushings to bank breakers in the low voltage ring bus, including the 12 kv. underground cables.

There are three ranges to this system:
(*1*) Heavy—instantaneous.
(*2*) Medium—time.
(*3*) Light Setting—time, for incipient faults.

As there is no oil circuit breaker on the 110 kv. side of the transformer bank, means must be provided to cause the breakers to trip the line at the other stations. To do this, one phase of the line connected to the respective bank is automatically grounded. This causes the instantaneous ground relays to operate on the line at the other stations. This automatic grounding switch is mounted on one phase of the 110 kv. air 1-break disconnecting switches at the outdoor transformer station.

110 Kv. Line Protection

The line protection differs from the station protection in that distance current potential type relays are used. There are three systems for this protection:

(*1*) Non-directional. Short range instantaneous short circuit protection. Includes transformer bank.
(*2*) Main line protection. Long range S.C.
Short range S.C.
Duplicate.
Directional.
(*3*) Line ground protection.

As the neutrals of the transformer banks at the generating stations are not grounded, a faulty line will first clear on the ground current relays at the transformer station where the bank neutrals are grounded. For a ground detector at Alexander, a tap is used in the transformer neutral bushing with potential network to indicate voltage from bank neutral to ground, this indicating a ground on the line. With this, a ground potential relay is used to trip the line at the generating stations through a line relay, which permits the breaker at the transformer station to operate first.

In addition to the above, there are the standby protective systems and station service bank protection.

Auxiliary Systems

The station service banks consist of three 250 kv-a., oil-insulated, self-cooled, 60-cycle, 12,000/575-volt, single-phase transformers for the main bank, and two 250 kv-a. transformers in open delta for the standby bank.

The main bank can be connected off either of two generators through double-throw, 12-kv. oil-immersed, disconnecting switches. The standby bank can be supplied from the Nipigon station.

The station service banks are located about 100 feet outside the main entrance to the generating station on concrete foundations. The 12-kv. and 575-volt cables from and to these banks are run underground. The 12-kv. and 550-volt structure over the transformers is constructed of 2-inch galvanized iron pipe with standard galvanized threadless fittings.

The secondary cables from the service banks are run to a 575-volt bus in the generating station. Power can be obtained from either the No. 1 or No. 2 banks through selective disconnecting switches. The service power is supplied to the various service mains by underground lead-covered cables, the feeders being controlled by automatic oil circuit breakers with series ammeters mounted on same. All electric motors in the station on the auxiliary equipment are designed for starting at full voltage across the line.

The mechanical equipment comprises air compressing equipment, including a compressor operating at 100 pounds, pressure for general purposes and generator brakes, and a high pressure compressor for supplying air to the governor tanks; these two systems are interconnected. The water pumping equipment includes duplicate pumps for supplying cooling water for the generator thrust bearings and general purposes throughout the plant. A fire pump is also installed and arranged to come into service automatically if a fire line valve is opened.

The generator lubrication equipment consists of a unit oil system for each generator, the pump being driven by a 550-volt motor supplied from the station service system. Connections are run from each unit system to a central filtering and storage system in the station basement.

The transformer oil storage and filtering systems are located in the station basement and can be connected to the main and service transformers by flexible metal hose at the respective outdoor units.

Closure of Diversion Channel

Construction work proceeded rapidly in all sections of the development throughout the summer of 1930. By the third week in September, the fill in the main dam was brought to elevation 681 throughout its length, the head gates were in place in front of each of the turbines, and a week later the gap in the auxiliary dam, through which the construction railway had passed, was closed, and No. 3 generator was completed. By this time also, arrangements had been made for closing the outlets of the diversion channel and raising the headpond to operating level.

For several days before the closure, the headpond levels at the Nipigon station were regulated to meet the period of shutdown without wasting into the Alexander reach, and to allow ample time to draw down the Alexander headwater pool to permit the steel gates to be placed in the diversion sluiceways.

When the time came for making the closure, the gates were assembled above their respective openings, and suspended on "A" frames, in readiness for lowering into the checks. On Sunday, September 28th, at 4 o'clock a.m., the Nipigon plant was closed down, and the flow in the river completely stopped, the forebay at the Nipigon plant receiving and holding the whole flow of the river coming down from Lake Nipigon, this having been reduced by partial closure of the Virgin falls dam. At 7 o'clock a.m. the water in the river below Cameron falls and between the main cofferdam and the earth dam had drained out so that only a very shallow flow was passing through the two sluices. This enabled the gates to be dropped into place without difficulty after the sluices had been thoroughly inspected for any possible obstructions in the way of waterlogged timbers or gravel. Practically no obstructions were found, and the gates were dropped into place and sealed. At 10.25 o'clock the entire closure had been completed, and word was given to the Nipigon operators that that plant could be placed on load again, and at 10.45 o'clock the station was again carrying load. The load during that day proved to be fairly light, and the headpond filled slowly. Early the following morning, water began to flow over the spillwall, and by evening was passing over to a depth of more than 3 feet. With a few minor exceptions, the structures proved to be entirely watertight. A very small leakage through the closure gates was stopped up by dumping cinders against the upstream side and allowing them to be carried into the openings by the current.

The concrete fill or plugs for the water passages behind the gates have been poured, and the upper lift sealed to the lower surface of the existing concrete with grout forced through 10-inch vertical pipes left projecting through the spillwall.

The first unit was turned over on October 1st and the plant first carried commercial load on October 21st.

Personnel

All work in connection with the development was handled by the Commission's staff, of which F. A. Gaby, M.E.I.C., is Chief Engineer. Construction of the plant was carried out by the Commission's Construction Department, of which A. V. Trimble, M.E.I.C., is the head. J. N. Stanley, A.M.E.I.C., was resident engineer and superintendent of construction. The design of all structures, except the power house superstructure and the general supervision of construction was in charge of the writer, chief hydraulic engineer, assisted by Otto Holden, A.M.E.I.C., assistant hydraulic engineer. The power house superstructure and all electrical design was handled by the Electrical Department, under E. T. J. Brandon, A.M.E.I.C., chief electrical engineer. W. S. Lee, M.E.I.C., of New York and Charlotte, N.C., was consulting engineer on the design and construction of the earth fill dam.

The Technique of Placing Concrete on Steep Slopes Without Forms

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Concrete Technician, Alcoa Power Company, Kenogami, Que.

Paper presented before the Annual General and General Professional Meeting of The Engineering Institute of Canada, at Montreal, February 4th, 5th and 6th, 1931.

SUMMARY.—A recent advance in concrete construction of portions of structures which are steeply sloped consists in the practice of placing the concrete without top forms. The paper describes the way in which this has been done at Chute à Caron on the curved surfaces of slopes up to 50 degrees. For this purpose somewhat stiff mixtures were used, requiring vigorous tamping when being placed. Preliminary laboratory tests showed that with this character of mixture, properly rammed, the resulting strength was entirely satisfactory. The surface was shaped by the use of screeds placed so that the bottom edges of the screeds represented the finished surface of the concrete; the precautions required to obtain satisfactory results are described. Considerable reduction in the construction cost of gravity type dams can be obtained in this manner.

The practice of placing Portland cement concrete on level surfaces, such as sidewalks and pavements, represents what is probably the most simple method of doing construction work where concrete is the principal material. Pavement sections have been successfully laid on grades up to 15 per cent with little or no difficulty where the workability of the concrete is properly regulated and controlled. Another common type of concrete construction is that of placing the material between vertical or sloping wall forms. The latter named type differs from the first only in the matter of form cost and placing equipment. A third, and rather new development in concrete construction, is found in the recent practice of placing concrete in sections of hydraulic structures having slopes which heretofore were considered to be steep enough to necessitate the use of top forms.

It is the purpose of this paper to describe a method of placing concrete on slopes up to 50 degrees without the use of top forms. Since a discussion or an analysis of the different methods of concrete mixture design is not intended to be within the scope of the paper, as little reference will be made to that phase of the operation as is necessary for a proper understanding of the methods employed. However, it should be stated that the water-cement ratio law was used as a basis for proportioning concrete mixtures on the work where this somewhat unusual method of placement was used. The interpretation of the water-cement ratio law is simply that the compressive strength and other desirable qualities of the concrete are regulated and controlled by the ratio of the volume of water to the volume of cement used in the concrete mixture—as long as the mass is workable and the aggregates are comparatively clean and structurally sound. Since concrete which is called "workable" for one type of construction and placement method might be entirely too soft, or too stiff, for another type of construction or handling method, it appears that the term "workability" is one which might include almost any condition from a soft and plastic mass which would flow easily into place with little or no manipulation, on up to mixtures which appear to be quite stiff and harsh and which require vigorous tamping and ramming to close the air spaces between the particles and compact and solidify the mass. On the work herein described the latter named mixtures were used, i.e., those mixtures which when dumped from a 4-yard concrete bucket stood up and formed a pile of large stones, the voids in which were filled by a quantity of cement-sand mortar appearing to be almost dry. Laboratory tests gave very clear evidence that when this character of mixture was rammed and packed into specimen moulds in a manner comparable to the methods used in the field, the resulting strength was equal to or even greater than the strength obtained from the so-called plastic mixtures having the same water-cement ratio.

In the pages which follow an effort will be made to show that the principal advantages to be obtained through placing concrete on slopes up to 50 degrees without the use of top forms are as follows:

(*a*) A reduction in the cost of forms of at least 25 per cent;
(*b*) A saving in time of about 30 per cent;
(*c*) A saving of about 10 per cent in the quantity of cement used;
(*d*) A higher quality of product in the finished structure;
(*e*) Better appearance of the structure through absolute elimination of any form-marks or honeycombing.

In dams of the gravity type, the downstream face of the spillway section, from the crest of the rollway to the bucket (see Fig. 1), is generally designed to have a slope which when formed causes the placing of concrete to be a slow and somewhat difficult process. The usual placing equipment will not permit the delivery of concrete directly beneath the sloping form therefore it must be dumped at the most convenient point and re-handled by shovels—or, the workability of the mass must be adjusted so as to

Fig. 1—A Section of the Spillway of Chute à Caron.

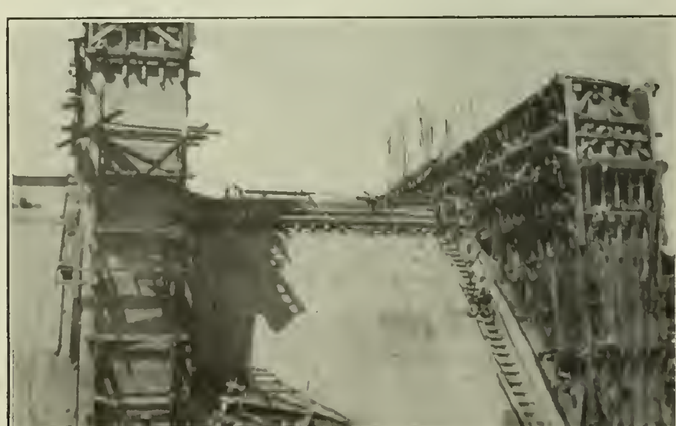

Fig. 2—A Block in the Spillway Section.

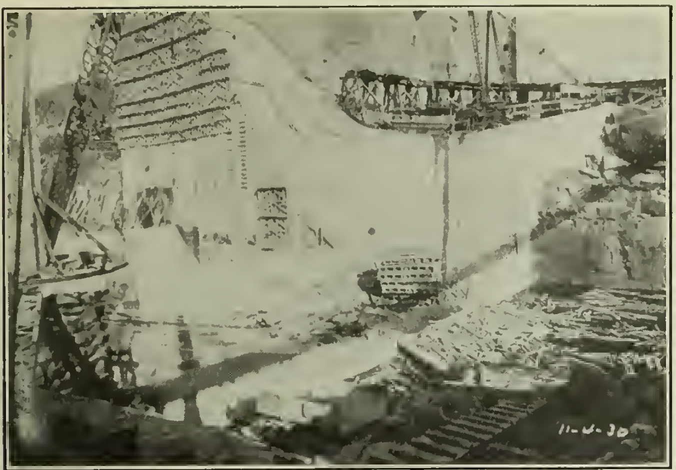

Fig. 3—Warped Surfaces in the Bucket of the Spillway Section.

provide almost fluid consistency. The first method retards the entire concreting operation and consequently increases the cost, and the second results in the two extremes of consistency being used in one form with the very great probability of a large number of shrinkage cracks. In order to place concrete at the toe of this form it must be cast a distance of from 12 to 13 feet with shovels.

In sections where the contour of the spillway is uniform, as is shown in Fig. 2, the cost of making the curved forms is only slightly greater than for the ordinary vertical faces since a large number of standard panels can be made in the shop and used in identical locations—generally throughout the entire job. However, the time required to erect the sloping forms and bring them to the proper line is about 25 per cent greater than for standard vertical forms. In certain sections of the spillway it may be desirable and economical to warp the surface of the bucket in order to fit topographic conditions. Such a situation is shown in Fig. 3. The form-work in a case of this kind becomes a very expensive item of construction cost—the laying out of the work at the shop is a tedious operation, and considerable skill and time is required on the part of the mechanics. Further, such forms can be used only once. The actual erection and proper bracing of warped forms of course requires more time and labour than ordinary vertical work.

The writer's first attempt to dispense with sloping forms was on the top lift of a certain block in the spillway section of Chute à Caron dam. This lift was 43 feet wide by 45 feet long by 13 feet deep, and specifications required that it be placed in one continuous operation. The downstream face was curved on a radius of 83 feet which gave a slope of approximately 25 degrees with the horizontal. Screed guides were set on about 10-foot centres placed at

Fig. 4—Showing Method of Setting Screeds in for a Rollway Lift, also Overhang of Sloping Forms.

right angles with the face of the dam, as shown in Fig. 4. The screed supports were pieces of 2-inch pipe set into holes drilled in the old concrete of the preceding lift. The top of the pipes were cut off about 6 inches below what was to be the finished surface and wooden plugs driven into the ends of the pipe to provide means of fastening the screeds to them. The screeds were 4-by 4-inch timbers cut to the proper radius. These were nailed to the plugs in the pipe supports so that the *bottom* surface of the screed represented the finished surface of the concrete. The straight-edges used to work between the screeds were dapped 4 inches at each end to conform to the depth of the screeds. It is an advantage to set the screeds entirely *above* the finished surface of the concrete for the reason that they can be left in place until the concrete has thoroughly hardened and thus serve as a bridge over which workmen can move, and also there is less difficulty in removing them than if they were imbedded in the concrete. A further advantage of placing screeds in this manner is in the elimination of cracks which invariably occur where screeds have been imbedded in the concrete and later removed and the trenches back-filled.

When the screeds are in position, concrete is delivered to the form in 4-yard buckets which are dumped in the space between the screeds. This operation requires a great deal of care in order not to strike the screeds with concrete buckets. As previously stated very stiff mixtures are used

Fig. 5—Surface being smoothed with Wooden Floats, Straight Edges being pulled forward between Screeds.

and, by using electric vibrators and a certain amount of hand-shoveling, the concrete is spread out in layers between the screeds and compacted so as to conform roughly to the finished grade. The vibrator and shovel-men are followed up immediately by a crew using the dapped straight-edges which are worked back and forth between the screeds and pulled upward along the slope. Fig. 5 illustrates rather well how this operation is accomplished. After the surface has been brought to grade by the straight-edges, it is smoothed off with a wooden float and all small surface voids filled. It should be stated that absolutely no mortar covering is used on the surface other than that found in the regular concrete mixture, and that every effort is made to obtain the greatest quantity of rock possible at the surface. Finishers are cautioned not to remove from the mass any fragments of stone which may protrude slightly above the surface—these are either left in place or are driven down with a small hammer. Obviously, there is no chance of honeycombing or form blemishes in a lift made in the manner just described, and the finished appearance of such a lift is noticeably better than where top forms are used. Fig. 6 gives an idea of the finished appearance of a rollway crest.

Care is taken not to deliver concrete to the screeding crews faster than they can handle it efficiently—however,

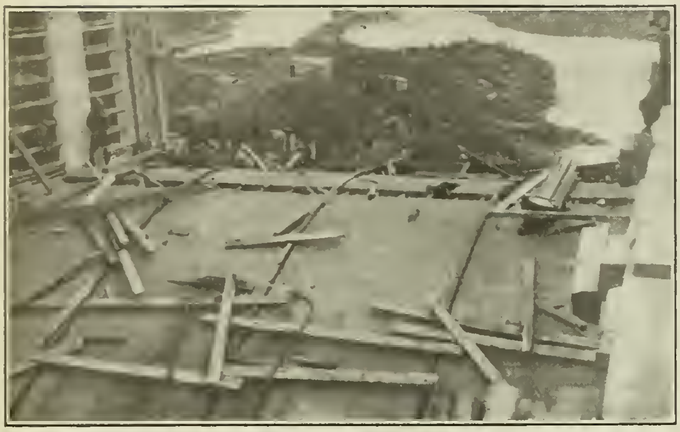

Fig. 6—Rollway Crest finished by Screeding.

with proper supervision the work can be carried on with little or no delay to the placing derricks or transportation system. The interior sections of the form toward the upstream face should be carried up at about the same level as the screeded section, and this provides dumping space for the concrete which the screeders are unable to handle and also permits continuous delivery from the mixing plant.

Five of the eleven rollways of the spillway section of Chute à Caron dam had been built under the old method of top-forming before it was thought feasible to accomplish the work by screeding alone. This offered excellent opportunity for comparison of the two methods. It was revealed that the placing difficulties encountered where top forms were used slowed down concrete delivery to where 22 hours were required to fill the forms of one block and complete the lift. Under the newer scheme of screeding only, the time was reduced to an average of 15 hours—and on one occasion under favourable conditions the lift was made in 13 hours.

The job of screeding the first rollway lift was attacked with a good deal of misgiving on the part of the placing foreman and his crew. The superintendent and engineers on the jobs were also inclined to be "doubting Thomases" and a rather large audience assembled at the forms, apparently to smile at the efforts which were to be made at placing concrete in such an unusual manner. As the work progressed the predicted difficulties turned out to be mere details and when the block was "topped-out" in eight hours less time than was required for the same lift in other locations, there could be no doubt about the success of the new method.

After two or three rollway blocks were successfully placed without top forms the placing crews grew ambitious to try their hand at even steeper slopes. Ample opportunity for a display of their skill was provided in the form of

Fig. 7—Method of Setting Screeds on Warped Surface of Bucket.

certain spillway buckets which, in addition to having slopes slightly steeper than 50 degrees, also had warped surfaces. The placing of this concrete was accomplished in practically the same manner as has already been described for the rollway blocks except that the "straight-edges" were cut on various curves as specified by the engineers. An example of the placing methods used on these steep slopes is illustrated in Fig. 7.

Specifications required that all concrete placed within 6 feet of the exposed surfaces of the dam should have compressive strength of 3,000 pounds per square inch at 28 days. Through previous experience and a knowledge of the characteristics of the materials to be used it was known that a water-cement ratio of 0.9 would produce concrete of approximately the strength specified. With the water-cement proportions set at the figure noted, the workability of the concrete was regulated to fit placing conditions by adjusting the sand and stone quantities.

Where top forms were used the concrete had to be very soft so that it would flow back under the 15 or 16 feet of overhanging form. This meant that the quantities of sand and stone in each mixer batch must be reduced approximately 30 per cent while the amount of cement and water remained constant. From this it follows that the unit cement content of mixtures of given water-cement ratios, increases as the mixture is softened. Where placing conditions allow the use of stiff mixtures, as is the case where top

Fig. 8—Electric Vibrators used to Compact Concrete.

forms are not used, the maximum amount of sand and stone can be added to the designated quantity of cement and water, and the unit cement content is reduced accordingly.

On five rollway blocks the unit cement content averaged 502 pounds per cubic yard of concrete where top forms were used. The average unit cement content on six rollway blocks placed by the screeding method was 449 pounds. This saving of 53 pounds of cement amounts to approximately 31 cents per cubic yard of concrete. Since the top lift in one rollway block only is about 1,000 cubic yards, the saving on the entire job would be very considerable.

The saving in the cost of forms on the regular rollway sections can be safely estimated at 25 per cent since one of the three sides formed under the old method is entirely eliminated except for the comparatively small expense of setting the screeds. However, the saving in form-work on the warped sections of the spillway bucket would be more difficult to estimate—but it would probably be much greater than 25 per cent.

In conclusion it would seem fitting to say that the experience gained on this work warrants the suggestion that the construction cost of gravity type dams can be reduced very materially if the designers of such structures bear in mind the application of the methods described in the foregoing.

The Design of the Chute à Caron Diversion Canal

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SUMMARY.—The Chute à Caron power development is being carried out on the Saguenay river about 10 miles upstream from the town of Chicoutimi, and the paper describes one of the most interesting features of this work, namely, the diversion and control of the river during the construction period. The discharge of the Saguenay river at this point is affected by the very large storage in Lake St. John, and by the load requirements of the Isle Maligne power plant, about 23 miles upstream. Flood conditions in the river are discussed as they affected the cofferdam and other structures necessary for the diversion work. The diversion canal described was required to carry the flow of the river during the period between the closure of the main channel by the tipping of a concrete "obelisk" and the completion of the closure section of the dam. The "obelisk" was tipped in July 1930, and the final cofferdam closure took place on October 4th, at which time about 150 feet of main dam still had to be completed. The water of the diversion canal was passed under the power house by a tunnel or sluice tube discharging into the permanent tailrace. Hydraulic studies were carried out as to the flow in the diversion canal and in the tailrace, and it was found necessary to line the latter with concrete wherever poor rock or gravel existed. Some difficulties arose in connection with this concrete lining due to the high velocity and turbulent flow in the tail race, but these were successfully met by the methods described. The hydraulic problems in the system were studied by means of large scale model experiments. A description is given of the extensive cofferdam work, the opening at the head of which was closed by means of the "obelisk."

Abnormal conditions during the spring and summer of 1930 affected the programme, as the spring flood was much lower than usual and of short duration, but from August 1st to September 1st flows varying from 70,000 to 100,000 second feet passed Chute à Caron, about 40,000 second feet of which flowed through the sluice tube, while the remainder spilled over the cofferdams, at which provision had been made for dealing with an overflow of this kind. After the final closure of the dams the sluice tube was permanently plugged with concrete, and the dam structure was carried to completion without further difficulty.

Chute à Caron is situated on the Saguenay river in the province of Quebec, about 10 miles upstream from the town of Chicoutimi. At the present time the Alcoa Power Company Ltd. is completing a hydro-electric power development at this point.

This paper is not a description of the entire project, but covers one of the most interesting features of the development, the diversion and control of the river during the construction period.

General Conditions Affecting Diversion and Control of the Saguenay

The Isle Maligne plant of the Duke-Price Power Company is situated on the Saguenay river at the junction of the Grand Discharge and Little Discharge about 9 miles below the outlet of Lake St. John, and about 23 miles upstream from the Chute à Caron plant. The load requirements of the Isle Maligne plant were such that there must be a discharge of about 30,000 to 37,000 second feet on week days and 15,000 second feet on Sundays throughout the entire year. This requirement fixed the capacity of the Chute à Caron diversion works at 50,000 second feet. The normal annual variation of flow of the river ranges between the natural maximum recorded peak of 326,000 second feet and the regulated Sunday minimum of 15,000 second feet. The annual flood peak comes in May or June, but there are frequent flood peaks of a magnitude of 100,000 second feet or more during the summer and fall months, up to December. There could be no assurance of a long uninterrupted period when the flow would be 50,000 second feet or less, hence it was necessary to arrange the cofferdam structures so that intermittent floods of more than 50,000 second feet could be safely passed. Lake St. John storage above the Isle Maligne dam was available to a limited extent as a help in controlling stream flow during the diversion period.

While the Chute à Caron plant was under construction it was necessary to divert the flow of the river only during the period between the tipping of the "obelisk" and the completion of the closure section of the dam. The latter operation entailed the placing of about 120,000 cubic yards of concrete or two and one-half months of uninterrupted work. The use of some 3 feet of storage capacity in the lake resulted in longer and more definite working periods between the intermittent freshets, and reduced the number of times it was necessary to discharge more than 50,000 second feet. The occurrence of flow in excess of this amount would have necessitated stopping work in the river section of the dam and allowing the water to overtop the cofferdams. A detailed description of these cofferdams will be given later. Originally, the construction programme called for this work to be done in the winter of 1930-31 between the periods of fall and spring floods. Later, it was decided to close the cofferdam in the early summer of 1930 and carry the main dam to completion with the exception of two blocks in the deep section of the channel which would be left low to pass the fall flood. Due to adverse flow conditions however, the cofferdam was not closed until September, but owing to a very light fall flood, the main dam was carried to completion in December with only two interruptions due to high flows.

General Description of Diversion Canal, Sluice Tube and Tailrace

Fig. 1 shows the general layout. The diversion is divided into three sections, namely: the diversion canal, the sluice tube and the tailrace. The diversion canal begins at survey station 2 + 00 and continues downstream to survey station 17 + 95, which is the face of the intake, and entrance to the sluice tube. Under the intake and power house on the centre line of number one generator, a tunnel or sluice tube was constructed which connects the diversion canal to the permanent tailrace. The water was taken from the Saguenay at the entrance to the diversion canal at survey station 2 + 00, along the canal, through the sluice tube into the tailrace, and was diverted back into the Saguenay at the end of the tailrace at survey station 45 + 00. The overall length of the excavated channel was about 4,300 feet. The material encountered was rock with no overburden in the vicinity of the power house, and considerable gravel overburden at the upstream end of the diversion canal and the middle portion of the tailrace.

In describing the diversion scheme, it is the author's intention to discuss the different portions of the structure as far as possible in the chronological order of their construction.

The Diversion Canal

The theoretical cross-section of the diversion canal was 40 feet wide at the bottom with side slopes of 1 to 4. The width was set by requirements to operate a shovel and a loading track in the canal bottom. As the excavation proceeded, it was found that this cut was too narrow to handle the work properly, and the channel was widened to provide space for a ramp track on the right bank. A typical cross-section is shown in Fig. 1.

During the late winter of 1927-28 the hydraulic studies of the diversion canal down to the sluice tube were completed. The canal was designed to have a capacity of 50,000 second feet with a velocity of 21.25 feet per second. A roughness factor "*n*" of .045 was assumed as it was considered uneconomical to do any trimming of the sides and bottom.

When the canal was completed, accurate cross-sections of the excavation were taken, and after it was put into operation, profiles of the water surface were obtained for various conditions of flow, with a view to establishing the actual roughness factor. At high flow the section was quite irregular and the sides were partly concrete, partly timber sheeting and the remainder rock. At low flow the canal was rock throughout and it was thought that under low flow conditions, a fairly accurate value of "*n*" could be computed. It was believed from observations and flow measurements that the roughness factor was probably less than the assumed, but it has not been possible to establish the fact mathematically, owing to certain unknown factors such as the time lag of flow changes between Isle Maligne and Chute à Caron and recovery of velocity head at points of variation in section.

The Tailrace

The theoretical cross-section on wchich the hydraulic studies were based was 50 feet wide at the bottom with side slopes of 1 to 4. This section was sufficiently large to keep the velocity within required limits and allow ample width for excavating purposes. In the central portion of the tailrace a heavy gravel overburden was encountered on the right bank which increased the width of the excavation, as the gravel necessitated flatter side slopes. Under these conditions the grade of the tailrace bottom was raised to partially counterbalance the increase in width, and the resulting tailrace, particularly the central portion, does not bear much resemblance to the theoretical. A typical cross-section is shown in Fig. 1.

Hydraulic studies of the tailrace were carried on simultaneously with those of the diversion canal. A roughness factor "*n*" equals .035 was assumed as it was necessary to give more attention to trimming the side slopes and bottom owing to the fact that this portion of the work was to be the permanent tailrace after the diversion was completed. Studies were made with regard to water levels in the channel during the diversion period for various elevations of tailwater. Due to the extremely high velocities in the tailrace during this period, it was necessary to line the canal with concrete where poor rock or gravel existed. The height to which the lining was carried was fixed by the maximum level the water would reach during diversion. Owing to the the type of lining used and the turbulence of the water, it has been impossible to obtain any information of value with regard to roughness factor. The velocities varied from 50 feet per second at the power house to about 30 feet per second in the lined portion of the canal.

Under operating conditions for full plant load of 18,000 second feet and normal tailwater, the average velocity in the tailrace will be considerably higher than ordinary. The size of the tailrace was limited for reasons purely economical as applied to this particular development

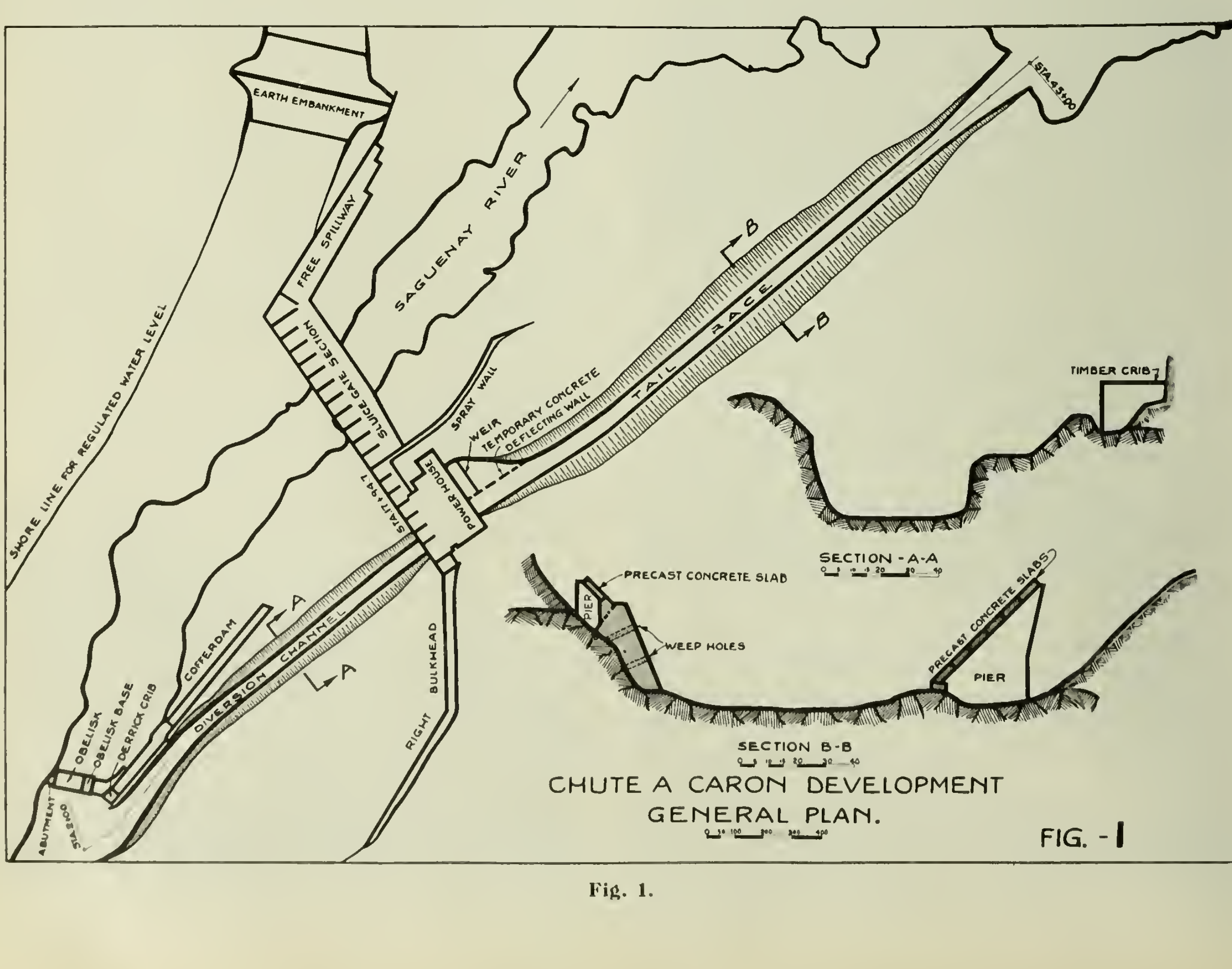

Fig. 1.

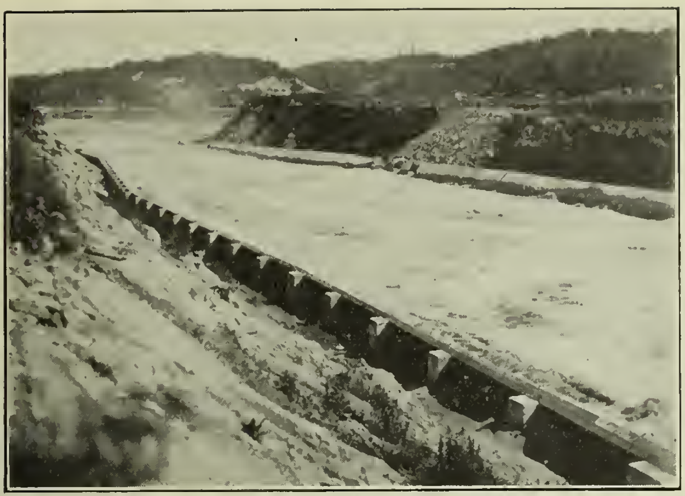

Fig. 2—Slab Displacement in Tailrace due to Gravel Slide.

and which probably would not apply to a development designed to operate under other conditions.

Fig. 1 shows a typical cross-section of the tailrace channel and the concrete lining provided. The rock in the left bank stood at a fairly high elevation throughout, although the quality was poor in places and it was necessary to protect this poor rock from erosion by a concrete slab covering. Weep holes were provided to prevent back pressure, tending to separate the slab from the rock during low flow periods in the tailrace. This portion of the lining was poured in place with the exception of a few precast concrete slabs which were used at the higher elevations. On the right bank the rock was low, with gravel overburden for a considerable portion of its length. This gravel overburden was protected from water flowing at high velocity by precast concrete slabs supported by concrete buttress piers.

The cost of building the lining in place on the right side of the tailrace would have been excessive as it would have necessitated forming the structure on all faces and the concrete quantities involved were small. To reduce the cost of protecting this bank, it was decided to build in place only the piers and low toe wall. The slabs were precast at a location which was easily accessible to the mixing plant, and after completion they were stored for a period of several weeks, and a full supply was available when required for erection. The piers were 3 feet thick, and were spaced at 20-foot centres. The maximum height of pier was about 40 feet. Reinforcing steel was placed in the piers, consisting of three-quarter-inch rods spaced at 18-inch centres both ways, and located 6 inches from the outside faces. Each pier was anchored at the heel by four 1½-inch round rods extending 8 feet into solid rock. The erection of the piers followed closely on the heels of the excavation.

The slabs which span between piers were 19 feet 11 inches long, 8 feet wide and 12 inches thick, and the sides so shaped that a 2-inch wide space existed between slabs when in place, except at the ends. It was assumed that turbulent flow would have practically ceased to exist by the time the water reached the slab structure and that a condition of almost equally balanced pressure would be obtained on the slabs, thus eliminating the necessity for heavy reinforcing steel. Sufficient reinforcing was placed therein only to insure against breakage, when being picked up and put in place by a derrick. Two holes, each 2 inches in diameter, were provided at the end of each slab, extending through its 12-inch thickness, for ease in handling and to facilitate anchoring to the pier. Adjacent to the hole in the slab when in place, a corresponding horizontal hole was provided in the pier and the two were fastened together by means of a three-quarter-inch diameter steel cable through these holes, which was drawn tight and clipped.

After the tailrace had been operating a short time during diversion, some difficulty was experienced with regard to sliding of the clay and gravel bank which caused the loss of a few slabs. This difficulty was overcome by dumping crushed rock on the sloping face of the bank. Fig. 2 shows slabs displaced by a gravel slide and the crushed rock which was placed to prevent further damage.

Several more slabs were lost due to surging in the canal and the cable type anchorage. From observation, it was seen that balanced pressure on the slabs did not exist at all points in the canal, as surges would rush up the sloping face and recede quickly causing practically no disturbance of the water behind the slab. At certain locations where this condition occurred, the punishment to which the slabs were subjected appeared to be increased by the flexible cable anchor. Fig. 3 illustrates the surging of the water in the tailrace.

In all, about twenty slabs were damaged, some of which disappeared. At the end of a month's operation it was decided to close the diversion for two days which would allow inspection of the sluice tube, replacement of the broken slabs and installation of a better type of anchorage for the slabs. The time available to accomplish these repairs was limited and thorough preparations were made for proceeding with the work the moment the sluice tube gates were closed. The missing slabs were replaced and all slabs except those at the extreme top were bolted to the piers by means of 1½-inch diameter anchor bolts and plate washers. When the slabs were designed, a 1-inch space was provided between the abutting ends when in place and this space was utilized for setting anchor bolts which were located on the centre line of the pier face and at approximately the quarter points of the slabs. A rectangular plate washer was then clamped over the ends of the two abutting slabs by means of the anchor bolt. The tension on the bolt was sufficient to prevent appreciable movement in the slabs due to water surges, but still allow slight freedom for expansion and contraction. This work was completed in about one and one-half days and since that time no difficulty has been experienced.

As a matter of fact, the slabs received excessive punishment only at certain points, the location of which varied with the flow and were impossible of predetermination, and it cost much less to replace a few slabs than to reinforce all slabs for heavy unbalanced pressure. On the whole, this construction has been satisfactory and in the light of experience very little change would be made if repeated.

Fig. 3—Flow in Tailrace during Diversion.

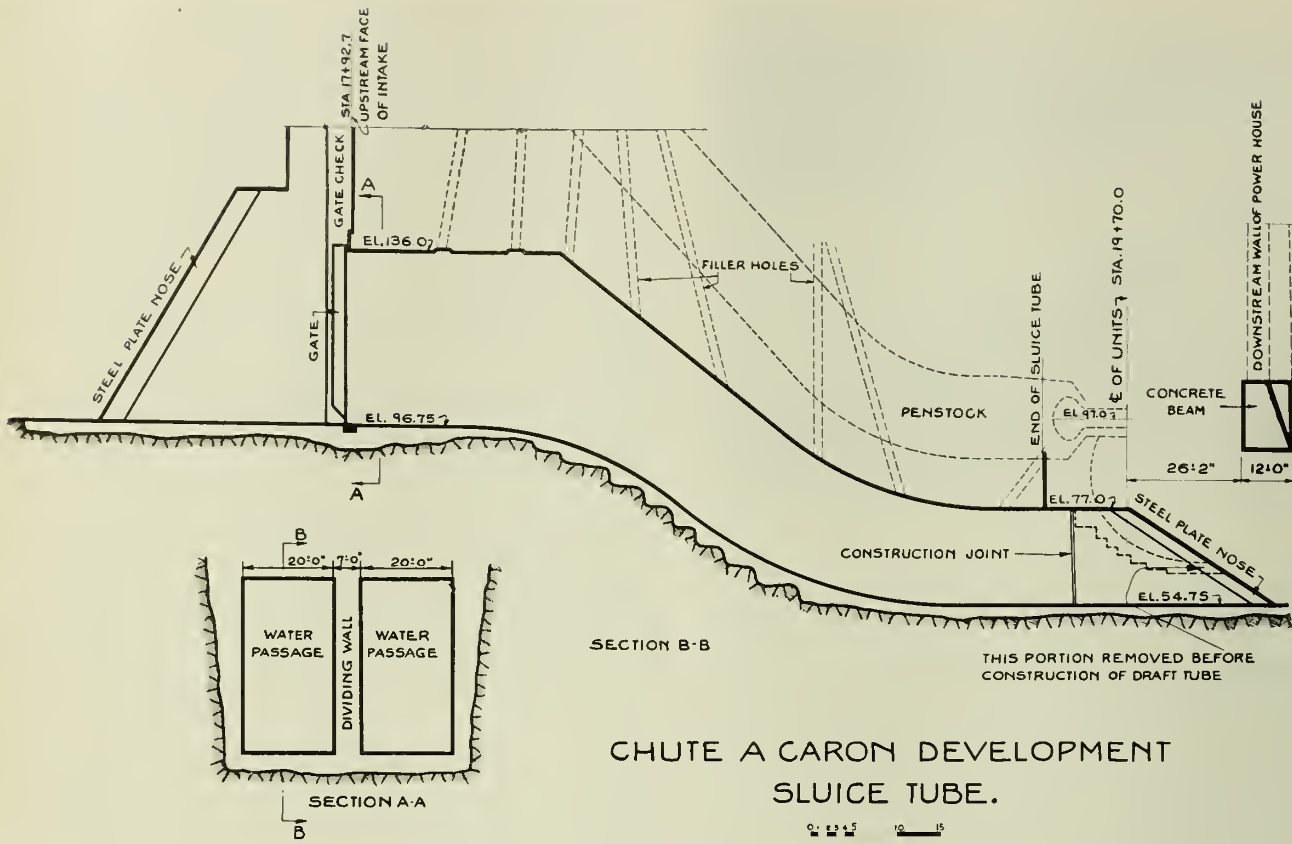

Fig. 4.

The Sluice Tube

The sluice tube, through which the water passed from the diversion canal to the tailrace, is located parallel to No. 1 penstock and under No. 1 generating unit. In the early stages of the design, consideration was given to the idea of excavating a tunnel immediately outside the westerly limit of the power house, but this was discarded for hydraulic and economic reasons. Looking at Fig. 1, it will be noted that the centre line of the sluice tube and the centre line of the tailrace coincide, thus providing direct alignment for high velocity flow.

Numerous hydraulic studies were made of the flow in the diversion canal upstream from the sluice tube, and in the tailrace downstream from the sluice tube, and by means of these studies the heights of the passage-ways were fixed. The elevation of the roof was so fixed that with a discharge of 40,000 second feet the water surface at the entrance would just make contact with the top, while at the outlet the water surface would be several feet below the top of the tube. A hydraulic jump was anticipated, but nothing definite with regard to location or height could be obtained from the computations. As there was very little technical information available on the behaviour of water at extremely high velocities, it was decided that a model should be built in order to verify or refute the computations.

In designing the power house, it was necessary to provide a huge concrete beam spanning the sluice tube at the downstream wall for supporting the columns. This beam was 16 feet deep, 12 feet wide and about 50 feet long. It was located 50 feet downstream from the end of the sluice tube and the bottom of the beam was 13 feet above the top of the tube. A standing wave or jump of any height in this vicinity might seriously damage this beam.

Another point of interest was whether or not an eddy would form in the tailbay and if it would be necessary to provide a temporary deflecting wall between the tailbay and the diversion channel, extending from the downstream power house wall to the throat of the tailbay. (See Fig. 1.)

The model was built of timber in several sections, in the carpenter shop at Chute à Caron, and installed at the foot of the dam adjacent to the Isle Maligne power house, immediately below the trash sluice gate, in the fall of 1928. The model was one-eighteenth full size and was hydraulically similar to the prototype. The length of the model was sufficient to reproduce about 200 feet of diversion canal, 180 feet of sluice tube, and 300 feet of tailbay and tailrace.

The cement mortar lining of the model of the diversion canal and tailrace was roughened before it had received its permanent set, in order to reproduce as closely as possible the friction co-efficient of the rock, and the sluice tube section was cement mortar lined with a smooth finish, with the exception of one side. This side was composed of very heavy plate glass in order that the conditions of flow in the tube might be plainly seen and measurements taken at any point under varying conditions of discharge. At the lower end of the tailrace section, a stilling box and measuring weir were installed. This consisted of a box about 5 feet deep tapering from tailrace width to a width of 8 feet at its downstream end. At the downstream limit of the stilling box, a sharp crested weir and staff gauge were installed. The stilling box contained a system of baffles which reduced the velocity and distributed the flow evenly over the crest of the weir. The velocity of the water was reduced at the entrance to the diversion canal at the foot of the dam by a similar system of baffles.

The model results verified the computations with regard to the water levels at the upper and lower ends of the sluice tube. In addition, it proved beyond a doubt that there would be no hydraulic jump in the vicinity of the beam in the power house wall, except under conditions of very low flow, at which time the jump was small and did not approach the beam. The model also clearly demonstrated that a dividing wall in the tailrace parallel to the canal between units 1 and 2 was essential to prevent an eddy in the tailbay which would seriously decrease the discharge.

It was interesting to note that for low flows, the water rolled back on itself inside the tube near the lower end and with the flow around 5,000 to 8,000 second feet, this backroll pounded the roof of the tube and caused considerable vibration in the model. At the opening of the gates in the power house, the first time water was passed, the same condition existed and although no vibration was noticeable, considerable pounding could be heard until the flow had increased beyond this stage.

At the higher stages of flow in the model, the backroll or standing wave was swept outside the sluice tube into the open canal and the distance downstream of the point at which the standing wave existed varied with the flow.

Inside the tube in the prototype, the flow was fairly smooth, with slight evidence of surging, except at very low stages, when the backroll occurred. For a distance of about 300 feet from the exit the water was relatively smooth considering the velocity at which it travelled. From this point downstream it was very turbulent for several hundred feet to a point where it passed through a transition stage somewhat resembling a hydraulic jump and then became fairly smooth. Fig. 5 shows water surface profiles for two conditions of discharge.

The sluice tube forms part of the power house substructure and is composed of two water passages separated by a concrete dividing wall 7 feet thick. This wall extends 55 feet upstream from the entrance, tapering to a very thin pier nose made of steel plate. At the downstream end it extends 50 feet past the exit, with a similar type of pier nose. An elevation of this wall may be seen in Fig. 4. The upstream and downstream extremities of the wall were designed to offer a minimum of obstruction to flow.

The sluice tube openings were each controlled by a Stoney gate at the entrance. Each gate was approximately 41 feet high and 21 feet 6 inches wide and weighed 72 tons. The gates were suspended from brackets set in the concrete above and operated by a system of sheaves and cables from a double drum winch located on the deck of the dam, about 200 feet distant. They were held in continuous suspension and might be raised or lowered on a few moments notice. The bottom of each gate was tapered to a thickness of about 1 inch at the downstream face, and satisfactory results were obtained while operating in a semi-closed condition, the vibration being negligible.

The water passages are each 39.25 feet high and 20 feet wide at the upper end, tapering to 22.25 feet high and 17.75 feet wide at the exit. Advantage was taken of the fact that the exit could be made smaller than the entrance, due to the increased velocity of the water at the former point. The smaller dimensions at the lower end enabled the building of the sluice tube without increasing the centre line distance between units 1 and 2. The taper also was advantageous in that when the sluice tube was plugged after closure, any movement in the plug would tend to close the joint due to its wedge shape.

The sloping bottom of the sluice tube is similar in shape to a rollway crest on a dam, the concrete projecting well into the under side of the waternappe. For a discharge of 40,000 second feet, the velocity at the upper end is about 30 feet per second, and at the lower end 50 feet per second. The tube has never run full at the lower end even for discharges of well over 40,000 second feet. For the latter discharge, the upper end seals just at the entrance but the water surface quickly drops away and at no time has the top of the tube been under hydrostatic pressure.

After several months operation during the summer and early fall of 1930, the gates were closed for two days and an inspection of the water passages made. No evidence of erosion of the concrete was noticeable and even timber fillers which had been bolted in the keyways on the sides were still in place with the exception of one piece. On December 20th, 1930, however, after the final closure of the gates, it was noted that some parallel grooves of about one-half inch depth existed on the bottom of the sluice tube in the vicinity of the crest. Due to the fact that these grooves existed only on the bottom, it was thought that they were probably caused by the passage of solid matter, such as small and large rocks, the greatest of which would probably weigh some thousands of pounds. For a period of several weeks before final closure, the water level in the diversion channel upstream was very high, which caused a slight amount of sliding of material from the banks and undoubtedly the major portion of this material passed through the sluice tube due to the high velocities in the diversion channel. There was no means of estimating the quantity of this material, but it probably was in the neighbourhood of from two to five thousand cubic yards.

Layout and Manipulation of Cofferdams

Fig. 1 shows the layout of the main cofferdams. A cofferdam 800 feet long was built between the river and the diversion canal and lying parallel to them. At the point where this cofferdam formed a foundation for the derrick crib, two branches were constructed, one of which extended across the entrance to the diversion canal, while the other extended part way across the river to the "obelisk" base. The former extension is not shown on the general plan as it was removed immediately after the completion of the excavation in the diversion canal.

That portion of the cofferdam lying downstream from the derrick crib and the branch across the entrance to the diversion canal was built in the fall of 1929. This was

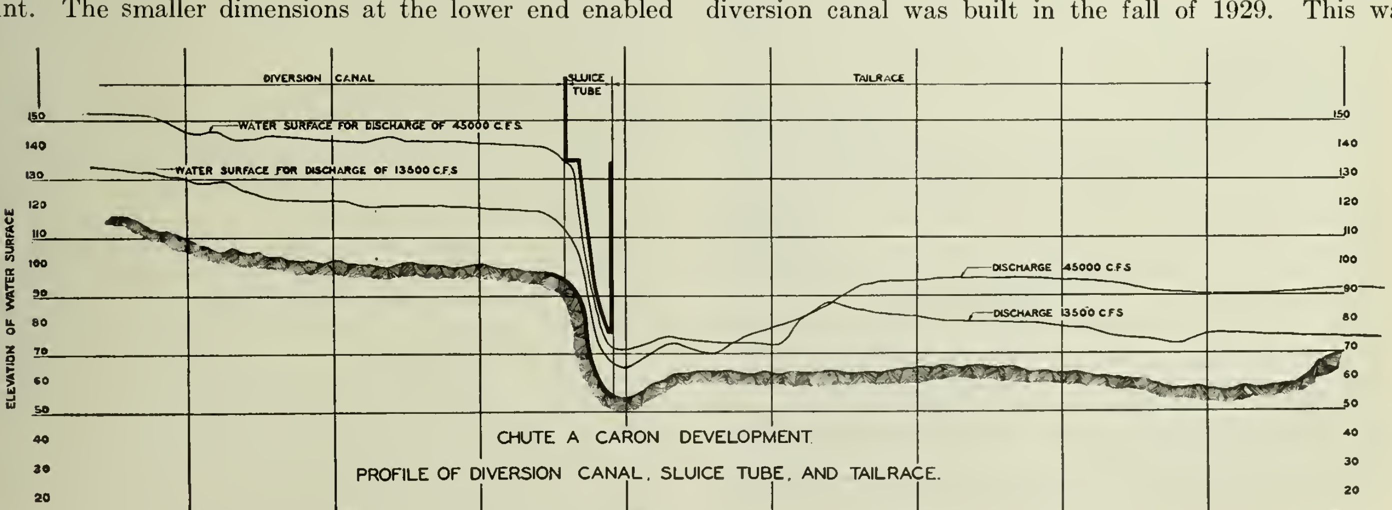

Fig. 5.

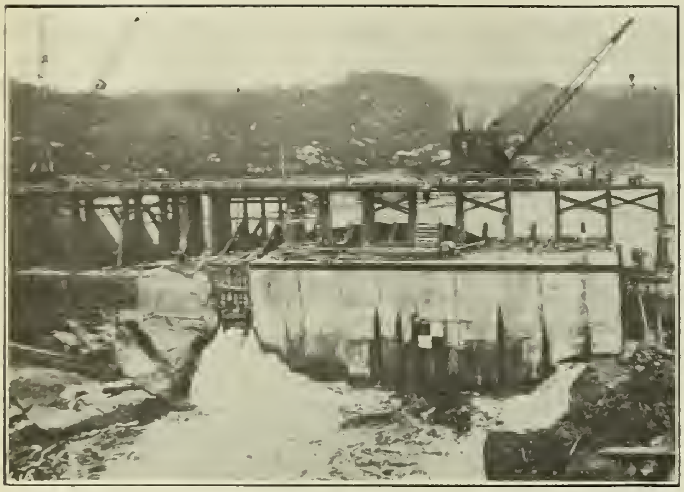

Fig. 6—"Obelisk" in final Position during Construction of Trestle.

necessary in order that the canal might be excavated in the dry, and to provide a track for transporting material to the "obelisk" during its construction. In addition, it was necessary to keep in mind that there must be a minimum of obstruction to flow in the river channel during the spring flood of 1930. As a result of these requirements the cofferdam from the derrick crib to a point downstream 300 feet distant was built to elevation 140, while the remaining 500 feet was carried to elevation 165, which was computed to be above maximum high flood level. Crest elevation 140 was decided upon to satisfy two conditions, namely: it was low enough to allow overtopping during flood periods and thus not unduly obstruct the flow, and it was sufficiently high to be above water level in the diversion canal during low week-end flows.

The Saguenay river was a very difficult stream to cofferdam, particularly in the vicinity of Chute à Caron, as the river channel is comparatively narrow with deep, swift water. The impracticability of constructing the ordinary type of rock-filled timber crib cofferdam in the deep section under such adverse flow conditions led to the development of the "obelisk." In this paper the author will give only a brief outline of the work connected with this huge concrete block. A full account of the design and construction of the "obelisk" is given in a paper by C. P. Dunn, M.E.I.C., chief engineer of the Alcoa Power Company Ltd., in the December 1st issue of "Civil Engineering," published by the American Society of Civil Engineers, New York.*

The method of final cofferdam closure was based on the assumption that the "obelisk" would act in accordance with the computations of design, and that it did so act is clearly indicated in Fig. 6, which shows it in its final position. It came to rest within a fraction of an inch of its computed location and practically no cracks in the block were noticeable.

In the spring of 1930, the river channel was obstructed by the east shore abutment, the "obelisk" pier, the derrick crib and 300 feet of cofferdam immediately downstream from the derrick crib, which was built to elevation 140. For a period of about two months, with the exception of a few days when the discharge from Lake St. John was kept low to enable work to be done at Chute à Caron, the cofferdam adjacent to the derrick crib and the east shore abutment were overtopped from 12 to 16 feet, and no noticeable damage occurred to these structures during that period. The east shore abutment was concrete, while the 300 feet of cofferdam adjacent to the derrick crib was a rock-filled timber crib with concrete caps. The sides of this cofferdam were vertical and the outer vertical surfaces inside the cribbing were concreted to a thickness of 3½ feet. The crest was protected with an 18-inch thick concrete slab placed on top of the rock fill. The top slab provided a smooth surface for the overflowing water as well as a good foundation for the railway trestle which was constructed thereon, and which will be described later.

In years of normal precipitation, the Saguenay river high flow reaches its peak about May 20th, and is down to normal flow about June 15th. The spring and summer of 1930 were not normal in the Lake St. John district. The spring flood was much lower than usual and of short duration, due to the light snowfall during the winter and lack of spring rains. Owing to the unusually low flow during May, there appeared to be a good possibility of tipping the "obelisk" in the latter part of June, which would have made possible the completion of the river section of the dam, with the exception of two blocks, before the fall flood. During the week-end immediately preceding June 18th, construction of the railway trestle previously mentioned was begun, which, when completed would extend from the upstream end of the 165 cofferdam over the 140 cofferdam, the "obelisk" and to the east shore abutment. At this time the trestle could not be completed, as the "obelisk" was still in its vertical position, but was constructed to within a few feet of the "obelisk" pier. The cofferdam, "obelisk" and east shore abutment formed the foundation for the trestle and the sills of the bents were firmly anchored to these structures. The elevation of the bent sills was about 140, throughout, and the base of rail was at elevation 165. The bents were made of 12-inch by 12-inch timber posts with 12-inch by 12-inch sills and caps, and were spaced 13 feet 6 inches centres. The trestle bents not only provided means for transporting material for sealing the "obelisk," but in conjunction with low intermediate bents spaced midway between, formed the support for a timber bulkhead which extended from elevation 140 to elevation 152. The bulkhead was necessary to prevent water overtopping these low structures and flooding out the work in the river section of the dam during a diversion of 40,000 second feet through the canal, because with this condition of flow the water in the canal stood at about elevation 150.

It was necessary to design the bulkhead in such a manner that it could be easily and quickly put in place during the low week-end flow when the crests of the 140 structures were dry. The bulkhead supports were sloped at 45 degrees with the vertical, and the bulkhead was composed of 8-inch by 8-inch timber needles standing on end, side by side, and supported by 12-inch by 12-inch horizontal stringers, which in turn were supported by the trestle and intermediate bents. These 8-inch by 8-inch timber needle beams, of which there were about eight hundred, were not fastened together nor held in place except by water pressure, and for ease in removal, "U" straps were bolted to their upper ends by means of which the railway crane could pull them out while the water stood against them. Canvas was placed over the top of these needles and a very watertight job was obtained. All bents were sheeted on both sides to elevation 154 to provide a smooth surface for the water passing between them when the needles were not in place.

After the completion of the trestle to the "obelisk" pier, flow conditions were such that it was decided to postpone the tipping of the "obelisk" until July. The water level in Lake St. John at this time was near its upper limit but was being lowered slowly by discharging about 170,000 second feet. Any further obstruction in the river channel at Chute à Caron, such as the "obelisk" in its final position, would have seriously decreased the discharge capacity of the river and thereby increased the length of time required to lower the lake for storage purposes. Sufficient lowering of the lake had been accomplished by July 20th, to insure a period of about eight days during which time the flow could

*See also "Engineering Journal," October 1930, page 598.

Fig. 7—"Obelisk" and Pump Crib during Sealing Operation.

be limited to such an extent that it would not overtop the "obelisk" in its final position, and it was decided to take advantage of this period to tip the "obelisk," erect the trestle thereon, and obtain additional information regarding the river bottom.

The "obelisk" was tipped July 23rd, 1930. Work was begun immediately on the closure of the openings at the ends of the "obelisk" and the extension of the railway trestle over the "obelisk," to the east shore abutment. Although no attempt was made to completely seal the cofferdam during this period, the leakage was relatively small (see Fig. 7), which made it possible to extend the main dam toward the river channel a distance of 27½ feet past the previous limit. At the end of eight days the discharge from Lake St. John was increased and the flow allowed to pass over the cofferdam into the river channel

From August 1st to September 1st, flows varying from 70,000 to 100,000 second feet passed Chute à Caron, about 40,000 second feet of which flowed through the sluice tube. The remainder spilled over the cofferdams, through the trestle bents to a depth of about 12 feet without serious damage to the latter, with the exception that two intermediate bents were torn away. One hundred thousand second feet was about the maximum discharge that could be accommodated at this time without serious damage to or loss of the railway trestle. Fig. 8 shows the water passing through the trestle with a river discharge of 80,000 second feet.

On September 1st, the needle beams were installed, as the lake had been drawn down about 3 feet, although the inflow was sufficiently above the discharge to allow a working period of only about fifteen days. The cofferdam in the vicinity of the "obelisk" was sealed at this time. It was thought that this period would allow sufficient time to do the necessary excavation in the deep portion of the channel and allow the placing of a full block of concrete 55 feet long in the main dam to an elevation above interference from the water when it would again be turned into the river. At the beginning of this period, about four days were employed sealing the "obelisk," installing secondary cofferdams, a flume and a battery of pumps to dry the river bottom. When this work was completed, excavating on one side of the river bottom and placing concrete in the 55-foot block on the other side were carried on simultaneously. Owing to a seam of poor rock, which entailed the excavation of some thousands of yards, this part of the work was not wholly completed before the water was again turned into the old river channel, September 16th. One block of concrete, however, had been carried above water level and was continued to the top during the remaining part of September.

While the needle beams were being installed and the cofferdam sealed at the beginning of this closure period, a low cofferdam was constructed across the river about 400 feet downstream from the main cofferdam. The idea was to form a pool from which leakage through the main cofferdam would be handled by a battery of pumps discharging into the diversion canal. Due to an excessive leakage of about 85 second-feet through a rock seam under the cofferdam lying downstream from the derrick crib it was found necessary to build a second low cofferdam immediately upstream from the face of the main dam. Thus two pools were formed, the excess flow over pump capacity in the upper pool spilling into the lower. From the lower pool the leakage was carried by a small timber flume extending across the area of the main dam and discharged at a point several hundred feet downstream.

The final cofferdam closure took place October 4th, at which time there remained to be completed about 155 feet of main dam. Construction was carried on rapidly on both sides of the river extending out toward the centre. By the time the small timber flume began to interfere with the placing of concrete, a small tunnel through the dam about 7 feet by 4 feet had been provided, the flume was dismantled and the water by-passed through the tunnel. Pumping was discontinued at once as the tunnel had ample capacity to handle all leakage. The tunnel entrance was provided with a closure gate which was dropped in place and sealed when the concrete in the last block reached elevation 150. A concrete plug 15 feet long was placed in the tunnel behind the gate by means of filler holes extending through the roof at elevation 150, and after the tunnel was sealed concreting operations on the last block were continued to completion.

Immediately after the final closure of the dam, the control gates in the sluice tube were dropped. During the period required for the water in the forebay to rise from elevation 150 to elevation 210, the crest of the rollway, no flow passed down the river below Chute à Caron. This period was utilized to construct a cofferdam in the tailrace a few feet downstream from the throat of the tailbay. The cofferdam was built to keep the tailbay dry during the erection of the substructure in No. 1 unit, and the extension of the tailbay weir.

The substructure for No. 1 unit was carried to such a height as to form a bulkhead at the exit end of the water passages of the sluice tube and from this point the filling of the sluice tube openings was carried on simultaneously with the concreting operation at No. 1 unit.

Concrete was placed in the sluice tube openings by means of 2-feet square filler holes (shown in Fig. 4) extend-

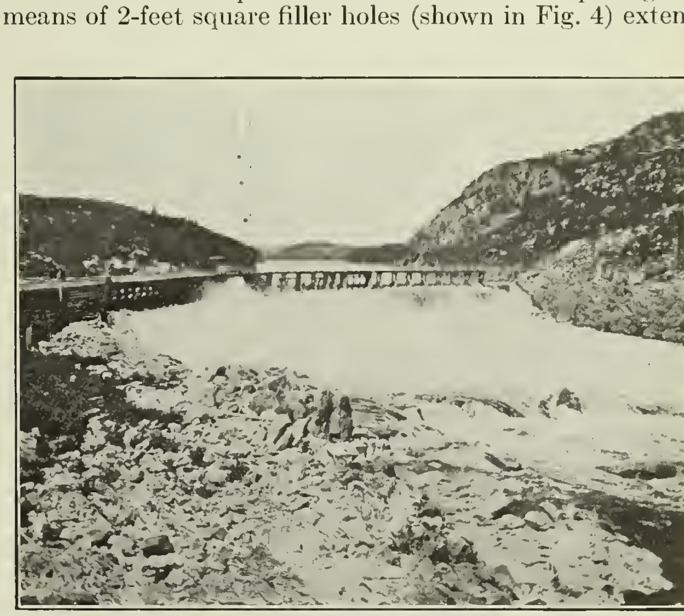

Fig. 8—Water passing through Trestle with River Discharge of 80,000 c.f.s.

ing upward from the roof of the sluice tube and converging to a common point on the downstream face of the intake. A hopper was built over the entrance to these openings, into which concrete was dumped from buckets operated by a traveller and from this point the concrete dropped almost vertically into the sluice tube. It was vibrated and spaded into place until the openings were completely filled. The concrete was then allowed to take its set after which grout was applied under pressure to fill up any space which might exist, due to shrinkage. No attempt was made to salvage the sluice tube gates because the cost of removal would have exceeded their salvage value.

When the substructure of No. 1 unit had been completed to elevation 90, which was 3 feet above normal tailwater, and the downstream face of the No. 1 draft tube sealed by means of the draft tube needle beams, the interesting and very often troublesome problems of diversion were things of the past. No combination of conditions with regard to flow could thereafter cause damage or delay, and the structure was carried to completion without further worry from this source.

No difficulties of any importance were encountered during the construction and operation of the diversion and the essential features of this scheme would be retained were it necessary to accommodate like conditions at any future development.

Personnel

The design and construction of the Chute à Caron project was undertaken by the Alcoa Power Company Ltd., a subsidiary of the Aluminum Company of America. Of the former company, C. P. Dunn, M.E.I.C., is chief engineer, I. G. Calderwood, general superintendent of construction, I. E. Burks, concrete technician, and the author, chief designing engineer.

James W. Rickey, M.E.I.C., chief hydraulic engineer, J. P. Growdon, assistant chief hydraulic engineer, T. J. Bostwick, electrical engineer, all of the Aluminum Company of America, and W. S. Lee, M.E.I.C., are serving as consulting engineers.

Arthur Surveyer, M.E.I.C., of Montreal, Canada, is collaborating engineer.

The Manufacture of Insulating Board at Donnacona, Quebec

Dr. John S. Bates, A.M.E.I.C.,
Executive and Chief Chemist, Price Brothers and Company Limited
and
A. A. MacDiarmid, M.E.I.C.,
Chief Engineer, Price Brothers and Company Limited

Paper presented before the Quebec Branch of The Engineering Institute of Canada on May 7th, 1930.

SUMMARY.—This paper gives a general account of the benefits derived from insulating materials and the use and properties of some that are at present manufactured into a product suitable for thermal insulation and sound absorption purposes in buildings. Particular reference is made to a board manufactured at the mill of Price Brothers and Company, Ltd., at Donnacona, Que., built under the authors' supervision, where sawmill waste and culled wood from paper mills is utilized and manufactured into a fibre board with high insulating properties. A general description of this mill is given, and also a sketch of the various processes in the manufacture of this interesting wood product.

Buildings in Canada are in special need of thermal insulation by reason of our extremes of climate. The public are taking an increased interest in the application of insulation, and there are complete research facilities for the study and development of insulation needs. Canada possesses a wide variety and an abundant supply of raw materials suitable for insulating products and industries are already established to meet the growing need for these products.

Thermal insulation means resistance to transfer of heat thereby offering protection to heat or cold. The fact has been established that the best practical means of obtaining the insulating result is to provide minute, still air spaces not subject to convection currents. In general it may be said that most organic materials of cellulosic composition are more or less equivalent in inherent heat conductivity and are fairly good natural insulators. The manufacture of an insulating product is largely a proposition of disintegrating these cellulosic raw materials into fibrous form and working them up into a porous board or felt for the purpose of producing a large proportion of these minute air spaces. The low density or lightness of the product is therefore a fairly good indication of the insulating quality although the distribution of the air spaces is a vital factor. For instance, dry solid wood weighing 25 to 30 pounds per cubic foot has a heat conductivity of about 1 (in terms of B.t.u's heat transfer per square foot per inch of thickness per degree F. temperature difference per hour), while disintegrated wood fibre in the form of insulating board weighing 15 pounds per cubic foot has a heat conductivity of about 0.33; in other words, the increased proportion of still air spaces has improved the insulating effect threefold with half the weight of material. From the economic point of view it should be noted that one pound of wood material manufactured into artificial lumber in the form of modern insulating board accomplishes six times the insulating effect of the same wood in the form of ordinary lumber.

The mechanics of heat loss in a building has been a subject of considerable study in recent years. The natural tendency for heated air to rise has directed particular attention to roof construction and it is now usually considered that about 50 per cent of the insulating requirements in a house should be provided in the roof. An interesting point is that better roof insulation allows wider scope in style of roof construction and during our Canadian winters by preventing the melting of snow automatically increases the protection during the coldest weather. The outside walls of the building also require adequate insulation to protect against wind and ordinary radiation. Limiting factors of windows, doors and other areas of heat transfer or air infiltration establish a balance making it unnecessary to carry building insulation beyond a reasonable degree. A fortunate factor in connection with building insulation is that the very means which protect our houses from cold weather during winter also guarantee coolness and extra comfort during summer and incidentally preserve quietness by keeping out sound.

The term "insulation" is sometimes also applied to sound absorption and there is a connection between sound insulation and heat insulation. Sound absorption however depends more on surface characteristics, the roughness of fibrous surface and the porous nature of the material creating friction to the air sound waves. New building materials are finding an important place in talking picture theatres, auditoriums, restaurants, offices, etc. for improved acoustics, and special materials are being used more extensively in partitions and walls for sound deadening between rooms of buildings.

Fig. 1—General View of Donnacona Insulating Board Mill.

One inch of wood fibre insulating board has a thermal insulation value equal to approximately 3 inches of lumber, 12 inches of brick or 25 inches of concrete. Reasonable structural strength is needed in insulating board and is well attained by the use of wood fibre. At the same time, the insulating board is manufactured in such a way as to give uniform strength in all directions, thereby eliminating the grain and inequalities of wood. Manufacturing from fibrous raw material also lends itself to special treatments which are impossible with natural building materials. Waterproofing of the fibres is a very valuable result in order to obtain as much protection as possible against humidity and moisture with their tendency towards expansion and contraction of the board. A porous material is naturally difficult to waterproof butwood fibre insulating board can be made more resistant than lumber to moisture absorption when immersed in water. Rotproofing is another desirable treatment to protect vegetable fibre boards from slow decay and thorough treatment can be easily accomplished during the course of manufacture. Absolute fireproofing is almost impossible with organic materials but fire-retarding properties would seem to be most logical for building materials in general. At the present time, there is no insistent demand for the fireproofing of insulating board on account of the quantities of wood and other combustible materials used in ordinary building construction, but it is the desire of insulating board manufacturers to meet the call for increased safety by fireproofing treatments which will give reasonable protection. The colour of the board is a factor for certain uses and the natural wood colour of wood fibre insulating board meets with public favour. Surface finish is another consideration of increasing importance and flexibility of manufacture makes it possible to produce a variety of pleasing surface finishes. The convenience of uniform dimensions of insulating board to suit standard building requirements, large sizes for easy handling, definite thicknesses to meet particular requirements and general control of packaging and distribution are commercial factors which represent improved service to the public.

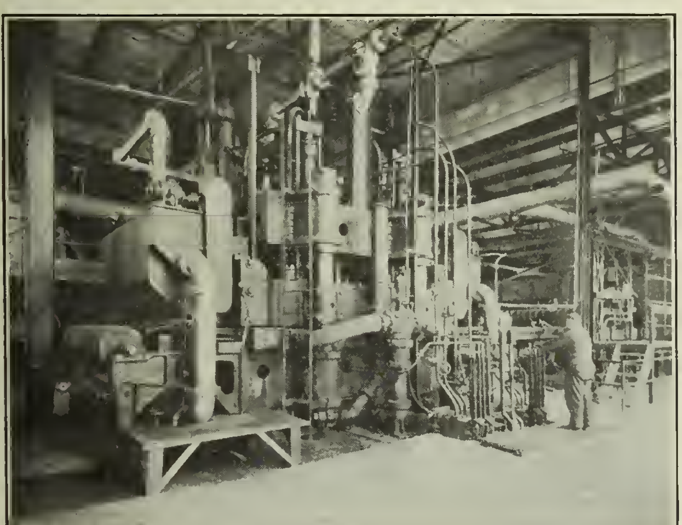

Fig. 2—View of Forming Machine.

Considering the fairly recent development of special insulating materials for building construction it is rather surprising to note the wide variety of products on the market and the extent to which they are used. Rigid insulating building boards are made of vegetable fibre raw materials, such as wood fibre, bagasse or sugar cane, licorice root fibre, cornstalks, etc. Other building boards, such as gypsum, stress fireproofing and smooth finish rather than insulating properties. Cork board is an example of a good insulating product which has practically no virtue as a structural material. Flexible insulation sacrifices structural strength for improved thermal insulation value, the better-known products consisting of dried eelgrass, a blanket of wood fibre between two layers of paper, a blanket of hair felt, a semi-rigid board of flax straw, etc. Loose insulation also finds a place in the air spaces of partitions, and includes wood fibre, gypsum, asbestos mixture, magnesia, diatomaceous earth, slag wool, etc.

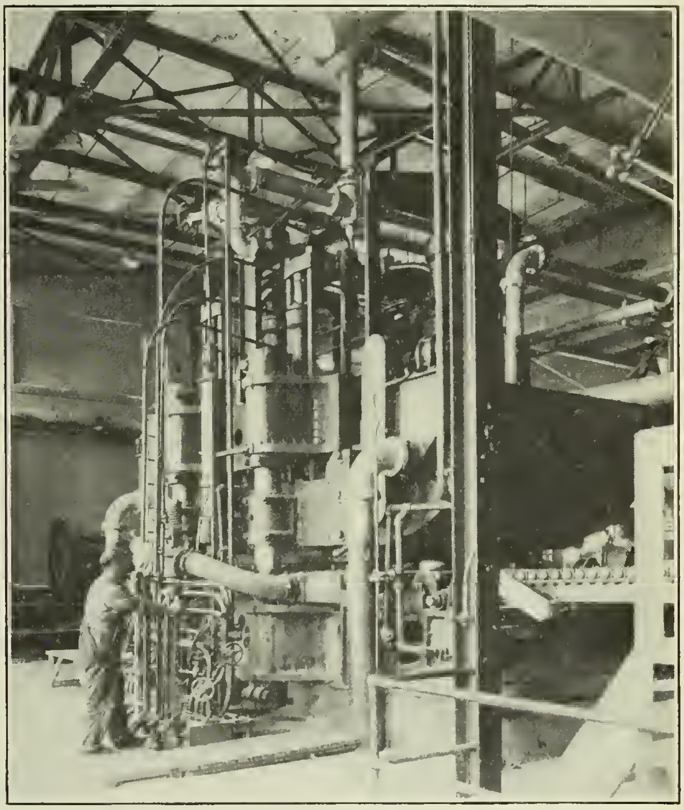

Fig. 3—Forming Machine showing Arrangement of Platens and Hydraulic Press.

As an example of modern methods of manufacture of insulating board, the processes employed at the recently constructed Donnacona mill will be described briefly.

The rated daily capacity of the Donnacona mill is 150,000 square feet on a ½ inch basis.

Fig. 4—Section of Roller Dryer.

The manufacture includes four operations, namely:
1. Preparation of fibres.
2. Forming the fibres into sheets of lumber.
3. Drying.
4. Sawing the lumber into commercial sizes.

1. Preparation of Fibres

The raw material consists of saw-mill slabs and edgings, planer mill shavings, short blocks, and dark or discoloured wood which is unfit for use in paper making, and the coarse fibres rejected in the screening operations in groundwood pulp mills.

The slabs, edgings and blocks are first reduced to chips or chunks of wood by passing them through a suitable type of "hog." This material, with the shavings and groundwood screenings, is then fed to special refiners of different types and reduced in these machines to a mass of fibres of varying size and having a fairly definite viscosity and freeness.

After the refining operations have been completed, various chemicals are added to make the board fire-resisting, water, vermin and rot-proof, and, when these have been thoroughly mixed and the solution adjusted to a definite consistency, the preparation of the fibres is complete.

2. Forming the Fibres into Sheets of Board

The mixture, when ready for forming into sheets, consists of approximately ninety-seven and one half per cent water and two and one-half per cent fibre, that is, the consistency is two and one-half per cent.

The forming machine is a large hydraulic press with platens or pressing surfaces set in a horizontal position. The machine weighs 210 tons and forms a sheet of lumber approximately 8 feet wide by 13 feet long, and in thicknesses from ½ inch to 2 inches.

The bottom platen is stationary, while the top platen is movable vertically and has surrounding it a cast-steel frame (known as a deckle) which also moves vertically and independently of the platen. This deckle is so designed that it makes a water-tight seal with the edges of the top platen and the top of the bottom platen.

Resting on the bottom platen is a fine mesh bronze wire cloth which is wrapped around metal rolls, one at each end of the press. The roll at the discharge end is driven with a motor.

Attached to each end of the cast-steel deckle is a large metal tank or reservoir for holding a quantity of the mixture of fibres and water.

The operating cycle of the machine is as follows:

(1) The top platen is set at a given distance above the bottom one, this distance being determined by the thickness of the sheet to be made.

(2) The mixture of fibres and water is admitted to the head boxes.

(3) The deckle is lowered until it rests tightly on the fine wire cloth which, in turn, is resting on the bottom platen.

(4) The mixture, of definite consistency, is then allowed to flow through gates in the sides of the head boxes and deckle to the space between the two platens and on top of the wire cloth.

(5) Pressure is then gradually applied to the 4 main pistons on the top platen and, as this is done, the water in the mixture is forced out through holes in the platens and to a storage tank. Vents are also provided in the sides of the deckle to allow any entrained air to escape.

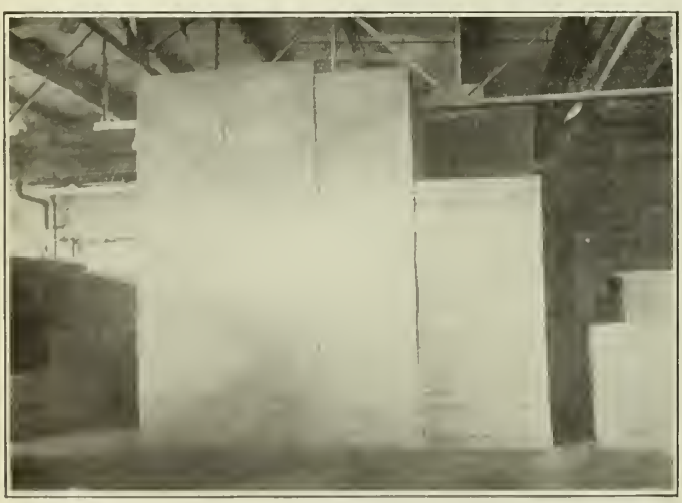

Fig. 5—Board Ready for Packing.

Fig. 6—Insulating Board Packed Ready for Shipment.

(6) The hydraulic pressure (which is 1,500 pounds per square inch) is held on the platen for a definite number of seconds and then released. This hydraulic pressure gives a pressure on the lumber being formed of about 125 pounds per square inch. Afterwards the deckle and top platen are raised and a wet sheet of lumber of a definite thickness remains on the wire cloth.

(7) The motor on the wire cloth roll is put in motion. This forms a conveyor belt of the wire cloth which carries the sheet of lumber out of the press and discharges it on a roller transfer table.

(8) The travel of the wire cloth is then reversed and on its return to the original position the cycle of forming a sheet of board is complete.

3. Drying

The machine used for this operation is known as a roller dryer and consists essentially of a large number of tubular rolls about 3 inches in diameter, spaced closely together horizontally and arranged in eight decks or tiers, one directly above the other. Under each deck of rolls there is fitted in sections a continuous layer of 1-inch return-bend steam coils.

The rollers are all fitted with a central chain drive and the entire apparatus is enclosed in a completely insulated steel casing which is about 300 feet long, 15 feet wide and 15 feet high.

An arrangement of fans and air ducts circulates air through the entire dryer and when this air becomes laden with moisture it is discharged to a heat reclaiming device.

The sheets of lumber are discharged from the transfer table at the forming machine to an automatic push-button-controlled elevator which, in turn, delivers them to each deck of the dryer in proper rotation.

As it requires not less than 3 hours to dry ½ inch thick lumber, the movement through the dryer is comparatively slow—about 1 to 1.5 feet a minute. In order to dry at this rate, a steam pressure of 125 pounds has to be used in the coils and the maximum air temperature in the dryer is held at about 320 degrees F.

4. Sawing the Lumber into Commercial Sizes

After the lumber passes out of the dryer it is conveyed to an automatic saw table that trims the sheets and cuts them into commercial sizes without the aid of attendants. The lumber is then carefully inspected, sorted, graded, wrapped and packed in crates of convenient size for shipment.

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The Development of the Aero Engine

Many technical societies commemorate by an annual lecture the life or achievements of some eminent engineer or man of science, after whom the lecture is named. This admirable custom brings yearly to remembrance the career and work of the man in whose memory the lecture is given and affords an opportunity of presenting an authoritative account of progress and recent accomplishment in some special branch of engineering, on which the lecturer is a recognized authority. It is to be regretted that in Canada we have as yet no foundation of this nature, but in Britain and the United States there are several, and the benefits of these discourses to the society and to the engineering public are very evident.

As an excellent example of such lectures we may take the recent Wilbur Wright Memorial Lecture of the Royal Aeronautical Society, an event of international interest. It was founded eighteen years ago as a memorial to the first man who achieved controlled power-driven flight in a heavier-than-air machine.

Last year, recognizing that the internal combustion engine made flight possible as we know it to-day, the Society chose as lecturer a pioneer in research on engines of that type, H. R. Ricardo, F.R.S. Taking as his subject the development of the aero engine, the lecturer discussed recent progress, particularly since the war, and pointed out that the aero engine of to-day is not only an extremely light and efficient prime mover, but also possesses in a high degree that quality of first importance, reliability. Advance during the past twelve years has been remarkable, and during that time the average output of aero engines of given cylinder capacity has been increased by no less than forty per cent, this result having been obtained partly by increasing the rotative speed and partly by increasing the available mean effective pressure, the latter feature having been made possible by a steady improvement in the quality of the fuel available. Mr. Ricardo has himself taken a leading part in research on the latter point and has been particularly associated with the investigation of the phenomena of detonation in engine cylinders. A few years ago hardly anything was known regarding the behaviour of different hydro-carbon fuels, the suitability of gasoline for engine use was judged merely by its specific gravity; no distinction was made between detonation and pre-ignition, and the engine designer was blamed for the troubles which accompanied any increase in speed and compression ratio. Research soon showed that detonation was not a form of pre-ignition but depended primarily upon the composition of the fuel, because some of its constituents, such as benzol and toluene, were found to cause less detonation than other hydrocarbons present. Then came the discovery of the efficacy of certain metals in suppressing detonation and the recognition of the beneficial effects of small doses of metallic dopes, such as lead tetra-ethyl.

Speaking of the concurrent development of both air-cooled and water-cooled types of engines, Mr. Ricardo considers that the obvious advantages of the air-cooled engine as regards lightness, simplicity and freedom from damage by frost, are largely out-weighed by disadvantages which are not so apparent at first sight. Thus, the advantage gained in the way of reduced weight is more than offset by increased head resistance, and in order to obtain effective cylinder cooling without local overheating at any point, the air-cooled engine has to expend more energy in cooling itself, besides requiring more lavish lubrication and working at a somewhat lower efficiency. The question of air versus water cooling, however, is still unsettled, and it is significant that much attention is now being paid to the use of steam cooling for radiators, and the employment of fluids other than water, having a lower freezing point and higher boiling point.

The improvement due to increase in compression ratio seems to have neared its limit, so that further progress in aero-engines of the present generally accepted type must be obtained by increasing the weight of air taken into the cylinder. This can, of course, be done by increase in speed, but this gives rise to difficulties in connection with ignition, carburetion, and distribution. There is no doubt that supercharging at present offers the best means for power increase, but here again development is limited by increase in the heat stresses resulting in valve difficulties and greater tendency to detonation. For supercharging, the exhaust-driven fan has largely been superseded by the gear-driven type and in some cases a pressure as high as 14 pounds per square inch above atmosphere has been maintained in the induction pipe. In the United States very promising results have been obtained by the use of a positive displacement type blower instead of a fan.

The exhaust valve in the four-cycle internal-combustion engine works under very severe conditions as regards temperature and mechanical stresses, and the working temperature of these valves in aero engines is now so high as to require all the skill of the metallurgist and designer to obtain satisfactory and reliable operation. It would, therefore, appear that any substantial increase in performance in the future is dependent upon the substitution of some other form of available mechanism for the time-honoured poppet valve, and in Mr. Ricardo's opinion the use of the sleeve valve opens up possibilities otherwise unobtainable.

In concluding his lecture, Mr. Ricardo directed attention to the promising results already obtained with heavy oil-engines for aircraft. If these can be used, there will result a great reduction in fire risk, much better fuel economy, the use of a cheaper fuel, and the elimination of electric ignition with its sparkplug troubles and interference with radio communication. Many investigators are at work on this problem, and very promising results have recently been obtained. One of the most successful engines of this type, produced by the Packard Company, is said to weigh little over 2¼ pounds per horse-power, a figure only about one-third greater than the weight of a gasoline engine of similar design. In the lecturer's opinion, it will be long before heavy oil engines will supersede the present type of aero engine, while both types will be utilized for many years to come.

Mr. Ricardo also said that in reviewing the progress of engineering in the past, we find that each new line of development starts, of course, with a period of experiment and groping, during which a wide range of types is evolved. By a process of elimination this range is very soon whittled to one or two survivors; in the final choice of these survivors, chance plays often quite as important a part as merit. On the one or more survivors the attention of the whole engineering world is concentrated, with the result that step by step it is improved out of all recognition and reigns supreme until it reaches almost the very limit of its capacity, when a new and fundamentally better type eventually replaces it. Such has been the history of the steam engine which fifty years ago had crystallized into an almost standard design of open-type, double-acting, slow-running engine; for many years this held undisputed sway until it was displaced by the enclosed high-speed vertical type; this again was perfected until it seemed almost final, only to be superseded in turn by the turbine. That this process is so prolonged and that the obsolete so long outlives its day, is due to the fact that in every age the newcomer, in its raw and undeveloped state, is invariably pitted against the champion of the older school and challenged to defeat it in the first round. Allowance is seldom made for the fact that the reigning type has enjoyed the benefit of many years' experience under every conceivable condition, supplemented by the combined skill of the best talent in the country, while the newcomer, of course, lacks these advantages. It is this attitude of mind, this want of imagination, perhaps, which frequently delays progress and allows obsolete types to outlive their day.

Past-Presidents' Prize

Members are reminded that the Past-Presidents' Prize for 1930-1931, value one hundred dollars, is offered for the best paper submitted by a member of The Institute of any grade, on "Engineering Education in Canada." As a guide to authors the following topics are suggested:

(*a*) Engineering Courses at Canadian Universities—Admission standards—Place of cultural studies—Desirability of specialization—Guidance of special abilities in undergraduates.

(*b*) The Need and Opportunity for Collaboration by Practising Engineers and Employers in the Practical Training of Undergraduates and Young Graduates.

Papers to be entered for the competition must be received during the prize year, July 1st, 1930, to June 30th, 1931, by the General Secretary, from whom further information can be obtained.

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 1930-1931 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, 1931. Further information as to the requirements and rules may be obtained from the General Secretary.

Prizes to University Students

At the Plenary Meeting of Council in September last it was decided to offer annually to each of the eleven important engineering schools in the Dominion a prize to be known as "The Engineering Institute of Canada Prize," for competition among the registered students in the year prior to the graduating year. This offer has been cordially accepted by the authorities of the following institutions:

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

and it is anticipated that the first awards will be made this month.

It has been determined that these prizes shall be continued for a period of five years, and it is the desire of Council that the method of their award shall be determined by the appropriate authority in each school or university, so that a prize may be given to the student in any department of engineering who has proved himself most deserving, not only in connection with his college work, but also as judged by his activities in the student engineering organization, if any, or in the local branch of a recognized engineering society.

It is not necessary for the recipient to belong to The Institute, and in this respect the prizes are quite distinct from those offered to Students and Juniors of The Institute, or from the prizes which are offered by a number of our branches to the Students attached to them.

It is felt that the establishment of these prizes will not only aid deserving students, but will assist in developing their interest in engineering societies' work, and in the resulting acquirement and interchange of professional knowledge.

Henry Martyn MacKay Memorial Scholarships

Plans are under way for the establishment of a memorial to the late Dr. Henry Martyn MacKay, M.E.I.C., former Professor of Civil Engineering and Dean of the Faculty of Applied Science, McGill University, who died on October 25th last. Arrangements are in the hands of a representative committee under the chairmanship of Professor Ernest Brown, M.E.I.C., and including Dr. D. A. Murray, J. Colin Kemp, A.M.E.I.C., G. McL. Pitts, A.M.E.I.C., W. E. Cushing, W. Taylor Bailey, Professors C. M. McKergow, M.E.I.C., R. DeL. French, M.E.I.C., and R. E. Jamieson, A.M.E.I.C., and Homer M. Jaquays, M.E.I.C., honorary treasurer. A memorial in the form of undergraduate scholarships in the Faculty of Applied Science has been decided upon as most appropriate, and the committee hopes to secure sufficient funds to permit the endowment of two or more such scholarships. It is estimated that a minimum sum of $10,000 will be required, and it is expected that at least one of these scholarships will be available at the opening of the session next October.

The committee is particularly anxious that the fund shall be fully representative of the large body of friends of the late Dean, and it is hoped that this notice may reach many of those whose addresses are unknown to the committee. Subscriptions should be made payable to "H. M. MacKay Memorial Fund," and sent to room No. 71, Engineering building, McGill University, Montreal.

The Forty-Fifth Annual General and General Professional Meeting

Convened at Headquarters, Montreal, January 22nd, 1931, and adjourned to the Windsor Hotel, Montreal, February 4th, 1931

Annual General Meeting at Institute Headquarters

The Forty-fifth Annual General Meeting of The Institute was held at Headquarters on Thursday, January twenty-second, nineteen hundred and thirty-one, at eight o'clock p.m., with Vice-President George R. MacLeod, M.E.I.C., in the chair.

The Secretary having read the notice convening the meeting, the minutes of the Forty-fourth Annual General Meeting were submitted, and on the motion of H. B. Montizambert, A.M.E.I.C., seconded by C. R. Lindsey, A.M.E.I.C., were taken as read and confirmed.

Appointment of Scrutineers

On the motion of J. B. O. Saint-Laurent, A.M.E.I.C., seconded by W. H. Cook, A.M.E.I.C., Messrs. L. H. D. Sutherland, M.E.I.C., and R. E. MacAfee, A.M.E.I.C., were appointed scrutineers to report the result of the Officers' Ballot.

Appointment of Auditors

On the motion of C. K. McLeod, A.M.E.I.C., seconded by A. Duperron, M.E.I.C., Messrs. Riddell, Stead, Graham and Hutchison were appointed auditors for the ensuing year.

There being no other formal business, it was resolved, on the motion of J. A. Burnett, M.E.I.C., seconded by H. W. B. Swabey, M.E.I.C., that the meeting do adjourn to reconvene on Wednesday, the fourth day of February, nineteen hundred and thirty-one, at ten o'clock a.m., at the Windsor hotel, Montreal, Quebec.

Adjourned General and General Professional Meeting at the Windsor Hotel, Montreal

The adjourned meeting was called to order by President A. J. Grant, M.E.I.C., at ten o'clock a.m. on Wednesday, February 4th, 1931, and the President welcomed the members and guests who were present, particularly F. L. Stuart, M.E.I.C., President of the American Society of Civil Engineers, and W. S. Lee, M.E.I.C., President of the American Institute of Electrical Engineers.

The Secretary having placed before the meeting the letters and telegrams of regret from members and guests unable to be present, the membership of the Nominating committee appointed to nominate the officers of The Institute for 1932, was announced as follows:

Nominating Committee 1931

Chairman: P. S. Gregory, M.E.I.C.

Branch	*Representative*
Halifax Branch	H. W. L. Doane, M.E.I.C.
Cape Breton Branch	K. H. Marsh, M.E.I.C.
Saint John Branch	J. P. Mooney, A.M.E.I.C.
Moncton Branch	G. L. Dickson, A.M.E.I.C.
Saguenay Branch	G. F. Layne, A.M.E.I.C.
Quebec Branch	P. Méthé, A.M.E.I.C.
St. Maurice Valley Branch	C. H. Jetté, A.M.E.I.C.
Montreal Branch	P. E. Jarman, A.M.E.I.C.
Ottawa Branch	W. D. McLachlan, M.E.I.C.
Peterborough Branch	A. L. Killaly, A.M.E.I.C.
Kingston Branch	W. L. Malcolm, M.E.I.C.
Toronto Branch	R. O. Wynne-Roberts, M.E.I.C.
Hamilton Branch	W. L. McFaul, M.E.I.C.
London Branch	F. C. Ball, A.M.E.I.C.
Niagara Peninsula Branch	C. G. Moon, A.M.E.I.C.
Border Cities Branch	J. Clark Keith, A.M.E.I.C.
Sault Ste. Marie Branch	W. S. Wilson, A.M.E.I.C.
Lakehead Branch	F. C. Graham, A.M.E.I.C.
Winnipeg Branch	J. W. Porter, M.E.I.C.
Saskatchewan Branch	H. R. Mackenzie, A.M.E.I.C.
Lethbridge Branch	R. Livingstone, M.E.I.C.
Edmonton Branch	E. Stansfield, M.E.I.C.
Calgary Branch	F. M. Steel, M.E.I.C.
Vancouver Branch	J. C. Oliver, Jr.E.I.C.
Victoria Branch	J. C. MacDonald, M.E.I.C.

Award of Medals and Prizes

The awards of the various prizes and medals of The Institute were next announced, and the President stated that arrangements had been made for their presentation at the Annual Dinner. The prize list was as follows:

The Sir John Kennedy Medal to George Herrick Duggan, M.E.I.C.

The Past-Presidents' Prize to Group-Captain E. W. Stedman, M.E.I.C., for his paper on "Rigid Airships."

Gzowski Medals to F. M. Wood, A.M.E.I.C., for his paper on "A Short Monograph on Nomography," and to P. B. Motley, M.E.I.C., for his paper on "Reinforcement in Place of the Stoney Creek Arch Bridge."

Leonard Medals and Prize—A Gold medal to C. G. MacLachlan for his paper on "Twelve Months Milling at Noranda"; a Silver medal to W. B. Boggs for his paper on "The Noranda Smelter"; a prize of books to A. E. Flynn for his paper on "Anhydrite Plasters and Cements."

The Phelps Johnson Prize to G. B. Jost, S.E.I.C., for his paper on "Steel Mitering Lock Gates on the Welland Ship Canal."

Reports of Council and of Finance Committee

The meeting next proceeded to the consideration of the report of Council together with the report of the Finance Committee, these having already been printed and placed in the hands of members. The reports having been read by the Secretary, discussion followed, during which J. H. Hunter, M.E.I.C., criticized the action of Council in failing to bring forward for the third time the proposal to amend Section 34 of the By-laws so as to provide a much-needed increase in revenue from increased members' fees; he considered the report of Council unsatisfactory in this respect. It was then moved by G. Stead, M.E.I.C., seconded by M. B. Atkinson, M.E.I.C., that the report of Council be received. In support of the motion, Mr. Atkinson thought that Council had been well advised not to bring forward the proposal this year, as he believed that when the membership had had time to consider the situation and when better times arrived, the proposal, if submitted again next year, would have a much better chance of carrying. George R. MacLeod, M.E.I.C., as chairman of the Finance committee, concurred with Mr. Atkinson, and after further discussion, in which Messrs. P. B. Motley, M.E.I.C., and J. L. Busfield, M.E.I.C., took part, Mr. Stead's motion was put and carried; subsequently, on the motion of Mr. MacLeod, seconded by Mr. Stead, the report of the Finance committee was adopted.

Committee on Tariff of Fees

The Secretary having gone over the principal points in connection with the reports of the Library and House committee, the Publication Committee, the Board of

Examiners, the committees on Engineering Education and International Co-operation, the Canadian Engineering Standards Association, the Membership committee, and the Publicity committee, Mr. Busfield gave a brief explanation as regards that of the Committee on Tariff of Fees, pointing out that the report now presented differed from that of 1922, which it superseded, in prescribing a rate of per diem remuneration of not less than $75.00, although "much higher rates may be charged." This, he thought, was quite in accord with present practice.

Mr. Busfield then summarized the work of the Committee on Remuneration, and stated that the report of this committee had not yet been published or presented to the membership, as it was still under consideration by Council.

On the motion of Mr. Busfield, seconded by P. E. Jarman, A.M.E.I.C., the report of the Committee on Tariff of Fees was unanimously adopted.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The Secretary next read the report of the Committee on Membership, and discussion on this was initiated by W. E. Ross, A.M.E.I.C., who pointed out the difficulties arising from the application of the rules regarding The Institute's examinations to men of mature years. Mr. Atkinson referred to the resolution of a meeting of the Montreal Branch regarding this matter which had been presented to Council, and H. B. Montizambert, A.M.E.I.C., thought that if the entrance examinations for the grade of Junior were rigidly adhered to, Council might perhaps be lenient in the matter of requiring examinations when application for transfer from that grade is made. Mr. Busfield pointed out that he had proposed the resolution of the Montreal Branch regarding Council's action on examinations to which reference had been made, and in order to get an expression of opinion on this point from this meeting he would move "that this meeting urges that the Council of The Institute should exercise freely its right under the present By-laws to waive examinations in the cases of applicants for transfer to Associate Membership who show by their engineering record that they have had a reasonable degree of professional experience." This motion was seconded by Mr. Ross.

O. O. LEFEBVRE, M.E.I.C.
Newly-Elected Vice-President.
Zone C.

Mr. Busfield considered that the primary purpose of The Institute was now educational rather than professional, the right to practise as an engineer being conferred by the action of the various Associations of Professional Engineers. He thought that the utility of The Institute would be increased by concentrating on the development of its educational features and by admitting engineers to its advantages on easier terms. He pointed out that the resolution proposed did not change the conditions for admission, but urged Council to use its judgment in applying them.

E. M. Proctor, M.E.I.C., enquired as to the nature of The Institute's examinations, and thought that junior engineers without college training would desire to get qualified by passing them. He did not think that the bars should be lowered.

Mr. Atkinson referred to the action of the Niagara Peninsula Branch in requesting Council to give more consideration to the recommendations of the Branch Executive committees in regard to applications for admission; after which the Secretary, in reply to Mr. Proctor, outlined The Institute's present examination requirements.

H. B. MUCKLESTON, M.E.I.C.
Newly-Elected Vice-President.
Zone A.

Dr. O. O. Lefebvre, M.E.I.C., opposed Mr. Busfield's motion as it would tend to lower the standard of admission to The Institute. He agreed with Mr. Proctor that too much attention was being paid to the question of examinations for non-graduates and pointed out that not enough attention was given to the engineering graduates of our colleges. If the grade of admission were lowered, graduates would no longer think it worth while to belong to The Institute.

S. G. Porter, M.E.I.C., pointed out that the question at issue was closely connected with the relations between The Institute and the various Provincial Associations of Professional Engineers, and remarked that when a close working arrangement had been entered into with these Associations the qualifications for admission to The Institute would be the same as the uniform standard which he hoped would be agreed upon by all the Associations and by The Institute. Such an agreement, however, would no doubt involve some change in the nomenclature of our grades of membership, so that these might correspond to those adopted by the Professional Associations.

After further discussion, Mr. Atkinson expressed the opinion that The Institute should not be bound to take any man because a Provincial Association has licensed him to practise as an engineer in some particular province. He thought that there should be means for admitting into The Institute men of ripe engineering training without the necessity of their qualifying by examination for admission to a Professional Association; such men would enhance the value of The Institute throughout the country.

Mr. Busfield's motion being put, the ayes numbered 20 and the nays 25, and the motion was declared lost.

Mr. Proctor enquired whether the adoption of the report of the Committee on Engineering Education would commit The Institute to all of its recommendations, including that suggesting a six-year course for engineers at the universities. The Secretary pointed out that the recommendation to which Mr. Proctor referred was merely that there should be a conference on the subject.

The President remarked that it would now be in order to move the adoption of the committee reports attached to the Report of Council, with the exception of those which had already been accepted. Accordingly, on the motion of Mr. Motley, seconded by R. L. Dobbin, M.E.I.C., the remaining committee reports were unanimously adopted.

Reports of the Branches

On the motion of Major L. F. Grant, M.E.I.C., seconded by Mr. MacLeod, the Branch reports were taken as read and adopted.

The meeting then adjourned at 12.30 o'clock p.m., to resume at 2.15 o'clock p.m.

Report of the Committee on the Relations of the Institute with the Provincial Associations of Professional Engineers

At the afternoon session the President asked Past-President H. H. Vaughan, M.E.I.C., the chairman of the Committee on the Relations of The Institute with the Provincial Associations of Professional Engineers, to speak concerning his report.

Mr. Vaughan explained that his committee had drafted proposals which had been forwarded to the Councils of the various Professional Associations, suggesting that the first problem to be considered was the establishment of uniform requirements for admission to the various Associations and to The Institute, and proposing the formation of a national committee on which all of the bodies would be represented. This committee hoped to arrange for the preparation of a comparison and analysis of the various present requirements of all the organizations. It was then proposed to select a small committee of three or four members, who would prepare a draft set of uniform requirements for admission, for consideration by the whole committee. The councils of a number of the Provincial Associations had already agreed to this course, and Mr. Vaughan hoped that the others would soon signify their concurrence.

The President thanked Mr. Vaughan for his explanation, and pointed out that the report of his committee had already been accepted by the meeting.

Proposals for Amendments to By-laws

At the request of the President, the Secretary next read the proposals made by Council for amendments to sections 66 and 67 of the By-laws, dealing with the constitution of the Nominating committee. Communications were presented from the Quebec Branch, the Moncton Branch and the Niagara Peninsula Branch expressing disapproval of Council's proposals, and asking that they be withdrawn.

Discussion on Council's proposals followed, during which Mr. Busfield explained the purpose of Council's suggestions, and Dr. Lefebvre pointed out that as there was evidently opposition to Council's proposals, it would be necessary for the chairman to appoint a committee to draft reasons for and against the proposals, such reasons to accompany the letter ballot when sent out to the membership.

Mr. MacLeod remarked that when these communications were received from the Branches named, it was too late to comply with their suggestion that Council withdraw its proposals, particularly as they were based on action taken at the Plenary Meeting of Council.

Messrs. Ross, Hunter and others having spoken, and Mr. Vaughan having proposed an amendment to Council's proposals, which he subsequently withdrew, it was moved by Mr. Proctor that "this meeting go on record as being opposed to the amendments now proposed by Council to sections 66 and 67 of the By-laws."

Dr. Lefebvre opposed this idea, and was of the opinion that it was undesirable when submitting a proposal to the membership to state on the ballot that the Annual General Meeting had declared itself against the measure.

Mr. Proctor's motion not being seconded, the President named as a committee for the preparation of reasons for the proposals, Messrs. J. L. Busfield and R. B. Young, M.E.I.C., and for the preparation of the reasons against the proposals, Messrs. S. L. DeCarteret, M.E.I.C., and W. E. Ross, A.M.E.I.C.

Mr. Proctor expressed a desire that his motion should be voted on, and after being seconded by J. M. H. Cimon, M.E.I.C., it was put to the meeting, and carried by 30 votes to 7.

Retiring President's Address

The President then delivered (in abstract) his retiring address, a masterly description of the great ship canals of the world, with comments on their economic possibilities. This address is printed *in extenso* on pp. 182 to 190 of the March, 1931, issue of The Engineering Journal.

Election of Officers

The Secretary having read the report of the scrutineers appointed to canvass the Officers' Ballot for 1931, the following officers were declared elected:

President	Sam G. Porter, M.E.I.C.
Vice-Presidents:	
Zone A	H. B. Muckleston, M.E.I.C.
Zone C	O. O. Lefebvre, M.E.I.C.
Councillors:	
Halifax Branch	W. P. Copp, M.E.I.C.
Cape Breton Branch	A. L. Hay, M.E.I.C.
Saint John Branch	A. R. Crookshank, M.E.I.C.
Moncton Branch	G. C. Torrens, A.M.E.I.C.
Saguenay Branch	G. E. LaMothe, A.M.E.I.C.
Quebec Branch	J. M. H. Cimon, M.E.I.C.
St. Maurice Valley Branch	B. Grandmont, A.M.E.I.C.
Montreal Branch	C. V. Christie, M.E.I.C.
	D. C. Tennant, M.E.I.C.
Ottawa Branch	F. H. Peters, M.E.I.C.
Peterborough Branch	R. L. Dobbin, M.E.I.C.
Kingston Branch	D. M. Jemmett, A.M.E.I.C.
Toronto Branch	Thomas Taylor, M.E.I.C.
Hamilton Branch	E. H. Darling, M.E.I.C.
Niagara Peninsula Branch	E. G. Cameron, A.M.E.I.C.
Border Cities Branch	A. E. West, M.E.I.C.
Sault Ste. Marie Branch	A. E. Pickering, M.E.I.C.
Lakehead Branch	G. H. Burbidge, M.E.I.C.
Winnipeg Branch	N. M. Hall, M.E.I.C.
Saskatchewan Branch	R. W. E. Loucks, A.M.E.I.C.
Lethbridge Branch	G. N. Houston, M.E.I.C.
Edmonton Branch	R. W. Ross, A.M.E.I.C.
Calgary Branch	R. S. Trowsdale, A.M.E.I.C.
Vancouver Branch	P. H. Buchan, A.M.E.I.C.
Victoria Branch	K. M. Chadwick, M.E.I.C.

The scrutineers reported that in the case of the Councillor from the London Branch, an equal number of votes had been polled by W. P. Near, M.E.I.C., and J. A. Vance, A.M.E.I.C.; in accordance with the By-laws a ballot was ordered to be taken, Messrs. G. R. MacLeod and E. M. Proctor being named by the President as scrutineers.

Induction of Newly-Elected President

Pending the result of the ballot the President asked Past-President J. M. R. Fairbairn and Vice-President O. O. Lefebvre to conduct the newly elected President to the chair, and this was accordingly done.

President Porter, in expressing appreciation of the honour conferred upon him, remarked that he was particularly gratified by this recognition of the western Branches, and he looked upon his election as being an endorsation of the efforts he had sponsored to bring about a more intimate relationship between The Institute and the Provincial Associations of Professional Engineers. He considered this the most important problem now facing The Institute, and believed that nearly all the other questions at issue would be found to be interwoven with it.

Regarding the handicap of distance which would separate him from the Headquarters of The Institute, he nevertheless felt that with the co-operation of the members of Council residing nearer Headquarters, and with well-chosen committees to look after the different phases of the work, there would be real progress in the affairs of The Institute.

The scrutineers next presented their report, and it was announced that W. P. Near, M.E.I.C., was elected as councillor from the London Branch.

Drawing attention to the calls made upon the time of officers of The Institute, Mr. W. C. Adams moved that the hearty thanks of The Institute be accorded to the retiring President and the retiring members of Council, in appreciation of their services during the past year. This motion was seconded by Mr. J. H. Hunter and carried by acclamation.

On the motion of Mr. J. H. Hunter, seconded by Mr. R. L. Dobbin, 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 ballots be destroyed.

Mr. E. M. Proctor moved that the thanks of The Institute be conveyed to the Montreal Branch in recognition of their hospitality and activity in connection with the holding of the Forty-fifth Annual General and General Professional Meeting of The Institute in Montreal. This motion was seconded by G. Stead, M.E.I.C., and carried unanimously.

There being no further business the Annual General Meeting then terminated.

Luncheon

On the first day of the meeting, Wednesday, February 4th, a luncheon took place in the Rose Room, at which A. Duperron, M.E.I.C., chairman of the Montreal Branch, presided. Mr. Duperron extended a welcome to the members and guests present, and was followed by Alderman Gilday, who in the unavoidable absence of His Worship the Mayor of Montreal, greeted The Institute on behalf of the city. Dr. Gilday was followed by Mr. B. K. Sandwell, who was introduced by K. B. Thornton, M.E.I.C., and explained that he intended to address the assembly on "Engineering and Morals." Spending most of the time available in explaining to his audience exactly what he thought of them, Mr. Sandwell was obliged to conclude a very entertaining address just as he seemed likely to reach his announced subject.

Annual Dinner

In the evening the Annual Dinner of The Institute was held in the Rose Room, President S. G. Porter in the chair. It was memorable as being the first Annual Dinner at which ladies have been present. After dinner, the prizes and medals of The Institute were presented. In accepting the Sir John Kennedy Medal, Past-President G. H. Duggan, M.E.I.C., expressed his gratification at receiving the honour, and drew attention to the remarkable development of The Institute and its branches since he was first associated with the then Canadian Society of Civil Engineers forty-three years ago. He urged that the engineer best serves his own interests by putting service to the profession first, and by service to the profession he meant giving of his best to encourage the younger members, to promote loyalty to The Institute, and to maintain its ideals. Justly proud of his profession, the engineer's rules of conduct should be based on good citizenship, by observing which he would do his part in maintaining public respect for his profession.

The recipients of the other distinctions, Group-Captain Stedman, Mr. P. B. Motley, and Mr. F. M. Wood, suitably acknowledged the awards they received.

The presentation of the prizes and medals was followed by brief speeches from F. L. Stuart, M.E.I.C., President of the American Society of Civil Engineers, and W. S. Lee, M.E.I.C., President of the American Institute of Electrical Engineers.

After this, Beaudry Leman, A.M.E.I.C., President of the Canadian Bankers Association, delivered a thoughtful address, in which he traced some analogies between the conditions under which engineering and business activities are carried on. He remarked that the factor of safety, which played such an important part in engineering construction, was intended, first, to guard against undiscoverable defects in the structural material employed, which defects reduce the ultimate strength of the material, and second, to provide against the possibility of an unforeseen increase in the load to be carried. The apparent factor of safety was the product of four other factors: the first being the ratio of the ultimate strength of the material to its true elastic limit, the second depending on the character of the stresses produced within the material, the third being affected by the manner in which the load is applied to the piece, and the fourth being the factor of ignorance. Such factors of safety were used by engineers in connection with materials whose resistance and strength had been carefully measured, and yet liberal allowance had to be made for the factor of ignorance. What a lesson for those who, engaging in business, had to build with far less stable materials and to contend with no less powerful forces. The pressure of competition, said Mr. Leman, the breaking strain of taxation, the abrasions made on profits by multitudinous fixed charges, the lack of elasticity in our budgets, the plasticity of politics and the resiliency of our incomes should be figured out in business and large factors of safety applied.

Drawing attention to the disastrous results of modern economic conditions, Mr. Leman pointed out the effect of abandoning factors of safety in business, and the growth of a policy of following the path of least resistance. Why adhere to the gold standard, he observed, when paper is so much easier to procure in abundance? Why practise self-restraint to accumulate capital when credit may easily be made available to all? Why work and toil when it is so much easier to speculate? Why save for the future when it is so much easier for the state to provide for your needs? Why row upstream when it is so much easier to drift? Why have ambition, initiative, forcefulness, when it is so much easier to wait for something to turn up? Why have public spirit and ideals when it is so very much easier to be unconcerned and sceptical?

In concluding his address, Mr. Leman remarked that we are all desirous that our laws should reflect a more advanced civilization, provide more social welfare and extend a more generous hand to those who are handicapped or afflicted, but in so doing we should guard against sapping the very foundation of human progress, which has been private initiative and personal interest. The speaker held the close attention of his listeners throughout.

Smoking Concert

After the dinner a very successful smoking concert was held in the Windsor Hall, and a remarkably good series of turns was presented. C. M. McKergow, M.E.I.C., presided.

Ladies Entertainment

At the same time the ladies listened to an illustrated talk by Miss Amy B. Stone on "Literary Rambles in Southern England," accompanied by folk songs and musical numbers.

First Technical Session

On Thursday, February 5th, the technical sessions began, the papers being presented as follows:—

In the York Room, under the chairmanship of P. L. Pratley, M.E.I.C.:

"Train-Ferry Landings at Port Mulgrave and Point Tupper, N.S.," by D. B. Armstrong, A.M.E.I.C., erection engineer, Dominion Bridge Company, Ltd., Montreal, and W. Chase Thomson, M.E.I.C., designer, Dominion Bridge Company, Ltd., Montreal.

"The Construction of the Steel Lock Gates of the Welland Ship Canal," by E. S. Mattice, M.E.I.C., vice-president, National Bridge Company of Canada, Ltd., Montreal.

In the Prince of Wales Salon, under the chairmanship of J. A. McCrory, M.E.I.C.:

"Breakwater Construction in Port Arthur Harbour," by F. Y. Harcourt, M.E.I.C., district engineer, Department of Public Works, Canada, London, Ont.

"A Method of Laying Out Warped Surfaces of Hydraulic Structures," by C. P. Dunn, M.E.I.C., chief engineer, Alcoa Power Company, Arvida, Que.

"The Design of the Chute-à-Caron Diversion Canal," by G. O. Vogan, A.M.E.I.C., chief designing engineer, Alcoa Power Company, Ltd., Arvida, Que.

"The Technique of Placing Concrete on Steep Slopes without Forms," by I. E. Burks, concrete technician, Aluminum Company of America.

Second Technical Session

At the technical sessions held in the afternoon, the papers presented were as follows:—

In the York Room, under the chairmanship of P. E. Jarman, A.M.E.I.C.:

"Structure and Oil Prospects of the Eastern Foothills Area, Alberta, Between the Highwood and Bow Rivers," by Dr. G. S. Hume, Geological Survey, Department of Mines, Ottawa.

"The Water Supply Problem in Southern Saskatchewan," by W. A. Johnston, Geological Survey, Department of Mines, Ottawa.

"Automatic Block Signalling on the Canadian Pacific Railway," by A. J. Kidd, assistant to signal engineer, Eastern Lines, Canadian Pacific Railway, Montreal.

In the Prince of Wales Salon, under the chairmanship of O. O. Lefebvre, M.E.I.C.:

"The Alexander Power Development on the Nipigon River," by T. H. Hogg, D.Eng., M.E.I.C., chief hydraulic engineer, Hydro-Electric Power Commission of Ontario, Toronto.

Ladies Visit to McGill Library

On Thursday afternoon a visit was arranged for the ladies to the remarkable Gest Chinese Research library at McGill University, and also to the library museum for writing materials of past ages, Japanese prints, illuminated manuscripts and early printed books. Dr. G. R. Lomer, the librarian, gave an explanatory address. Later on the ladies were entertained at tea at the Themis Club.

Third Technical Session

The final technical sessions of the meeting were held on Friday morning as follows:—

In the York Room, with C. M. McKergow, M.E.I.C., acting as chairman:

"The Steam Station for the Head Office Building of the Sun Life Assurance Company of Canada, Montreal," by F. A. Combe, M.E.I.C., consulting combustion and steam engineer, Montreal.

"The Mechanical Equipment in the Head Office Building of the Sun Life Assurance Company of Canada, Montreal," by E. A. Ryan, M.E.I.C., consulting engineer, Montreal.

"The Plumbing Systems Designed for the Head Office Building of the Sun Life Assurance Company of Canada, Montreal," by A. Traver Newman, consulting engineer, New York.

In the Prince of Wales Salon, with W. C. Adams, M.E.I.C., in the chair:

"The Structural Engineering of the Head Office Building of the Sun Life Assurance Company of Canada, Ltd., Montreal," by A. H. Harkness, M.E.I.C., Harkness and Hertzberg, consulting engineers, Toronto.

"The Electrical Equipment for the Head Office Building of the Sun Life Assurance Company of Canada, Montreal," by J. H. Mencke, consulting engineer, New York, and E. A. Ryan, M.E.I.C., consulting engineer, Montreal.

Visits to Engineering Works

Arrangements were made for members to visit a number of new buildings and engineering works on Friday afternoon, and a great many availed themselves of the opportunity offered. Among the places visited were: the new Head Office building of the Sun Life Assurance Company of Canada, which is approaching completion, and is designed for a population of 10,000 people; the new shops of the Canadian National Railways at Point St. Charles, which employ the most advanced methods in locomotive construction and maintenance, and are amongst the most complete on the continent; the Dominion Engineering Works at Lachine, which specialize in the construction of large turbines and paper machines; the Dominion Bridge Company, also at Lachine, with the largest bridge and structural shops in Canada; the new bronze foundry of the Robert Mitchell Company at St. Laurent, exemplifying the last word in modern foundry equipment; the new plant of the Montreal Island Power Company at Bordeaux; the factory of the Canadian Marconi Company, Ltd., which manufactures commercial radio equipment for government and marine use as well as broadcast receiving apparatus, and the works of Canadian Copper Refiners Ltd., the first unit of which will begin operation almost immediately, and which will have an annual capacity of 75,000 tons of electrolytic copper made from blister copper and shipped in the form of wire bars.

Reception and Dance

In the evening the Annual Reception and Supper Dance of The Institute was held at the Windsor hotel, the members and their friends being received by the President and Mrs. Porter. This function concluded a very enjoyable and successful meeting.

Sam Graham Porter, M.E.I.C.

President of The Engineering Institute of Canada

Among the many activities of the Canadian Pacific Railway, none has been of greater benefit to the western provinces than the work of its Department of Natural Resources. Dealing with the development and administration of the company's agricultural and timber lands and its town sites, the exploration and operation of its coal, natural gas and oil properties, and handling also the construction, operation and maintenance of its extensive irrigation systems, the direction of this department gives ample scope for the exercise of administrative as well as of technical ability.

In electing its manager, S. G. Porter, M.E.I.C., as President of The Engineering Institute of Canada, The Institute has chosen a man prominent in both these respects, and has directed attention to the fact that many engineers naturally develop as leaders in the executive as well as the purely technical field. The choice of the new President further recognizes the growing importance to the welfare of the Dominion of the adequate development of the natural resources of the West.

SAM GRAHAM PORTER, M.E.I.C.

Originally of Scottish extraction, Mr. Porter was born September 1st, 1875, and his early education was received at a private school in his native place, Kyle, Texas. Living on a farm and working there during a great part of the year, he gained a practical experience in agriculture and its methods which was later to stand him in good stead.

Entering Baylor University at Waco, Texas, he graduated A.B. in 1898, and, after teaching school for a time, proceeded to the Massachusetts Institute of Technology, receiving there the degree of S.B. in Civil Engineering in 1903. Mr. Porter began his professional career in the United States Reclamation Service, and in 1903, as assistant engineer, was assigned to survey work in New Mexico, Colorado, Nebraska, and Wyoming, having charge of a portion of the construction of the inter-state canal between Wyoming and Nebraska. The years 1905 to 1906 were spent on railway location work, and in 1907 he became chief engineer of the Arkansas Valley Sugar Beet and Irrigated Land Company at Holly, Colorado. In 1913 he came to Canada, entering the Dominion government service, and becoming inspecting engineer in the Irrigation Office of the Department of the Interior at Calgary. He was later promoted to assistant chief engineer and acting commissioner of irrigation. Leaving the Civil Service in 1918, he joined the Canadian Pacific Railway, becoming superintendent of operation and maintenance of the Southern Section of the Canadian Pacific Railway irrigation system, with headquarters at Lethbridge. He retained that position until 1925, when he was appointed assistant manager of the company's Department of Natural Resources, and in 1927, on the retirement of Mr. P. L. Naismith, was promoted to the position of manager of that department, which he still holds.

Mr. Porter's connection with The Engineering Institute of Canada began with his election as Member in 1914. He was active in the affairs of the Calgary Branch, organized the Lethbridge Branch in 1921, and was its first chairman. He served on Council from 1921-23, and was a vice-president in 1927-1928. He is a Member of the American Society of Civil engineers. Always interested in community matters, he is on the Council of the Calgary Board of Trade and on the Board of Directors of the Calgary Rotary Club; he was president of the Lethbridge Rotary Club in 1920 and vice-president of the Lethbridge Board of Trade during 1923-1924. In 1921 he became naturalized as a British subject.

Mr. Porter's interest in the progress of the engineering profession has been evidenced not only by his activities in connection with The Institute, but also by his unremitting efforts in connection with the Association of Professional Engineers of the Province of Alberta and in promoting the movement for the registration and licensing of professional engineers in Canada. For some years a member of Council of the Alberta Association of Professional Engineers, he was vice-president of that organization in 1923-24.

It will be remembered that, following a conference held at Montreal in 1926 between representatives of the various Provincial Associations of Professional Engineers, the Council of The Institute, at its Plenary Meeting in October, 1927, appointed a Committee on the Relations of The Engineering Institute of Canada with the Provincial Professional Associations, of which committee Mr. Porter was a member. He took over its chairmanship in 1928. The committee's report outlined a course of inquiry and negotiation designed to promote uniformity in requirements for admission as regards the various associations and The Institute, and, after approval at the Plenary Meeting of 1929, was adopted at the Annual Meeting in Ottawa, in 1930. At this time, pressure of work compelled Mr. Porter to withdraw from the chairmanship, but he was succeeded as chairman by Past-President H. H. Vaughan, M.E.I.C., and the committee, after further discussion at the Plenary Meeting of Council in October, 1930, is continuing its work and is in communication with the governing bodies of the eight professional associations.

The election of Mr. Porter as President of The Engineering Institute of Canada will be generally welcomed, and will receive special endorsement from those who have at heart the co-ordination of the work of the professional engineering associations throughout the country, by the ultimate federation of these bodies.

Address of the Retiring President

A. J. Grant, M.E.I.C.

Delivered before the Forty-fifth Annual Meeting of The Engineering Institute of Canada, Montreal, February 4th, 1931.

We have listened with interest to the reports of Council and the various committees who have generously given much time and effort throughout the year in assisting Council to manage the business of The Institute, and to them and to all the members of Council, I now desire to express my deep appreciation of the time and thought that they have unselfishly given to the welfare of The Institute. I also desire to record my sincere thanks to our General Secretary for his able assistance throughout the year.

On considering the present status of The Institute, it is sufficient for me to say that its membership is increasing, its financial position is sound and that it is well supported by the members.

It will be noted from the report of the Special Sub-Committee of the Committee on the Relations of The Institute with the Provincial Associations of Professional Engineers, that some progress has been made towards bringing about the co-ordination of the interests and activities of The Institute and those of the Professional Associations and I have no doubt that the new President and Council will very materially advance this work during 1931 and that, in a very few years, a satisfactory working arrangement will be evolved that will make for the mutual advantage of the Professional Associations and The Engineering Institute.

On retiring as President of The Engineering Institute of Canada, custom and not the by-laws of The Institute, requires the President to inflict an address upon the members. Annual presidential addresses have touched upon such a variety of engineering subjects that it seemed difficult to find one that would prove of general interest. After considering the matter for some time, it finally occurred to the writer that as the Welland Ship canal will be officially and formally opened in 1931, that the time was opportune for stating briefly the history of some of the large canals of the world and comparing them with the Welland Ship canal.

The question has recently often been asked:—"Is the Welland Ship canal as large or larger than the Panama canal and other large canals of the world?"

In order that those interested may readily obtain some knowledge on the subject and answer the question for themselves, the histories of the following canals are briefly outlined:—Panama, Manchester, North Sea, Kaiser Wilhelm, Suez and Welland.

THE GREAT SHIP CANALS OF THE WORLD

Panama Canal

History,—The subject of transportation across the isthmus of Panama (or Darien) has intensely interested mankind for the past four hundred and thirty-eight years. Its first highway was a pack mule trail or portage which was superseded after three hundred and sixty-three years by a steam railroad, and sixteen years ago this was replaced by a canal. There is as yet no state, or canal, highway across the isthmus.

As early as 1517 surveys were made for a canal across the isthmus and as late as 1788 Spain surveyed the Caledonian bay route and in 1814 decreed the construction of an isthmian canal, but the independence of her American possessions at the close of the Napoleonic Wars ended for ever her contemplated action.

Many surveys were made and projects put forward for the construction of a canal during the early years of the nineteenth century, but nothing definite was accomplished until May, 1878, when a concession was granted by the Colombian government to French promoters to build a canal across the isthmus. This concession was transferred to the Compagnie Universelle du Canal Interocéanique de Panama, commonly called the Panama Canal Company, chartered under the laws of France, with a capital stock of $60,000,000. The Company turned the first sods for the construction of a sea level canal at Panama and at the famous Culebra cut in January, 1880, under the direction of the company's engineer, Count Ferdinand de Lesseps. In 1889 the company was placed in the hands of a receiver whose report showed a total expenditure of $262,000,000 and that 65,000,000 cubic yards of material had been excavated. The new or reorganized Panama Canal Company, formed in October, 1894, sold all its rights and property in the isthmus and its maps and archives in Paris for $40,000,000 to the United States Isthmian Commission, organized in March, 1904, under the authority of the Act of Congress of 28th June, 1902.

As the work of the Commission proceeded the old question forced itself to the front and stayed there until finally decided by Congress, viz., a sea level canal versus a lock canal. The Act of Congress ordering the construction of a lock canal became effective on the 29th June, 1906. On the 1st April, 1907, the civilian control and management of the Isthmian Canal Commission came to an end when Colonel George W. Goethals became chairman and chief engineer of the Commission. When the military commission took over the work, an effective working organization had been built up and perfected, machine shops erected and equipped, many thousands of employees secured and 80 per cent of the required plant had been purchased or contracted for.

Route of Canal,—The canal connects the city of Colon on the Atlantic ocean with the city of Panama on the Pacific. It is 42 miles long from shore line to shore line or 50 miles long from deep water in one ocean to deep water in the other. The lowest point in the Gaillard (Culebra) cut through the continental divide was 305 feet above sea level when the French began excavation in 1880.

A ship on leaving Cristobal, the Atlantic terminal of the canal, passes through the Atlantic sea level section of the canal in Limon bay to Gatun. This section has a bottom width of 500 feet and is 6⅔ miles long. At Gatun the ship is raised 85 feet to Gatun lake through three twin locks in flight. From Gatun to Gamboa, 24 miles, the ship sails through Gatun lake in a channel varying between 500 and 1,000 feet wide and 45 to 85 feet deep. From Gamboa to Pedro Miguel, 9 miles, it passes through the continental divide in the Gaillard cut, 300 feet wide on the bottom and about 45 feet deep. At Pedro Miguel it enters a twin lock and is lowered 30⅓ feet to Miraflores lake, and sails across it 1½ miles, to Miraflores locks where the ship is lowered 54⅔ feet through two twin locks in flight to sea level. Three twin locks in flight would have been built on the Pacific side if it had been possible to secure a rock foundation long enough to accommodate them. From Miraflores the ship passes through the Pacific sea level section of the canal to Balboa, the Pacific terminal of the canal. This section has a bottom width of 500 feet and is 8 miles long. The axis of the isthmus at the canal zone runs from south-west to north-east, and as the canal is built almost at right angles to this line (north-west to south-east) the Pacific end of the canal is about 27 miles east of the Atlantic end.

Gatun Dam,—The Gatun dam may be called the keystone of the lock canal scheme, for on its stability rests the life and existence of the whole project. The dam forms Gatun lake by damming the flow of the Chagres river. It is situated in a narrow part of the valley 7 miles from the mouth of the river and controls nearly the whole of the drainage area of the Chagres basin, about 1,320 square miles.

The dam is 1½ miles long on the crest, 100 feet wide on the top, elevation 105.0, and about half a mile wide at the bottom. The slope on the upstream side is 1 to 7 below water and on the downstream side the slope varies between 1 to 8 and 1 to 16. The normal water level of the lake created by the dam is at elevation 85.0. The upstream slope is protected by stone rip-rap for a height of 10 feet above and below the waterline. The dam rests on a bed of silted clayey material over 200 feet deep, impervious to dangerous seepage and not soft enough to be pushed aside by the weight of the dam. It is a combination of rock fill and hydraulic fill, the latter consists of a mixture of clay and sand and forms an interior core. The dam for part of the distance across the valley is 105 feet high.

On the axis of the dam, midway across the valley, is a hill of rock, through which a channel 300 feet wide and 1,200 feet long is cut for the regulation of the river. The upper end of the channel is closed by a concrete spillway in the form of a circular arc 808 feet long. The crest of the spillway, elevation 69.0, is divided by piers and two abutments into 14 bays, each 45 feet wide, closed by Stoney valves. A short distance below the apron of the dam, the channel is narrowed to 285 feet wide between side walls. The floor of the channel is at elevation 10.0.

The bottom of the valves when fully open are at elevation 92.0. When the lake is at elevation 85.0 they will discharge 140,000 c.f.s. It is allowed to rise for water storage to elevation 87.0, at which level the sluices will discharge 154,000 c.f.s. The top of the walls and gates of the Gatun locks is at elevation 92.0. If the lake rose to this level the sluices would then discharge 220,000 c.f.s. At the time the dam was built the momentary discharge of the river was calculated to be 182,000 c.f.s. It is apparent therefore that the means provided are ample to control any possible flood.

Gatun Lake,—At elevation 85.0 Gatun lake has an area of 164 square miles. It is kept filled by the Chagres river. For eight months of the year there is a water surplus, during which period the lake is kept constantly filled to elevation 87.0. Water is stored for the operation of the canal during the four dry months of January, February, March and April. The month of least flow is March. The annual rainfall varies from 128 inches at Colon, to 92 inches in the interior and 70 inches at Panama. As navigation can be carried on in the canal when the lake is at elevation 82.0, there will be stored for use in the dry season a depth of 5 feet of water, or sufficient after making allowance for evaporation, seepage and power for about forty lockages daily through the locks, using them at full length.

Pedro Miguel Dam,—At the Pacific end of the Gaillard cut, an arm of Gatun lake, the Pedro Miguel lock and dam hold the waters of the Lake from descending into the Rio Grande. The dam is built in a similar manner to the Gatun dam, but without a spillway, as all regulation is done at Gatun.

Miraflores Lake and Dam,—The small lake about 1½ miles long, between the Pedro Miguel and Miraflores locks, has an area of about 1.6 square miles and is 54⅔ feet above sea level. It is fed by the Pedro Miguel and Grande rivers. The lake is maintained by the Miraflores lock and dam. The latter is built in a similar manner to the Gatun dam and has a concrete spillway with eight sluices each 8 feet deep by 45 feet wide for the regulation of the lake. The spillway is designed to discharge 90,000 c.f.s., the estimated discharge from Gatun lake through one of the Pedro Miguel twin locks should its gates be completely carried out, instead of the small run off from its 38½ square miles of watershed.

Locks,—The Gatun locks including their approach piers are 1-1/5 miles long; the Pedro Miguel locks 5/6 mile long; and Miraflores locks 1 mile long. The Gatun locks have a combined lift of 85 feet (28⅓ feet each); Pedro Miguel 30⅓ feet; and at mean tide the Miraflores have 54⅔ feet lift (27⅓ feet each). The maximum useful dimensions of all the locks are the same, 110 feet wide by 1,000 feet long. The depth of water on the mitre sills is 40 feet in salt water and 41⅓ feet in fresh water. The locks are filled and emptied through culverts in the side walls. As about 95 per cent of the vessels in the world are less than 600 feet long, intermediate gates are placed in the locks, dividing the chambers into two parts suited to vessels 350 and 550 feet in length. The lock gates are the mitering type and are made of steel. They have a uniform width of 7 feet and a length of about 65 feet and vary from 47 to 82 feet high and weigh between 390 and 750 tons per leaf.

Safeguards against Accidents,—On account of the naval importance of the canal to the nation in case of war, the United States has made extraordinary provisions for the protection of the canal against accidents that would make the waterway impassable to ships.

All the locks are double, so that if one lock is temporarily out of commission, navigation can still be carried on through the other. The upper locks of each of the three groups of locks are provided with two pairs of gates at their upper and lower ends. The gates are protected by chain fenders and emergency dams are built at the heads of the locks at each end of the summit level and at the head of the Miraflores locks to cut off the flow between the upper and lower levels, should a stream be accidentally established. In order to protect the lock gates as far as possible from being struck by ships, the latter are towed into and out of the locks by electric locomotives moving on the lock walls. No vessel is allowed to move under her own steam when passing through the locks. The movement of all gates, fenders and valves of each group of locks is controlled from a central control desk provided with an elaborate mechanical and electrical system of interlocking to prevent any of the gates, fenders and valves being operated out of their proper sequence.

Gaillard Cut,—The Gaillard cut through the continental divide is 9 miles long and reached a maximum elevation 312.0 on the centre line of the canal near Gold Hill, north of which the ground surface and slope of the cut intersect at elevation 540.0. On the south side, at this point, elevation 410 was reached. No definite slopes are possible at present on account of slides. At the inception of the work the bottom of the cut was elevation 40.0 but has been lowered since by dredging. The cut has a minimum bottom width of 300 feet. The excavation of the cut was one of transportation and there was for a long time about 70 miles of track in the cut, about one mile of which was moved every day. The average output during the peak years of the work was between twelve and sixteen million cubic yards per annum. Up to the end of 1925 about 148,000,000 cubic yards of rock and earth had been removed from the cut and of this quantity 41,000,000 cubic yards was handled in the wet, due to slides.

Total Quantities,—The total excavation taken out by the United States government for the construction of the canal, up to the end of 1925, was 326,000,000 cubic yards. The two French Panama canal companies excavated 78,000,000 cubic yards, of which 30,000,000 was useful excavation for the canal, as built. In the construction of the locks, dams, docks, etc., about 5,000,000 cubic yards of concrete were required. The daily working force during 1911-1912 and 1913 averaged 45,000 men, of whom 5,000 were American.

Tides,—On the Atlantic side the normal variation between high and low tides is one foot and on the Pacific 12½ feet with occasional ranges of 21 feet. The mean level of the Pacific at the isthmus has been found to be about 8 inches higher than the mean level of the Atlantic. In February the mean levels of the oceans are the same, but throughout the rest of the year, on account of current, tide and wind influences, the mean level of the Pacific is above that of the Atlantic. In October the difference is as much as one foot.

Hydro-electric Station,—The canal has built and maintains at Gatun a hydro-electric station of 13,000 kw. capacity with provision for future extension to 22,000 kw. capacity and uses water from Gatun lake for the generation of electric power. A transmission line crosses the isthmus via the Panama railroad and distributes power to the various canal locks and dams and to the towns in the canal zone.

Cost,—It may be said that the United States built the canal from two motives:—national defence and commerce, and due to these causes the cost has been, for accounting purposes, accordingly separated. The investment charged to national defence is about $125,000,000 and that chargeable to commercial use, $275,000,000. The latter figure may therefore be considered the capital investment in a commercial sense.

Opened,—The first ocean steamer passed through the canal on August 3rd, 1914, and on August 15th, 1914, the canal was opened to commerce. The official and formal opening of the canal was proclaimed by the President on July 12th, 1920.

Tolls,—Tolls are levied on the net tonnage of the ships. For laden vessels the rate is $1.20 per net ton and for ships in ballast the rate is 72 cents per net ton, Panama canal measurement. A net ton is 100 cubic feet. The average cost per ton of bulk cargoes is about 65 cents per ton of 2,240 pounds. The cost of tolls on laden ships is equivalent to about 6 days' operation of the ship at sea.

Sixteen Years' Operation,—The Canal Record states that the canal completed 16 years of operation at the close of business on August 14th, 1930. During the 16 years of operation 60,133 commercial vessels have passed through the canal, aggregating 267,490,045 net tons, Panama canal measurement, on which tolls amounting to $250,660,068.98 were levied and which carried 279,338,333 long tons of cargo. Of these totals, the past ten years have accounted for 82 per cent of the transits, 87 per cent of the net tonnage, 86 per cent of the tolls collected and 86 per cent of the cargo carried.

The canal maintains at Balboa large supply depots and repair shops for the use of the canal and shipping. The repair facilities include a drydock 1,000 feet long and 110 feet wide with a depth of 43 feet over keel blocks at normal high tide. Large quantities of coal are always kept on hand and the coaling plants can load from 100 to 500 tons per hour. The oil tanks operated by the canal and oil companies have very large storage capacity, and the supply of pure water is practically unlimited. The canal stores regularly supply 35,000 people on the isthmus and keep ample reserve stocks of all kinds.

Manchester Ship Canal

History,—The Manchester Ship canal provides water communication for ocean going ships between the sea and the city of Manchester. The city with its suburb Salford has a population of one million and within a radius of 50 miles of the city there live nearly ten million people.

The canal was built by the Manchester Canal Company between 1887 and 1894 and was opened for traffic on New Year's day 1894, and in May, 1894, the waterway was formally opened by Queen Victoria.

Original Cost,—At the opening of the canal it had cost about £15,000,000, including the £1,710,000 for the Bridgewater canal which carried with it the old rights of the Mersey-Irwell navigation. It was not until after the War, which shook shipping out of all the old routes, that the Port of Manchester and the canal began to receive their due. The enforced recognition that the canal then received brought dividends for the shareholders and the past 12 years have brought steadily growing prosperity to Manchester. To date, £18,000,000 have been spent on the project, including its docks, warehouses, grain elevators, etc. that have turned the city of Manchester into one of the ocean ports of the Kingdom.

Description of the Canal,—The canal as built may be briefly described as follows:

The entrance to the canal at Eastham is 19 miles from the bar in the lower estuary of the Mersey. Eastham, Cheshire, is on the south side of the river, 6 miles above Liverpool.

The tides in the estuary are referred to Liverpool bay datum, which corresponds to low water springtide, or 14.8 feet below mean sea level. Ordnance datum is mean sea level. Manchester canal datum is 50 feet below mean sea level.

The lower entrance channel to the Eastham locks has been excavated for a distance of 3 miles to only a depth of 13 feet below Liverpool bay datum. The river from this point to Liverpool has a channel depth of 30 feet at low tide.

The canal from Eastham to Manchester is 35½ miles long and has a total rise of 70 feet between mean sea level at Eastham and ordinary water level at the Manchester docks. The difference in level between Eastham and Manchester is overcome by locks at Eastham, Latchford, Irlam, Barton and Mode Wheel. At Eastham, there are three parallel locks and at all the other places two parallel locks. The lower sill of the large lock at Eastham is 13 feet below Liverpool bay datum, and there is a depth of 30 feet on its upper sill.

Dimensions of Locks

Location	Dist. from Eastham Miles	Lift of Locks Feet	Length Feet	Width Feet	Depth on Sill Feet	Length Feet	Width Feet	Depth on Sill Feet	Length Feet	Width Feet	Depth on Sill Feet
Eastham.....		11.5	150	30		350	50		600	80	30
Latchford....	21	14.5				350	45	25	600	65	28
Irlam........	28.5	16.0				350	45	25	600	65	28
Barton......	30.5	15.0				350	45	25	600	65	28
Mode Wheel.	34.0	13.0				350	45	25	600	65	28
Manchester Docks	35.5										

All the locks, except those at Eastham, are provided with an intermediate gate, that may be used for economizing water. The large locks 600 feet by 65 feet can in this way be made 450 feet by 65 feet and 150 feet by 65 feet. The smaller locks 350 feet by 45 feet, along side the larger ones, can be made 230 feet by 45 feet and 120 feet by 45 feet.

The canal between Eastham and Stanlow oil dock, 4½ miles above Eastham, has been excavated to a depth of 30 feet and from Stanlow oil dock to Manchester the canal is only 28 feet deep.

The standard bottom width of the canal, 28 feet deep, is 120 feet. In the rock cut between Warburton bridge and Millbank wharf it is only 90 feet wide.

Eastham-Latchford Reach,—This reach of the canal, 21 miles long, is tidal and its normal depth is 30 feet as far as the Stanlow oil docks, and for the remaining distance, 16.5 miles, its normal depth is 28 feet. The reach receives a very large flow from the River Weaver, which enters the canal 10 miles above Eastham, and it also receives an influx from the tide during the levelling period. When the tide rises 26 feet 2 inches above Liverpool day datum, the water levels in the river and canal equalize and the Eastham locks are opened and the tide allowed to enter the canal. When a 31.0 feet tide occurs the water level in the canal rises about 5 feet. When the tide is flowing into the canal the current above the Eastham locks is about 2 to 3 miles per hour. The greatest velocity in the reach occurs at Pool Hall cutting, where during the levelling period on certain spring tides the velocity may reach 4.5 miles per hour, which, however, only lasts for a few minutes, and practically causes no hindrance to navigation, as the movement of vessels can be timed to avoid the difficulty. Just before the tide turns the Eastham lock gates are closed and the surplus waters above the normal level (elevation 61.5) of the reach are discharged back into the river under regulated conditions through sluices and side locks.

The Weaver sluices have a total length of opening of 300 feet and are the most important of the regulating works on the canal. The only currents produced in the reach during the operation of discharging the surplus waters back into the river is that adjacent to the sluices and is not detrimental to navigation. The current in the river below the Eastham locks is about 5 knots per hour at half tide, and at the later stage of the river, the elevation of the water is the same for both spring and neap tides.

For a distance of 13 miles above Eastham the canal follows the shore line of the river, and for long distances across bays, etc., the canal channel is only separated from the river by an embankment. The toes of the embankment are made with rock and the hearting with clay from the excavation of the canal prism. The slopes and top of the bank are covered with stone pitching. Where the bank was built on sand beds, timber sheet piling was driven down to a substratum of clay and gravel, along each toe of the bank. Above Runcorn, for a distance of a quarter of a mile, the north side of the canal prism is formed by a concrete gravity section wall instead of an earth embankment.

At low tide the head on these embankments is 24.5 feet. They have given no trouble from settlement, erosion or leakage.

The deepest cutting is near Runcorn where the depth is 66 feet for a short distance. The largest cutting is at Latchford, where it averages 55 feet for a distance 1½ miles. The slopes of the cuttings vary from 1 to 1, to 2 to 1, and in rock cuts the sides are nearly vertical.

Bridges,—The canal is crossed by fifteen bridges, eight being swing spans, and seven, fixed bridges.

The height from normal water level to the underside of the girders in the seven fixed bridges over the canal gives a clear head room of 74 feet 6 inches, except the Runcorn bridge, which is 82 feet 4 inches above normal water level. This head room is however several feet less on the Eastham-Latchford reach at high tides, and in order to avoid detention to ships from this cause, the masts and funnels of ships are lowered to clear the bridges at 70 feet above normal water level.

The five railways that cross the canal are all carried over it by high level bridges. These crossings involved the construction of eleven and one-quarter miles of railway diversion. The question of railway diversion was a formidable one to deal with in the design of the canal, and added greatly to its cost.

The swing bridges are all operated by hydraulic power and with one exception provide a clear waterway of 120 feet.

Barton Aqueduct,—The Barton aqueduct, an iron trough 235 feet long, 75 feet wide, and 6 feet deep, carries the Bridgewater canal across the Ship canal. The trough is supported on a swing bridge, that provides two openings each 90 feet wide. The bridge is operated with hydraulic power. The trough is closed at each end with gates when the bridge is opened for navigation. Similar gates are raised across the ends of the Bridgewater canal to retain the water in it when the bridge is open.

Locks,—All the locks are founded on red sandstone. Their walls are built of concrete throughout with a brick facing above the level of the lower reach. The brick is a hard blue non-absorbent metallic brick, and has stood up very well over a period of 35 years. The width of the centre wall of the two locks at each locality above Eastham is about 30 feet. The locks are fed through culverts in the side walls, which were originally controlled by Stoney sluices. These sluices were taken out some years ago, due to wear and trouble with their roller nests and rails, and replaced with solid greenheart shutters sliding on polished granite. The shutters are operated with hydraulic rams and have given excellent satisfaction and are moreover absolutely water-tight, a very desirable feature in the Mode Wheel and Irlam locks.

Lock Gates,—The upper gates of the locks are placed on a breast wall. The gates are made of horizontal bars of greenheart timber, and sheeted with plank. The original gates are still in use and are in excellent condition. The iron spikes of the planking corroded badly and have been replaced with galvanized iron lag screws and the planking recaulked. The gates are operated by hydraulic machinery.

Preventer Cables,—After the canal had been in use for about 10 years wire cables attached to the gate recess walls and to the tops of the gate leaves at their mitre ends were placed on the gate leaves of all the locks. The object of the cables is to prevent the gate leaves tipping over when slammed against the sills by bad operation and when struck on the upstream side by ships. It is said that these cables have saved gates being knocked out on more than one occasion.

Lighting Canal,—With the exception of the locks, which are dimly lighted, the canal is not lighted. During 1928 the canal authorities were going to experiment with a vessel using a searchlight placed under each end of her bridge to light the cânal banks. When passing another ship the light nearest the approaching ship would be turned out. If this experiment proved unsatisfactory, it was then the intention of the company to light the canal in a similar manner to that of the Kiel canal, by a line of small lamps along each bank.

Water Supply,—As the upper or inland section of the canal, Latchford to Manchester, has taken the place of the Rivers Mersey and Irwell, the canal now acts as the main drain for a large section of country. The Manchester Basin and Mode Wheel locks are supplied with water from the Irwell river. The supply for the Barton and Irlam locks is augmented by some minor streams and a flow of 46 c.f.s. from the Manchester and Salford sewage works, and as the Mersey enters the canal above the Latchford locks, the latter have an unlimited supply.

As the canal above Latchford is a canalized river each lock has alongside it a broad and deep raceway, controlled at its lower end by a battery of Stoney sluices, each 30 feet wide. There are four sluices at the Mode Wheel and Barton locks, five at the Irlam locks and only three at the Latchford locks, as the combined flows of the Irwell and Mersey rivers do not flow all the way down the canal to the Latchford locks, but are discharged into the old course of the Mersey at Rixton Junction and thence through the Woolston weir (opposite Mile 22 above Eastham) and then assist in maintaining the depth in the navigable channel of the river to Warrington, as prescribed by Act of Parliament. The crest of the Woolston weir is maintained at the same elevation (76.00) as the Latchford-Irlam reach, and acts as a spillway for the reach.

Silting,—The Mersey and all its tributaries above Liverpool carry large quantities of silt when in flood, The Irwell is continually filling up the Manchester basin. The Mersey enters the canal at Mile 28, below the Irlam locks, and in heavy flood periods, which last ten to fourteen days, will in that time deposit in the canal as much as 80,000 cubic yards of silt. An ordinary flood deposits in the canal 40,000 cubic yards of silt.

This silting up of the canal reaches and the lower entrance of the Eastham locks necessitates the Canal Company maintaining a fleet of ladder and clam shell dredges constantly at work in the canal.

Use of Canal by Ships,—It took ten or more years for the Canal Company to convince ship owners that the canal could be safely navigated by large ships. The Great War helped materially to break down this prejudice, as many ships were then ordered by the Admiralty to go to Manchester, and during the four years of the War, they learned against their will that the canal could be safely navigated, and today the old prejudice against large ships going up the canal has gone forever.

Draft,—Ships are allowed to load at Manchester to 26 feet and on special occasions may load to 26 feet 6 inches as a maximum. When they reach Stanlow, they may load to 28 feet, which they generally do with bunker coal. The canal operates on the principle that a ship will draw about 6 inches more in fresh water than in salt water. A ship will also on maximum draft go faster in the canal at slow speed than at half speed, as in the latter case she will feel the bottom more and consequently slow down.

Eastham Entrance,—Ships enter the canal at Eastham on ebb tides and leave it on flood tides.

Navigation at Night,—Notwithstanding the fact that the canal is not lighted it is used at night by large and small boats, as it is to their advantage to do so. During certain seasons of the year, fog prevails, especially during the early morning hours and in the forenoon. By sailing at night ships can reach Manchester before fog falls towards dawn, and therefore save 6 to 12 hours delay. The canal is not navigated during foggy weather.

Tolls,—At Liverpool the dock and town dues are paid by the merchant, these are comparable to the wharfage dues and the Ship canal tolls paid on the Manchester Ship canal by the merchant. At Liverpool the ship's net registered tonnage dues are paid by the ship owner, the same as on the canal.

Railways,—The Canal Company have built to date 200 miles of railway on the docks and at many points along the canal, and connect with the railway systems of the Kingdom at several places between Ellesmere port and Manchester. The company's railway rolling stock consists of 54 locomotives and 2,432 cars for hauling freight over their own lines.

Oil Docks,—During 1927 there were imported 304,000 tons of gasoline and 455,000 tons of oils. The latter are chiefly handled through tanks at Manchester, Eccles, Weaste and Barton. The gasoline is handled through tanks at the large oil dock at Stanlow, 5 miles above Eastham.

Canal Docks,—In 1927 nearly 700,000 tons of coal were exported from the Port of Manchester. The coal was largely, if not all, bunker coal. The principal bunkering station on the canal is the Partington coaling basin, which is the nearest port of shipment for the Lancashire, Derbyshire and Staffordshire coalfields. Other coaling facilities are at Haydock coal wharf and at Acton Grange. During 1927 the Canal Company built a $2,000,000 eoal loading plant at Ellesmere port, which will enable the largest outbound vessels to complete their coaling at this point. The plant includes a concrete dock 1,200 feet long, railway exchange sidings and railway storage yard and two coal handling units which under normal working conditions of emptying the railway cars and delivering the coal from them at a continuous and regular rate within the ship's holds or bunkers, has a capacity of 800 tons per hour (or 400 tons per hour per unit).

The Port of Manchester includes the whole of the canal from Eastham to Manchester. The dock estate of the city covers an area of 407 acres. This acreage includes a water space of 120 acres. The dock walls are 5½ miles long. The docks are equipped with hydraulic steam and electric cranes and also with a large coaling crane and a fleet of lighters and floating pontoons. The towns along the canal are also equally well supplied with docks and equipment.

The import and export tonnage of the port amounted for the year 1927 to 6,359,420 long tons and the revenue to £1,576,237.

North Sea Canal

History,—In the delta of the rivers Scheldt, Meuse and Rhine lies the Kingdom of Holland or the Netherlands. Its western eoast line trends south and north and at the intersection of 53 degrees north latitude and 5 degrees east longitude, the cost line turns almost due east along the Frisian islands, slices of the original coast line. Behind the western end of this chain of islands lies the Zuider Zee (Southern sea) which acquired its present shape about 1300 A.D.

The Zuider Zee is mean sea level and has a tidal movement of only 4 to 15 inches. Its bottom is very flat and only over a small area does it exceed 14.5 feet in depth. Its most important ehannel to the North sea is Texel strait between the northern point of the province of North Holland and Texel island. At Den Helder, on the North sea end of Texel strait, the tidal variation is about 5 feet.

Centuries ago, when ocean vessels were no larger than the smaller schooners of to-day, the Amsterdam fleet ruled the seas through the Y and the 14 feet channels of the Zuider Zee. The Y, on which is situated the city of Amsterdam, is a long narrow arm of the bay in the south west corner of the Zuider sea. The silting up of the Y, and the bar outside of it called the Pampus, reduced the Zuider Zee channel to 9 feet, and caused ocean vessels to abandon Amsterdam about the beginning of the nineteenth century.

North Holland Canal,—The first attempt that Amsterdam made to overcome the destruction of its trade wrought by the Pampus sand bar was the construction, in conjunction with the government of Holland, of the North Holland canal during 1818-25, from Amsterdam to Den Helder on Texel strait, at a cost of 11,000,000 guilders. The canal was 49 miles long and 16.5 feet deep. Owing to its shallow draft and tortuous course, and its indirect route for vessels bound south, and the advent of the steamship, and the ever-increasing size of vessels, Amsterdam was soon left as badly off as when the construction of the canal was begun in 1818.

North Sea Canal,—As the city again faced the loss of its ocean trade, an east and west waterway was projected to the North sea, and a company, aided by Amsterdam and Holland, was formed to build it. The new waterway, called the North Sea canal, was located along the axis of the Y for 11 miles to the coastal uninhabited sand dunes at Velsen and through them for 3.7 miles to the coast, where a small town, "Ymuiden" (mouth of the Y) soon grew up at the North sea entrance of the canal. At Ymuiden, ordinary high tide is 2.5 feet above mean sea level and ordinary low tide is 2.8 feet below mean sea level. Storms cause a tidal variation of as much as 12.0 feet above mean sea level and 8.0 feet below it.

All canal elevations are referred to Amsterdam datum (known as N.A.P.) which is approximately mean sea level off the Netherland coast.

The normal water level of the canal between Ymuiden and Amsterdam is 1.5 feet below the datum plane.

Old Locks, 1869-72,—The first North Sea canal was designed for a depth of 23.0 feet below normal water level and a bottom width of 88.5 feet. Through the Y the canal channel was excavated 88.5 feet wide on the bottom, with 2 to 1 slopes, but the banks built along each side of the channel were placed 400 feet apart for future widening of the canal. Two locks and one weir were built at Ymuiden between 1869-72. These structures are still in existence. The larger one is 59 feet wide, 390 feet long, with a depth of 24.5 feet on the sills below normal canal level. The piers of the outer harbour at Ymuiden extend seaward 4,900 feet to the contour of 28 feet below mean sea level, and the channel between them was then dredged to 28 feet at the end of the piers and decreasing to 24½ at the locks.

Orange Locks,—Concurrently with the construction of these works, the Orange locks, weir and dyke at Schellingwoude were built to close the eastern end of the Y at Amsterdam. Storms raise the Zuider Zee at the Orange locks 8.5 feet above its mean level and lower it 7.5 feet below it. The canal was opened for 16.5 feet draft in 1876, and for 21 feet depth in 1877, and was completed for 24.5 feet depth in 1880. The canal was then crossed by three swing bridges, each with a clear channel opening of 62 feet. Two of the bridges were near Velsen and one at Zaandam.

In 1881-83 the depth of the canal entrance from the North sea was deepened to 28.0 feet below mean sea level and the canal to 25.5 feet below normal water level.

Canal Taken Over by the State, 1883,—On account of the financial difficulties that the canal company incurred in the construction of Ymuiden harbour and the enlargement of the canal, the Holland government took over the canal in 1883.

To-day, the state owns and maintains the canal, the Orange locks, weir and dyke at Schellingwoude, but the city of Amsterdam owns and maintains the Port of Amsterdam within the city limits, and as the water level of both are the same, they may be considered as a large wet dock 16 miles long.

About 1760 Amsterdam purchased from the holding company representing the various dock owners and other interests who then controlled the harbour, all their lands, docks, warehouses, equipment, etc. and the municipality also owns to-day all the canals within the city limits and the railway sidings and yards on the docks. Many of these docks are now leased to steamship companies and the railway sidings on the docks to the railway companies.

The Amstel river is now held at the same level as the Port of Amsterdam, and forms one of the many small canals that intersect the city in all directions. These small canals are flushed every night by water from the Zuider Zee, through the weir at Schellingwoude.

Improvements, 1889-1924,—Following the purchase of the canal by the government in 1883, it soon became apparent that owing to the rate at which the size of ships was increasing, it would be necessary to build a new lock at Ymuiden and deepen the canal if the Port of Amsterdam was to retain her foreign trade, and towards this end the following improvements were carried out between 1889 and 1924 at a cost of about 61,000,000 guilders ($24,400,000).

Present Lock (1896),—Between 1889 and 1896 a new lock was built at Ymuiden, north of the old lock. Its dimensions are 82 feet wide, 738 feet long, with a depth on the sills of 32.0 feet below normal eanal level. Concurrently with the construction of the loek, the canal was deepened to 28 feet and the harbour to 31.0 feet below mean sea level.

Between 1897-98 the bottom width of the canal was increased to 118 feet on tangents and to 130 feet on curves.

In 1899 the government decided to enlarge the canal to such dimensions as would accommodate the largest ships that could lock through the 1896 lock at Ymuiden, and in accordance with this decision the following improvements were carried out between 1899 and 1907: viz., the Ymuiden harbour was deepened to 34.5 feet below mean sea level and the canal to 32.0 feet with a bottom width of 164 feet on tangents and 197 feet on curves with slopes 3 to 1. At the same time the two railway swing bridges over the canal were rebuilt so as to give clear navigable openings of 180 feet and the highway bridge at Velsen was replaced by a steam ferry.

Harbour,—The North sea entrance is formed by two converging lines of concrete piers, each about 5,012 feet long, that extend seaward to the contour of 28 feet at mean sea level. At the shore line they are 3,936 feet apart and at the outer ends 853 feet. The latter width is reduced to 722 feet by blocks of concrete placed around the pier heads. The top of the piers vary from 13 to 16 feet above mean sea level.

Lighting Canal,—Along each bank of the canal there is an electric transmission line. The poles are set on a narrow berm at the top of the stone rip-rap of the prism slopes. The canal is lighted by 25 candle power incandescent lamps placed opposite each other and spaced about 800 feet apart on tangents, 400 feet apart on curves and near the locks 300 feet apart. The locks are lighted with clusters of three 50-candle power lamps. The lamps have clear glass bulbs and along the canal are set 45 degrees to the vertical plane on short brackets placed 25 feet above the water. Small reflectors at the back only of the lamps throw the light rays down, which very effectively marks the water line along each bank. The lamps are connected in series of 113 lamps and lighted by single-phase alternating current of 3,500 volts.

Ice Conditions,—The winters in Holland are not severe. January is the coldest month when the temperature may drop to 12 degrees F. for a few days at a time. During many winters there has been no ice in the canal. In the winter of 1927-28, the ice was 6 inches thick, and in 1890, it was about 20 inches thick, and gave a lot of trouble. In the Port of Amsterdam, ice causes very little trouble on account of the large number of small and large vessels that are constantly moving about.

Since the canal was equipped with ice breakers in 1893 it has never been closed by ice. This work is done by a company assisted by the government, the province of North Holland and the city of Amsterdam. The company own two ice breakers, the larger being 141 feet long, 35.5 feet beam with a draft of 17.5 feet and 830 i.h.p.

Drainage and Flushing Canal,—About 1¼ million gallons of water are pumped every 24 hours into the canal from the low-lying lands surrounding the canals. In wet seasons as much as 2 billion gallons are pumped into the canal every day from the polders. The Port of Amsterdam is also flushed every night with about 110,000,000 gallons of water from the Zuider Zee. All this water is discharged into the North sea through the Ymuiden weir at ebbtide. The water level in the canal is maintained as closely as possible at its normal water level, 1½ feet below mean sea level, but may vary from 4 inches below normal to 1½ feet above it during the process of receiving and discharging the foregoing waters. If these surplus waters, on rare occasions, cannot be discharged into the North sea due to storms or other causes they are pumped out of the canal into the Zuider Zee by six steam-power-driven scoop wheels at Schellingwoude.

Silting in Ymuiden Harbour,—The prevailing winds along the Holland coast are southwest to northeast. The greatest storms come from the northwest and cause the highest storm tides.

The tidal currents are parallel to the coast. Flood tides flow northeast and have a velocity of 1.75 miles per hour and the ebb tides flow southwest with a velocity of 1.25 miles per hour. These velocities are 1/5 greater at springtides and 1/5 less at neaptides.

Under normal weather conditions the tidal currents carry very little sand and silt, but give serious trouble from this cause during stormy weather. Flood tides during storms from the southwest silt up the channel beyond the piers and in the outer harbour and make constant dredging necessary. The canal maintains for this purpose a fleet of three suction and three dipper dredges.

As the present breakwaters only extend out to the 28 feet contour at mean sea level, it is considered impossible to maintain a greater depth than 39 feet below mean sea level in the channel beyond the breakwater until a new line of breakwater piers are built out to the contour of 49 feet below mean sea level which it is the intention of the state to do in the future in connection with the canal improvements authorized by the government in 1917. When the new breakwaters have been built it is expected that silting in the harbour channels will be materially reduced.

As very little silting occurs in the canal, only a small amount of dredging has to be done every ten years to maintain the required navigable depth.

Canal Dues,—Since 1890, there have been no canal dues levied; pilot dues are however collected.

Ymuiden Fishing Fleet,—When the North sea canal was opened in 1876 the Dutch North sea fishing fleet sought shelter in Ymuiden harbour and 20 years later (1890-96) a large basin and docks were built for the fleet on the south side of the lock entrance. The basin is 2,300 feet long by 500 feet wide and its docks are equipped with sheds, ice plants, water supply and railway facilities for the fish trade. Today the Ymuiden fishing fleet is one of the largest on the North sea coast.

Rhine Canal,—The port of Amsterdam competes with Rotterdam for the large and lucrative trade of the Rhine valley. Its connection with the river is through the Merwede canal which to-day accommodates barges of 2,000 tons carrying capacity. The Rhine barges are not charged canal or port dues. Amsterdam's trade with the Rhine basin has increased sevenfold during the past thirty years and is therefore of great importance to the port. In order not only to retain this trade, but to enlarge it, Amsterdam contemplates in the near future enlarging and extending the Merwede canal to Tiel on the Rhine, a distance of about 44 miles. Tiel to Rotterdam via the river is about 45 miles. The enlarged Merwede canal will have a bottom width of 164 feet and be 15 feet deep. Its three locks will have a length of 1,082 feet and width of 98.5 feet, and will accommodate 5,000 ton barges. The largest Rhine barges today have a carrying capacity of about 4,300 tons.

1917 Enlargement,—In 1928 there were in operation two locks at the North sea entrance of the canal, the large old 1876 lock, long out of date, and the 1896 lock which can accommodate the largest vessels likely to visit Amsterdam in the near future. The port is however solely dependent upon its continual operation and any damage to it that would necessitate closing it for extensive repairs would react seriously on the trade of Amsterdam. This fact and the rapidly increasing size of ships (in 1925 there were 1,047 ships too large for the lock) determined the government to appoint a Royal Commission in 1909 to investigate the question and to recommend what enlargement of the canal it considered necessary for the preservation and maintenance of Amsterdam's trade.

In 1911, the Commission recommended the construction of a new lock 360 meters by 40 meters and a depth of 14 meters below Amsterdam level (1,180 by 131 by 44.5 below normal canal level), but due to the war and other conditions, it was not until 1917 that an act was passed, authorizing the following enlargements of the canal to be carried out:—

(1) The construction of a new lock at Ymuiden 400 meters by 50 meters by 15 meters below Amsterdam datum (1,312 feet by 164 feet by 47.5 feet below normal canal level).

(2) The enlargement and deepening of the canal to 47.5 feet as and when required.

Cost of Enlargement,—The new lock and its entrance channels is estimated to cost $7,500,000, of which the Dutch government will bear 66 per cent, the municipality of Amsterdam 28 per cent and the province of North Holland 6 per cent.

Canal Enlargement,—In conjunction with the construction of the new lock additional land has been purchased for the ultimate enlargement of the canal to a bottom width of 328 feet and a depth 47.5 feet below normal water level with 3 to 1 slopes, but the canal will only be enlarged for the present to a bottom width of 246 feet and a depth of 39.5 feet below normal water level with 3 to 1 slopes. The curves in the canal will also be reduced to a minimum radius of 9,840 feet and both channels under the swing bridges will be excavated. When these improvements have been completed by 1934, ships like the "Aquitania" (886 feet by 97 feet by 36 feet) can then navigate the canal, as the wetted cross section of the ship and that of the canal will leave a ratio of 1 to 4.3, or slightly greater than the ratio of the wetted cross section of a lake freighter 65 feet beam and 24 feet draft to the wetted cross section of the 25 feet depth of the Welland Ship canal.

Ymuiden Breakwaters,—The ultimate enlargement of the canal to 47.5 feet depth also involves the construction at Ymuiden of a new northern breakwater and the extension of the present southern one at that point. For the present it is only contemplated to excavate the entrance channel to the new lock and the existing harbour entrance channel to 41 feet below mean sea level. If it is found impossible to maintain a channel 41 feet deep beyond the present piers the construction of the new breakwaters will then be proceeded with. It will, however, be a very costly undertaking, as the 49 foot (15 meters) contour at mean sea level is 2 miles or more off shore and the 16 meter contour is more than 3 miles out to sea.

1919-1931 Lock,—The new lock is located north of the present one, but it was not until 1919 that the work of excavating its 2½ miles of approach channels and pit was begun and the placing of concrete was not started until 1922. It is expected that the lock will be completed and placed in commission early in 1931, at which date its approach channels will only have been excavated to a depth of 33 feet.

Gates,—The lock chamber is closed at each end by rolling caisson gates that are moved normal to the axis of the lock. The caisson is supported at each end on two rollers set normal to its axis on two eight-wheel trucks. At the western end of the lock there are two gates, one of which is a spare that can replace either of the service gates as all three are exactly alike. A gate weighs 1,184 tons and its airchamber has a volume of 49,400 cubic feet divided into 16 compartments, each one of which may be filled with water and emptied by compressed air. Under normal working conditions the air chamber is partly filled with water in order to reduce the weight of the gate to 120 tons on its trucks. When empty the caisson has a draft of 12 feet. The gate recesses are designed to be closed with steel bulkheads and unwatered for inspecting, repairing and painting the caissons. The gates were built at Rotterdam during 1928 and were towed to Ymuiden floating in a horizontal position.

Operation of New Lock,—All the gate and valve machinery is erected as far as possible above the top of the lock walls, and will be electrically driven and operated by remote control from an operating cabin built on top of the gate machine house at the eastern end of the lock. There is a cable tunnel at each end of the lock. In the operating room a large wall board will show by small panels and coloured lamps the positions of the valves and gates as they are opened and closed. Sensitive water gauges will also show the water levels in and outside the lock chamber, as the gates can only be operated when the water level on each side of them has been equalized. The operator in the control room will be directed in his operations by men on the lock walls who will communicate with him by phone or electric horn. The latter condition is an inherent defect in a remote control system where the operator is blind and is one that has been eliminated as far as possible in the local remote control system adopted for the locks of the Welland Ship canal.

Conclusions,—At the beginning of the last century the port of Amsterdam faced the Zuider Zee, but in its efforts to keep its approaches deep enough for the largest ships it has been completely turned about and now faces the North sea. During the hundred years struggle to retain its position as one of the great European ports, it has enlarged its North sea entrance three times, and is now engaged on the fourth enlargement which it believes when completed will assure its maritime position for many decades to come. These four enlargements remind one of the hundred years fight that the Welland canal has had to accommodate the largest size of ships, which all over the world appear to be constantly ahead of channel, lock, and port accommodation.

The Kaiser Wilhelm Canal

Entrance to Baltic Sea,—The North sea is separated from the Baltic sea by the Jutland peninsula and up to the time the Kaiser Wilhelm canal (commonly called the Kiel canal) was opened for traffic in 1895 the only access to the Baltic for shipping was via the Skagerrak, Kattegat and the channels between the Danish islands at the southern end of the Kattegat.

The route round the Skaw is 240 miles longer than via the Kiel canal and it is besides very dangerous to shipping, due to bad currents, shoals, reefs, prevailing hazy and foggy weather, and to the want of aids to navigation. The Skagerrak and the Jutland coast have therefore always had a bad reputation among navigators on account of the many shipwrecks that have occurred along these channels.

History,—Towards the middle of the last century an agitation arose for the construction of a ship canal across the southern end of the Jutland peninsula and as Prussia at this time was engaged on the consolidation of the numerous German provinces into a United Empire, she determined to acquire the Danish Duchies of Schleswig and Holstein so that she could control the construction of the projected canal as its construction would place Germany in control of the Baltic and provide a protected base for her contemplated navy.

As the result of the short Danish-Prussian-Austrian war of 1864, Denmark, under the Treaty of Vienna, 30th October, 1864, renounced all her rights in the Duchies in favour of Prussia and Austria, and by the Treaty of Prague, 23rd August, 1866, Austria ceded the Duchy of Schleswig to Prussia.

The formation of the Prussian province of Schleswig-Holstein gave Prussia absolute control of the southern half of the Jutland peninsula and placed in her hands the construction of the projected canal across Holstein from the mouth of the River Elbe on the North sea to Kiel on the Baltic sea.

Baltic Sea,—The Baltic is 960 miles long and has a maximum width of 400 miles with a coast line of 5,000 miles, and is surrounded by Sweden, Russia, Prussia and Denmark. The principal Prussian port is Kiel, the German naval base on the Baltic. At Swinemuende, Prussia, the mean level of the Baltic is 0.22 feet below mean sea level at Ostend. There are no tides in the Baltic but due to storms the water level will fall 6.5 feet and rise nearly 10.0 feet above its normal level.

Proprietor,—The Kaiser Wilhelm canal is owned by the state, which administers it through the Reichs Kanalamt in Kiel. The managing director in Kiel and the port captains at the entrances to the canal are in charge of the shipping and the canal locks under the Reichs Kanalamt. Special officials are in charge of the maintenance of the canal works.

First Canal,—The canal is 62 miles long and traverses the old Danish Duchy of Holstein from Brunsbuettelkoog on the Elbe (20 miles above Cuxhaven and 45 miles below Hamburg) to Holtenau (a suburb of Kiel) on the Baltic. The canal is fairly straight and runs through the west Holstein marshes, the moorland plain of Kudensee and Burg, the watershed between the Elbe and the Eider, and the lowlands of Gieselau, Haarlerau, Luhau and Jevenau. In the vicinity of Rendsburg it follows the valley of the Eider into lakes Audorf and Schirnau which were lowered 6.5 to 8.0 feet, and 8 miles west of Holtenau it crosses Lake Flemhude which was lowered 23.0 feet. From the Rendsburg lake district to Holtenau the land is generally 10 to 40 feet above the water surface of the canal.

Normal Level of Canal,—The normal level of the canal was about 0.2 feet above the normal level of the Baltic, or about mean sea level of the North sea.

Dimensions of Canal Prism,—It was 72 feet wide on the bottom, 220 feet on the surface and had a depth of 29.5 feet. At curves with a radius of 3,280 to 8,200 feet the bottom width was increased to 197 feet.

Cost of Canal,—The first canal was built between 1887 and 1895 at a cost of about 166,000,000 marks ($39,840,000). Of this amount $2,640,000 were spent for the canal right-of-way.

Locks,—The canal was protected at both ends by twin locks that were designed to accommodate ships 475.5 feet long, 75.5 feet beam and a draft of 28.0 feet. The locks were accordingly designed for a usable length of 492 feet, a width of 82.0 feet and a depth on the sills at Holtenau of 31.4 feet and at Brunsbuettelkoog of 32.7 feet. These locks are provided at each end with two pairs of mitering steel gates placed back to back, so that the locks could be used at all stages of the tide. These locks also have a middle pair of gates. A lock 223 feet long, 39.4 feet wide and a depth of 16.5 feet on the sills was built at Rendsburg to connect the Eider river with the canal.

Bridges,—Highway and railway traffic was carried over the canal by two overhead and four swing bridges. The overhead bridges had spans of 515 and 534 feet and a clearance of 137.7 feet above normal water level. The swing bridges had clear openings of 164 feet and were operated by hydraulic power.

The canal was lighted by electricity from power stations at Brunsbuettelkoog and Holtenau.

Second Canal, 1909-1914

Second Canal,—The first canal satisfied shipping requirements for about a decade when it became manifest that it could no longer accommodate the larger ships of the navy and mercantile fleets. The "Deutschland" built at the beginning of this century was 656 feet long and the "Imperator" ("Berengaria") then under construction and finished in 1912 was 884 feet long, 98 feet beam with a draft of 36 feet. On account of these and many other ships of the merchant marine and of the navy not being able to pass through the canal, and on account of the constantly increasing congestion of the waterway, the canal authorities recommended the enlargement of the canal to the German government. The recommended enlargement was approved by the Reichstag in 1907.

Recommended Improvements,—The improvements that were finally decided upon were:—

1. To deepen and widen the prism.
2. To flatten the curves.
3. To rebuild the bridges.
4. To build two new twin locks at each entrance to the canal.

Normal Level of the Canal,—In order to facilitate navigation into the Baltic and North seas, the normal level of the canal, which was then only slightly above the mean level of the Baltic, was raised about 1.1 feet above the normal level of the Baltic or about 0.9 feet above the mean level of the North sea, or about 4.0 feet below the average high tide in the Elbe at Brunsbuettelkoog. Raising the normal level of the canal made it 37.1 feet deep and made the canal 338.0 feet wide at the waterline and provided a wetted cross section of about 9,243 square feet.

The canal was deepened from 29.5 feet to 36.0 feet and the bottom was widened from 72.0 to 144.0 feet. The bottom width was increased at the sharper curves and also at the passing places or sidings.

The curves were flattened to radii of 5,904 to 19,680 feet.

Passing Places or Sidings,—There are eleven sidings where the canal is widened on both sides of the canal prism for ships to pass. The sidings are generally about 440 feet wide and 2,300 feet long. Four of them are 540 feet wide and 3,600 feet long. Each siding is provided at one end with a turning basin 1,000 feet in diameter. Many of these sidings are old ones enlarged. Along each side of the sidings clusters of 7 to 12 timber piles have been driven. The clusters or dolphins are about 50 feet apart. Ships moor against the dolphins with their lines on mooring posts ashore. The dolphins last about 15 years and ships damaging them pay for the damage done.

Bridges,—Although the spans of the fixed overhead bridges were long enough for the enlarged canal, they were replaced with longer and stronger steel bridges. The main span of the new bridges is about 492 feet and the clearance is the same as provided by the old bridges — 138 feet. There are highlevel railway bridges at Hochdonn, Gruenental, Rendsburg and Levensau. The Prinz-Heinrich highway bridge at Holtenau is also a new highlevel bridge and there is a new swing bridge at Rendsburg with a clear opening of 246 feet.

The Rendsburg highlevel bridge is a fine structure 8,200 feet long and contains 18,000 tons of steel. The approaches to the canal span are long curved inclines. The canal span carries a suspended trolley car ferry like the one at Duluth. At Nubbel there is a double swing span highway and railway bridge, whose pivot piers are 308 feet apart. The bridge operates very quickly.

New Locks,—New twin locks were built north of the old locks at Brunsbuettelkoog and south of those at Holtenau. The new locks have an effective length of 1,082.5 feet, a width of 147.5 feet and a depth on the sills of 46.2 feet below the new normal water level of the canal, and 39.4 feet below extreme low water level of the Elbe and 45.1 feet below normal level of the Baltic and 39.4 feet below low level of the Baltic. These dimensions provide for future deepening of the canal and the passing through it of damaged ships. It may be noted that these locks are larger than the Panama canal locks.

Caisson Gates,—The locks are provided with three rolling caisson gates 154 feet long by 26 feet wide. Those at Brunsbuettelkoog are 71.5 feet high and those at Holtenau are 61.0 feet high. The middle gate of each lock divides the chamber into usable lengths of 328 and 725 feet, and it may also be used as a spare gate, as the gates of each lock are interchangeable. The gates are opened and closed in four minutes with an electric current of 50 amperes at 500 volts, but they may be opened and closed in two minutes with double the current.

Remote Control of Locks—The gates and valves are equipped with electric motors that are operated by remote control. The operator's cabin is located at the middle of the centre wall. In the cabin on each side wall there is a board about 3 feet wide by 12 feet long on which are shown by small panels the gates and valves of the locks. The small panels move as the gates and valves open or close. Full open positions are also indicated by green lamps and full closed positions by red lamps. Along the bottom of the boards are the switches for controlling the gates and valves. Water level indicators record the water levels inside and outside of the lock chambers. One operator looks after both boards and performs all operations of opening and closing the gates and valves by directions from men on the lock walls, who transmit their orders to the operator by telephone, or by signals on an electric horn in the operator's cabin. The remote control was designed and installed by the Siemens-Schuckert Werke, Berlin. A similar remote control equipment will be used at the new Ymuiden lock of the North sea canal.

Dates of Construction,—The work of enlarging the canal was begun in the summer of 1909 and completed at the end of 1914. Most of the work was done by contract, but the canal forces unwatered the lock pits and did some of the dredging in the upper Eider lakes, and the canal authorities also built and operated camps and hospitals for the contractors' men employed on the work.

Cost,—The cost of the enlargement was estimated at 223,000,000 marks ($53,520,000). Of this amount, about $5,280,000 was spent for additional right-of-way. The greater part of the new right-of-way was acquired as spoil ground as only a small quantity of the excavated material was required for building embankments and only that adjacent to each end of the canal could be readily disposed of in the sea.

Power and Transmission Lines,—The canal owns and operates Diesel engine driven electric power stations at Brunsbuettelkoog and Holtenau. In each station there are three units — two 340 h.p. and one 180 h.p. unit. During the daytime only the 180 h.p. units are used. There are two transmission lines on each side of the canal—a main supply line and a lamp line. The main supply lines transmit current at 7,500 volts. The lamps are 25 watt in series and are opposite each other across the canal and are 328 feet apart except at sidings where they are 164 feet apart. The lamps are about 20 feet above the water. At the locks the lamps are 100 watt and 75 feet apart.

Time of Transit,—It takes a ship from 6 to 9 hours to make the transit of the canal. The speed limits vary between 6.0 to 9.5 miles per hour.

Fog,—The canal is closed by fog about 10 days or less per year.

Ice,—About every five years ice as thick as 9 inches will occur, but does not close the canal which is kept open by ice breakers. The lowest temperature that has been observed is about 2 degrees below zero F.

Night Navigation,—The canal is navigated at night all the year by large ships. About 50 per cent of the shipping that uses the canal pass through it at night. Steamers following one another must keep 1 km. (0.62 mile) apart. All motor driven vessels and tugs towing barges have to tie up at the sidings after sundown, as they are not allowed to run at night.

Traffic,—In 1900, 8,235 ocean steamers passed through the canal and in 1913, 16,012, and by 1919, owing to the war, the number using the canal had fallen to 6,723, but by 1922 the traffic had again increased to 20,122 ocean ships. There is, in addition, a large traffic of smaller boats and barges passing through the canal.

Tolls,—The Treaty of Versailles, 23 June, 1919, under Articles 380 to 386, lays down certain regulations respecting the Kiel canal. The canal and pilotage dues are limited to rates sufficient to cover the cost of administration, maintenance and improvements. All commercial and naval vessels of nations at peace with Germany have permanent free use of the canal without special permission and on terms of entire equality with those of Germany. Traffic on the canal is subject only to police, customs, sanitary, emigration or immigration regulations and those relating to the import or export of prohibited goods. Goods in transit may be placed in bond and are then not subject to any further customs formalities. In the event of violation of any of the conditions of Articles 380 to 386 or of disputes as to the interpretation of these articles, any interested power can appeal to the jurisdiction instituted for the purpose by the League of Nations. A local German authority at Kiel is qualified to deal with disputes in the first instance.

Supplies,—Shipping may obtain coal, oil, provisions and other supplies at Brunsbuettelkoog, Rendsburg and Holtenau.

Suez Canal

History,—The name of Ferdinand de Lesseps will always be connected with the construction of the Suez canal. When he was the French consul in Egypt in 1830, he began to study the possibility of building a canal across the isthmus of Suez but it was not until 1854 that he obtained a concession to build the canal from the Egyptian Prince Mohammed Said. This concession was however not finally confirmed by the Turkish government until 1866.

In the meantime he succeeded in forming the Compagnie Universelle du Canal Maritime de Suez with a capital of 200,000,000 francs ($40,000,000) to build the canal and in August, 1859; the first sod was turned. The canal was opened for traffic in November, 1869.

Description of Canal,—The Suez canal is a sea level canal, without locks, and is about 102 miles long from Port Said on the Mediterranean to Suez on the Red sea. There are about 88 miles of straight lines and the balance of the distance is curved, with a minimum radius of 2 miles.

The original depth below lowest tide level was 26.3 feet with a bottom width of 72.2 feet. To-day the depth varies between 37.4 feet and 42.6 feet and the width is now 196.8 feet at a depth of 32.8 feet throughout the entire length of the canal, except for a short distance when it is only 147.6 feet wide. This short distance will be widened to 196.8 feet in the near future. The minimum width at the water line is about 345 feet.

Material,—The material encountered in excavating the canal was chiefly sand and sand clay. The maximum depth of cutting at El Gisr was about 90 feet. At Serapeum and Shaluf some rock was taken out. In the early days of construction, excavation was done by Egyptian hand labour and the material was taken away in baskets. At this stage of the work the maximum force was 30,000 men. Machinery was introduced in 1865.

Canal Entrances,—The Mediterranean entrance is protected by piers 1¼ miles long and the Red sea entrance by shorter ones.

Cost,—The canal has cost to date with all improvements about $157,000,000.

Time of Transit,—Before 1886 ships were only allowed to navigate the canal during the day, since then steamships that are provided with the required electric lights are allowed to proceed at night. Prior to 1886 the average time of transit was 48 hours. The time of passage is now about 16 hours. The maximum speed for ships transiting the canal is fixed at 6.5 knots per hour. No ship is allowed to pass through the canal without a canal pilot in charge.

Traffic,—In 1910, 4,533 vessels, with a net tonnage of over 20,000,000, tons passed through the canal. In 1928, 6,084 vessels, with a net tonnage of about 32,000,000 tons, made the transit of the canal. In 1928, 57 per cent of the traffic that passed through the canal was British.

Tolls,—At present ships loaded pay tolls at the rate of $1.34 per net ton. Ships in ballast are allowed a reduction of $0.48 per net ton on the full rate. In addition to the tonnage dues, transit dues are paid on all passengers at the rate of $1.94 per passenger above 12 years of age, and $0.97 per passenger between 3 and 12 years of age.

Levels,—Mean sea level of the Mediterranean and Red sea is about the same elevation. The range of ordinary spring tides at Port Said is 6 to 8 inches and at Suez from 5¼ to 6 feet. The difference in level appears never to be greater than 4 feet at the two ends of the canal which are about 102 statute miles apart.

Currents,—As a result of observations it has been found that between May and October a small current flows in a southerly direction through the canal, and that in winter months southerly winds reverse this condition. A volume of water is consequently moving alternately from sea to sea.

Distance Saved London to Hong-Kong,—From London to Hong-Kong the distance via the Cape of Good Hope is 13,089 miles, and via the canal 9,678 miles or a difference of 3,411 miles. This means a saving of about ten days in the voyage of a fast passenger steamer and indicates the economy of time that is obtained by using the canal.

Welland Ship Canal

History,—The St. Lawrence river canals, including the Welland and Sault Ste. Marie, canals form a great chain of inland navigation, extending from the straits of Belle Isle westward to Duluth at the head of the Great Lakes.

From the days of the earliest settlements on the St. Lawrence down to the present time the Canadian people have looked forward to the day when large ocean ships would be able to sail up the St. Lawrence to the Great Lakes, and towards this end Canada during the past century spent large sums of money improving the ship channel of the St. Lawrence up to Montreal and building canals between Montreal and Sault Ste. Marie.

The largest canal on the route is the Welland, which crosses the Niagara Peninsula 10 miles west of Niagara falls and connects Lake Ontario with Lake Erie. The difference in elevation between the standard low water levels of these lakes is 327 feet. The first canal was built by a private company between 1824-1833. This canal was later taken over by the government of Upper Canada and enlarged between 1841-1850. The completion of the second canal coincided with the completion of the St. Lawrence canals between Montreal and Lake Ontario in 1848 when boats 140 feet long, 26 feet beam and 9 feet draught could then for the first time ascend the river from Montreal to Lake Erie. The construction of the third Welland canal was began about 1873 and completed for 14 feet navigation in 1887, but the enlargement of the St. Lawrence canals for 14 feet navigation was not completed until 1901 when a boat 256 feet long, 43 feet beam and drawing 14 feet could ascend the river from Montreal to the head of the Great Lakes.

Description of Route,—The Welland canal now nearing completion is 25 miles long from the shoreline of Lake Ontario at Port Weller to the shoreline of Lake Erie at Port Colborne and is the fourth canal built by Canada across the peninsula.

From Port Weller it follows the Ten Mile creek to Thorold and between these places it crosses the third canal above lock No. 3 where the water levels of both are elevation 382.0, and between lock No. 7 and the guard gate at Thorold it again crosses the third canal. From Thorold to Allanburg a new channel has been excavated and between Allanburg and Port Robinson the third canal has been deepened and widened.

From Port Robinson to Welland the canal follows the west side of the Chippawa creek valley and is separated from the creek throughout this distance by an embankment 50 feet wide on top. From Welland to Port Colborne the third canal has been deepened and widened, with the exception of a section 2½ miles long immediately north of Lake Erie where a new channel has been excavated through the villages of Humberstone and Port Colborne.

Depth and Width,—The canal has a minimum bottom width of 200 feet and a minimum depth of 25 feet. For a great part of the distance throughout the summit level, Thorold to Port Colborne, it has been excavated to 26.5 feet depth below elevation 568.0 extreme low water level of Lake Erie. All the locks and their entrance piers, bridge piers and the docks at Port Weller and the new docks at Port Colborne have been built for a depth of 30 feet so that the canal at some future date can be deepened by simply dredging the canal prism and harbour entrances.

Locks,—The fall of 327 feet between the lakes is overcome by eight locks. The normal lift of the locks is 46½ feet, except that of the guard lock (lock No. 8) at Port Colborne, which varies with the level of Lake Erie. During the summer months the lift of the guard lock is about three feet. Locks Nos. 1 to 7 are 859 feet long between gates, 80 feet wide, and have 30 feet of water on the sills. These locks have a usable length of 820 feet. Lock No. 8 is 1,380 feet long, 80 feet wide, and has a depth of 30 feet on the sills. It has a usable length of 1,355 feet. Locks Nos. 1 to 7 are located between Port Weller and Thorold. The direct line of the canal down the face of the Niagara escarpment and the slope of the lower plateau permitted the adoption of 46.5 feet lifts for the locks, which constitutes a peculiar feature in the design of the canal and has no precedent in actual construction for locks of their size. Locks Nos. 1, 2, 3, 7 and 8 are single locks. Locks Nos. 4, 5 and 6 are twin locks in flight. The flight is double in order that ships may be passed simultaneously in opposite directions.

About three-quarters of a mile above lock No. 7 a guard gate and weir have been built for safety purposes only, as the water level on each side of them is the same.

The abandoned part of the third canal at Port Colborne is now used as a raceway to feed the new canal, and the flow through it is regulated by a large weir.

As it requires about 70 acre-feet of water to fill one of the locks with a lift of 46½ feet, it is essential that there shall be a large pondage area above each lock, in order to avoid drawing down the canal levels too much when filling the locks. For this purpose lock No. 1 has a pondage area of 107 acres, lock No. 2,200 acres, and lock No. 3,150 acres. Above lock No. 6 a pond of 84 acres has been formed by building an earth dam 3,300 feet long with a maximum height of 75 feet.

Harbours,—Port Weller harbour is situated about 3 miles east of Port Dalhousie and is formed by two parallel earth embankments extending 1½ miles into the lake. The channel between them is 800 feet wide on the bottom, which is narrowed to 400 feet wide at the harbour entrance by two converging lines of concrete cribwork.

Port Colborne harbour is an artificial one, developed in a small bay of the lake to protect the canal entrance and provide shelter for the transfer of bulk cargoes to the government elevator and other industrial plants located on the harbour docks. The outer harbour is formed by two lines of breakwaters placed about 4,400 feet off shore. The entrance, 600 feet wide between the eastern and western breakwaters, is protected against southwest gales by a spur breakwater that extends 2,000 feet into the lake from the eastern end of the western breakwater. Port Colborne harbour is one of the finest harbours on the Great Lakes and has over 5.5 miles of concrete dock walls, 4 miles of which have a depth of at least 25 feet of water in front of them.

Lock Gates,—The gates of the locks are of the mitering horizontal girder type, sheathed on both sides, and are built of steel. The gates at the head of locks Nos. 1 to 7 are 35.5 feet high and weigh 190 tons per leaf. The lower gates of these locks are 82 feet high and weigh 490 tons per leaf. The gates of lock No. 8 and the guard gate are 44.5 feet high and weigh per leaf 240 tons. All the gate leaves are 5 feet thick. The gates were all built at their respective sites in the locks, and will be handled in the future when taken out for repairs, etc., by a pontoon

Table of Ship Canals and Docks

Canals and docks	Year		Canals					Locks					
	Begun	Finished	Length	Depth	Bottom width min.	Capital Cost	Rise	Total	No.	Length between gates	Usable length	Width	Depth on Sills
			Miles	Feet	Feet	Mill. $	Feet	No.		Feet	Feet	Feet	Feet
Welland	1913	1931	25.0	25.0	200.0	128.0	327.0	8	1 7	*1380.0 859.0	*1355.0 820.0	80.0 80.0	30.0 30.0
Panama	1880	1914	50.0	45.0	300.0	275.0	85.0	6		1080.0	1000.00	110.0	40.0
Sault Ste. Marie... (Canadian)	1888	1895	1.1	19.0	150.0	5.0	21.0	1	1	900.00	860.00	60.0	18.2
Sault Ste. Marie... (American)	1853	1881							1	515.0		80.0	12.6
Sault Ste. Marie... (American)		1896							1	800.00		100.0	18.0
Sault Ste. Marie... (American)	1914 &	1919	1.1	21.0		26.8	21.0	4	2	1350.0		80.0	24.5
Manchester	1887	1894	35.5	28.0	90.0 120.0	87.5	70.0	5	1 4	600.0 600.0		80.0 65.0	30.0 28.0
Suez	1859	1869	102.0	33.0	197.0	150.0	Tidal	0					
North Sea	1865 1917	1896 1931	15.5	32.0	197.0	47.0	Tidal	2	1 1	738.0	1312.	82.0 †164.0	32.0 47.5
Kiel	1887 1909	1895 1914	62.0	37.0	144.0	94.0	Tidal	8	4 4	492.0	1082.5	82.0 147.5	32.0 46.2
Port of London:													
George V dock...		1921									800.0	100.0	45.0
Tilbury dock....							Tidal			1300.0	1000.0	110.0	45.5
Port of Liverpool:													
Gladstone dock..							Tidal				1070.0	130.0	48.8

*Longest lock in world. †Largest lock in world.

gatelifter built for the purpose. Spare gates of each size have been built and are stored in the gate dock at Port Weller. For a full description of the gates see the paper by F. E. Sterns, M.E.I.C., in The Engineering Journal, February, 1928.

Safeguards,—All the gates of the locks are provided with safety castings which permit any pair of gates being opened at the mitre about 4 feet without the leaves of the gate losing contact with one another.

Wire rope fenders are being installed above and below the lower gates of a lock, and above the upper pair where no bridge crosses the upper entrance of a lock. The fenders consist of a heavy steel wire rope suspended across the lock chamber at the upper or lower coping level.

For further protection in the operation of the locks, all the control equipment of the machinery operating the gates, valves, fenders and signals is so electrically interlocked that the lock motorman in the operating cabin at each end of each lock can only carry out a lockage by a definite sequence of operations.

Bridges,—There are 20 movable bridges built across the canal:—six are 80 feet Scherzer bascule spans at locks; one is a double leaf Scherzer 200 feet span; two are equal arm swing bridges with channels 80 feet or 100 feet wide under each arm; eleven are vertical lift 200 or 220 feet spans with a clearance of 120 feet under them when raised for navigation. For a description of the bridges see the paper by M. B. Atkinson, M.E.I.C., in The Engineering Journal, February, 1928.

Power,—All the gates and the valves of the locks, the valves of all weirs and all the bridges are electrically operated. The Dominion Power and Transmission Company, Hamilton, is now supplying power for the operation and lighting of the canal until the power plant of the canal is completed and ready for operation. The power house is being built below lock No. 4 and will operate under a nominal head of 189 feet. It will be ready for operation in 1931.

Chippawa Creek Syphon Culvert,—The Chippawa creek was carried under the third canal at Welland by a cut stone aqueduct that is now being removed. It has been replaced by an inverted syphon culvert built of concrete. The culvert consists of six 22 feet internal diameter tubes with vertical shafts at each end, located immediately north of the aqueduct.

The material at this place is a very soft clay 100 feet deep to rock and as the culvert pit was about 82 feet deep, and the bottom of it 75 feet below the water surface of the adjacent canal, the construction of the culvert was a very dangerous and costly undertaking but was successfully carried out. Navigation was diverted across the culvert in December, 1928, and in September, 1929, the creek was passed through it. For a detailed description of the culvert see the paper by the author in The Engineering Journal, February, 1928.

Transit of Canal,—The canal is in continuous operation twenty-four hours per day during the season of navigation, approximately 15th April to 15th December. It is excellently lighted from lake to lake and is easily navigated at night. The time of transit through the canal of a great lake freighter has been estimated at 8 hours. During 1930 the St. Lawrence canals sized ships traversed the canal in 6½ to 7½ hours.

At the opening of navigation in 1930, locks Nos. 1, 2 and 3 were placed in commission and remained in service throughout the season. Locks Nos. 4, 5, 6 and 7 were placed in commission on September 10th, 1930. Lock No. 8 was placed in commission on September 16th, 1929, and has been in use ever since. The whole of the canal was placed in service in September, 1930, and towards the close of the season was available for 18 feet draft by the St. Lawrence canals sized boats. It is anticipated that the canal will be officially and formally opened for use by the great lake freighters sometime in 1931.

On November 22nd, 1930 the last ship passed up through locks 11 to 24 of the third canal. This event may therefore be taken as the closing act in the navigation life of the third canal after an existence of 48 years.

Cost,—The construction of the canal has involved the excavation of about 51,000,000 cubic yards of earth, 9,000,000 cubic yards of rock and the placing of about 3,500,000 cubic yards of concrete, and will cost, including its power house and engineering expenses, about $128,000,000. At the end of October, 1930, the net expenditure on the project amounted to about $120,000,000.

The following table gives the dates of construction, capital cost, and the principal dimensions of the six large canals of the world, and also the dimensions of the Sault Ste. Marie locks and the principal entrance locks of the ports of Liverpool and London.

The construction of a canal not only involves the solution of problems more or less common to all waterways, but also the solution of many problems local to the district through which the waterway passes. In the former category may be placed the width and depth of the waterway and the size of its locks. On the Welland the question was, what size of canal would be required to accommodate the largest ships that would sail the Great Lakes in the future? It was finally determined that a canal 200 feet wide on the bottom and 30 feet deep with locks 800 feet long by 80 feet wide would accommodate the largest vessels that would be built on the Great Lakes for many years to come. To-day the largest ship on the Great Lakes is 633 feet long and 70 feet beam. The present maximum loading depth of the great lake freighter is about 21 feet. The foregoing dimensions would permit of about 65 per cent of the ships that passed through the Panama canal in 1930 to transit the Welland canal. The 3,500,000 cubic yards of concrete required for the construction of the locks and other structures of the Welland canal also compares favourably with the 5,000,000 cubic yards required for the locks, etc., of the Panama canal.

The great rise of the canal and the high lift of its locks is the outstanding feature of the canal. The high lifts is a departure from previous canal practice, and has no equal to-day on any other canal in the world.

As the canal passes through a highly developed agricultural and industrial section of the country many bridges cross it and for safe navigation of the canal by large ships it was deemed most desirable that the canal prism should not be obstructed by bridge piers placed on the bottom of the canal. This decision led to the use of vertical lift bridges over the canal. This type of bridge has proven very satisfactory to navigation, highway and railroad interests, and where movable spans are required has probably forever displaced the old reliable swing bridge.

One of the most important problems connected with the construction of the Welland canal, was the maintaining of uninterrupted navigation in the third canal, while the fourth was being built. The two canals crossed each other seven times and at two places, viz. lock No. 3 and the Chippawa creek syphon culvert, the risks during construction of the fourth canal to the existing canal were very great, but throughout the entire period of construction no delays and very little inconvenience to navigation occurred. At several points the transfer of navigation from the third to the fourth canal was made during the closed season of navigation.

The Welland is and always will remain one of the large canals of the world. The quantities of rock and earth excavation are not as large as those of the Panama canal and several of the other large canals, nor is its cost if compared on a pre-war basis nearly as large as that of the Panama and Suez, but compares favourably with that of the Manchester, North Sea and Kiel canals. The Welland however stands pre-eminently above them all in its total rise and the lift of its locks.

In concluding, permit me on retiring from the position of President to express the hope that the membership and influence of The Institute will continue to grow and that the Council in its labours will always have the unanimous support of the members with the assurance that their actions have only the welfare of The Institute in view and that each member will always feel that The Institute is of real value to him and a benefit to our nation.

Meetings of Council

A meeting of Council was held at the Windsor hotel, Montreal, on Wednesday, February 4th, 1931, at five o'clock p.m., with President S. G. Porter, M.E.I.C., in the chair, and sixteen other members of Council present.

George R. MacLeod, M.E.I.C., announced with regret that F. P. Shearwood, M.E.I.C., who had wished to resign the Treasurership last year, desired his resignation of that office to become effective now. Mr. MacLeod suggested the appointment of W. C. Adams, M.E.I.C. This was unanimously agreed to, and the Secretary was directed to write to Mr. Shearwood expressing Council's thanks and appreciation of his long and effective service as Treasurer, and regret at the necessity for his retirement.

On the termination of his term of office as vice-president, Mr. George R. MacLeod resigned the chairmanship of the Finance committee, and upon his suggestion it was unanimously agreed to appoint J. L. Busfield, M.E.I.C., to succeed him. The other members of the committee were also unanimously appointed as follows:—

W. C. Adams, M.E.I.C.
F. A. Combe, M.E.I.C.
T. J. Lafreniere, M.E.I.C.
F. P. Shearwood, M.E.I.C.

D. C. Tennant, M.E.I.C., was unanimously appointed chairman of the Library and House committee.

It was unanimously decided to continue the following committees, their membership to be decided at the next meeting of Council:—

Board of Examiners and Education
Committee on International Co-operation
Honour Roll and War Trophies Committee
Biographies committee
Engineering Education

and that the following committees should not be re-appointed:—

Classification and Remuneration committee
Committee on Policy
Publicity committee.

Attention was drawn to the retirement from Council of Dr. A. R. Decary, M.E.I.C., after a very long service as Councillor, Vice-President, and President. The President expressed Council's good wishes to Dr. Decary, and pointed out particularly the benefit accruing to The Institute through his sympathetic activity as President of the Corporation of Professional Engineers of Quebec, particularly in regard to the question of the confederation of the various provincial associations.

Dr. Decary expressed thanks for Council's kind wishes. He had had great pleasure in doing what he could for The Institute, and would long retain pleasant memories of his association with the Council and the many members of The Institute with whom he had served. He hoped that the work of unification of the professional associations would continue, and that during Mr. Porter's term of office as President, real definite progress would be made.

The Council rose at five forty-five p.m.

A meeting of Council was held at Headquarters at eight o'clock p.m., on Tuesday, February 17th, 1931, with Vice-President O. O. Lefebvre, M.E.I.C., in the chair, and six other members of Council present.

The minutes of the meetings held on January 20th, and February 4th, 1931, were taken as read and confirmed.

The membership of the following committees was approved as follows:

Finance Commitee: J. L. Busfield, M.E.I.C., Chairman
F. A. Combe, M.E.I.C.
T. J. Lafreniere, M.E.I.C.
F. P. Shearwood, M.E.I.C.
W. C. Adams, M.E.I.C., Treasurer

Library and House Committee:
D. C. Tennant, M.E.I.C., Chairman
H. Massue, A.M.E.I.C.
A. R. Roberts, A.M.E.I.C.
E. A. Ryan, M.E.I.C.
J. H. Trimingham, M.E.I.C.

Legislation Committee:
H. Cimon, M.E.I.C., Chairman
A. Duperron, M.E.I.C.
N. D. Paine, A.M.E.I.C.

Publication Committee:
J. A. McCrory, M.E.I.C., Chairman
F. S. B. Heward, A.M.E.I.C.
C. R. Lindsey, A.M.E.I.C.
G. K. McDougall, M.E.I.C.
H. S. Van Patter, A.M.E.I.C.

Committee on International Co-operation:
John Murphy, M.E.I.C., Chairman
J. B. Challies, M.E.I.C.
H. B. R. Craig, M.E.I.C.
J. M. R. Fairbairn, M.E.I.C.
Fraser S. Keith, M.E.I.C.
H. R. Safford, M.E.I.C.
A. Surveyer, M.E.I.C.
W. F. Tye, M.E.I.C.
H. H. Vaughan, M.E.I.C.

Honour Roll and War Trophies:
Brig.-Gen. C. J. Armstrong, M.E.I.C., Chairman
Col. A. E. Dubuc, M.E.I.C.
Fraser S. Keith, M.E.I.C.
Brig.-Gen. G. E. McCuaig, M.E.I.C.

Engineering Education:
Fraser S. Keith, M.E.I.C., Chairman
R. W. Brock, M.E.I.C.
C. V. Corless, M.E.I.C.
F. R. Faulkner, M.E.I.C.
E. P. Fetherstonhaugh, M.E.I.C.
A. Frigon, M.E.I.C.
W. J. Johnston, A.M.E.I.C.
C. J. Mackenzie, M.E.I.C.
C. H. Mitchell, M.E.I.C.
J. Stephens, M.E.I.C.
R. S. L. Wilson, M.E.I.C.

Membership Committee:
Brig.-Gen. C. H. Mitchell, M.E.I.C., Chairman
W. C. Adams, M.E.I.C.
H. F. Bennett, A.M.E.I.C.
C. J. Mackenzie, M.E.I.C.
D. C. Tennant, M.E.I.C.

The chairmen of the following committees were appointed, and the Secretary was directed to ask them to suggest the names of members of their committees for submission to Council at its next meeting:

	Chairmen
Past-Presidents' Prize Committee..........	C. M. McKergow, M.E.I.C.
Leonard Medal Committee................	F. W. Gray, M.E.I.C.
Plummer Medal Committee................	W. H. DeBlois, M.E.I.C.
Board of Examiners and Education.........	C. M. McKergow, M.E.I.C.

In accordance with the rules governing the awards of the Students' and Juniors' Prizes, the following vice-presidents were appointed chairmen of the examiners in their respective zones:

Zone A—H. N. Ruttan Prize—Vice-President H. B. Muckleston, M.E.I.C.

Zone B—John Galbraith Prize—Vice-President T. R. Louden, M.E.I.C.

Zone C—Phelps Johnson Prize (English)—Vice-President W. G. Mitchell, M.E.I.C.

Zone C—Ernest Marceau Prize (French)—Vice-President O. O. Lefebvre, M.E.I.C.

Zone D—Martin Murphy Prize—Vice-President F. R. Faulkner, M.E.I.C.

Considerable discussion took place regarding the work of the Committee on Biographies, after which F. H. Peters, M.E.I.C., was appointed chairman of that committee.

The budget submitted by the Finance committee was considered, and indicated that in order to maintain the activities of The Institute on the same scale as last year additional funds would be required. The recommendation of the Finance committee was approved, that an effort be made to obtain an increased revenue from Journal advertising to provide the necessary additional sum.

The Secretary read a letter from Past-President A. J. Grant advising of his contribution towards the Past-Presidents' Prize Fund, and expressing the hope that members of The Institute would continue to show great interest in this prize by presenting every year a large number of papers on the subject selected by the Council for the competition. The Secretary was directed to express the sincere thanks of Council to Past-President Grant for his generous gift.

Discussion took place as to the Plenary Meeting for 1931, and the Secretary was directed to obtain written opinions from all councillors regarding its date and location.

A letter was presented from the Toronto Branch asking that arrangements be made to hold the 1932 Annual Meeting of The Institute in Toronto. This invitation was accepted with appreciation.

The newly elected officers of the Cape Breton and London Branches were noted.

A proposed change in the By-laws of the Toronto Branch was submitted and approved.

An invitation was presented from the Royal Institution of Great Britain asking Council to appoint a delegate from The Institute to be present at the Faraday Celebrations which will be held in London on September 21st, 1931, and following days.

A similar invitation was received from the Verein Deutscher Ingenieure to appoint two delegates to represent The Institute at the Seventy-fifth Anniversary Celebration of the Society of German Engineers, which will take place in Cologne in June 1931.

Seven resignations were accepted, one reinstatement was effected, and three 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	
Members	1	Junior to Assoc. Member	6
Associate members	5	Student to Assoc. Member	1
Juniors	2	Student to Junior	6
Students admitted	35		

The Council rose at eleven thirty p.m.

Address at Annual Dinner of The Institute

By Francis Lee Stuart, M.E.I.C., President, American Society of Civil Engineers, February 4, 1931

To the President and Members of The Engineering Institute of Canada, and guests:

It is a pleasure for me, as president of the American Society of Civil Engineers, to greet The Engineering Institute of Canada at their annual convention and convey to them our best wishes for their continued growth and usefulness.

I am a member of The Institute, have a summer home in Canada, and have been interested in your country for years. I want you to know that as an engineer, when I study your map and statistics, see the wealth of mines and minerals, and the unusual cheapness and quantity of electric power for industry and your abundant agricultural and other products of a self-contained nation, I can not help but feel that the future holds far-reaching surprises for you beyond your most optimistic dreams of today.

At the present moment we are passing through a critical period. Individual reward for initiative and energetic efforts have made both our countries great. This very incentive has been rewarded by such continued prosperity that the herd instinct and avarice of men have run wild with our judgment and greatly aggravated world conditions and brought on us all an unwarranted period of strain and stress, but I believe we are even now beginning to recover.

You have a continent to develop, with potential resources that can hardly be visualized. It offers vast opportunities for pioneering and for attracting additional populations and because it is so sure to respond to well-directed efforts which you will make, it would seem wise to educate the minds of your people as a mass, in the direction of the arts of engineering, so that as your population increases, from the world sources, your sons and daughters will have the education and training necessary for able leadership, as such emigrants are absorbed into your nation.

The Institute, which represents the collective forces of your engineers, is destined to be a great force in the future, and my faith is so great in the importance of the profession in your welfare, that if I were a Canadian I would try to interest every member of my family in the study of engineering, and all the arts pertaining to the developing of the natural resources of your great country, and prepare for coming events.

Let me leave with you the hope that by co-operation with all interested in engineering progress you will co-ordinate your efforts and keep The Institute growing greater and greater, to the mutual advantage of both countries.

Address at Annual Dinner of The Institute

By W. S. Lee, M.E.I.C., President, American Institute of Electrical Engineers, February 4, 1931

Mr. President, ladies and gentlemen, I am here to-night as President of the American Institute of Electrical Engineers to extend my greetings not only on my own behalf but on behalf of the institution to which I belong. We congratulate you gentlemen upon the field you are covering, upon the work you are doing and the magnificent way in which you are doing it. I am a member of your Institute, and have been for several years. Your Institute covers a great number of engineering activities. My dear friends, you can go to this window and look out upon the Sun Life Assurance Building and find more engineering going on in that one building than would have taken place in this entire province two decades ago. The design and lay-out of the modern elevator has more electrical design and more work and detail than many whole buildings designed two decades ago.

It is my business as a consulting engineer to work with various organizations, and I am surprised on many occasions how few men in the different branches of engineering know and come in contact with one another. It is such meetings as you are having here which give us the ambition and inspiration to carry on our work.

Now, ladies and gentlemen, your good President in his talk said this was the first time the ladies had honoured The Institute with their presence. As your speaker at lunch time said, you will never be without them again; I agree with him; they will be here at all times.

I want to say to my friends here that we must keep the ladies with us; you will have more members and better Institute meetings. When I look through your audience and see the men to whom you entrust your engineering work in the Dominion of Canada I must say that they are men of intelligence, they are fine looking men and they are men who are ready to put their shoulders to the wheel and work.

And I say to you that if you cannot win with these men you deserve to lose.

Award of Medals and Prizes

Past-Presidents' Prize

The Past-Presidents' Prize of The Institute for the year 1929-1930 has been awarded to Group-Captain E. W. Stedman, M.E.I.C., for his paper on "Rigid Airships," which was published in The Engineering Journal for February, 1930.

Group-Captain Stedman, who is a Whitworth Scholar and an Associate of the Royal College of Science, London, was for some time engaged in aeronautical research work at the National Physical Laboratory, Teddington, England, and from 1914 to 1919 served in the Royal Naval Air

Service and Royal Air Force. In 1919-1920 he was chief of technical staff with Handley Page, Ltd., of London, England, and coming to Canada in 1920 became director of the technical section at the Air Board, Ottawa. Group-Captain Stedman is at present chief aeronautical engineer, Royal Canadian Air Force, Department of National Defence, Ottawa.

Group-Captain E. W. Stedman, M.E.I.C.

P. B. Motley, M.E.I.C.

F. M. Wood, A.M.E.I.C.

Medallists and Prizewinners for 1930

C. G. MacLachlan

W. B. Boggs

A. E. Flynn

G. B. JOST, S.E.I.C.

Gzowski Medal

Two Gzowski medals have been awarded this year, one to P. B. Motley, M.E.I.C., for his paper on "Reinforcement in Place of the Stoney Creek Arch Bridge," which was presented before the Montreal Branch of The Institute on February 20th, 1930, and published in the May, 1930, issue of The Journal, and another to F. M. Wood, A.M.E.I.C., for his "Short Monograph on Nomography," which was published in two parts, the first appearing in the June, 1930, and the second in the August, 1930, issue of The Journal. Both these papers were considered by the committee as of outstanding merit.

Mr. Motley is engineer of bridges of the Canadian Pacific Railway, having been with that company continuously since 1892, with the exception of a brief period of work with the Dominion Bridge Company.

Mr. Wood graduated from Queen's University, receiving his degree of Master of Arts in 1911, at which time he was awarded the gold medal in mathematics, and taking his degree of B.Sc. with honours in civil engineering in 1914. He served overseas, first in the engineers and artillery, and later for two years as flying officer in the Royal Air Force. For two sessions from 1919 to 1921, he was

lecturer in mathematics at Queen's University, and was subsequently appointed resident engineer on location and construction in connection with the irrigation system of the Lethbridge Northern Irrigation District, which position he occupied until joining the hydraulic department of the Dominion Engineering Works, Ltd., in 1923. In 1925 he became lecturer in civil engineering at McGill University, which appointment he still holds.

Leonard Medal

Three papers were considered worthy of receiving prizes under the Leonard Medal award this year, and presentations were announced at the Annual Meeting of The Institute as follows:

A gold medal to C. G. MacLachlan, for his paper on "Twelve Months Milling at Noranda," which was published in the Bulletin of the Canadian Institute of Mining and Metallurgy for February, 1930. Mr. MacLachlan is connected with Noranda Mines, Noranda, Que.

To Mr. W. B. Boggs, smelter superintendent at the Noranda Mines, Noranda, was awarded a silver medal for his paper on "The Noranda Smelter," which appeared in the Bulletin of the Canadian Institute of Mining and Metallurgy in March, 1930.

A. E. Flynn, professor of mining at the Nova Scotia Technical College, Halifax, received a prize of books, for his paper on "Anhydrite Plasters and Cements," published in the June, 1930, issue of the Bulletin of the Canadian Institute of Mining and Metallurgy.

Students and Juniors Prize

The Phelps Johnson Prize, competition for which is open to Students and Juniors in the province of Quebec, was awarded to G. B. Jost, S.E.I.C., for his paper on "Steel Mitering Lock Gates on the Welland Ship Canal." Mr. Jost is an undergraduate in the civil engineering course in the Faculty of Engineering, McGill University.

OBITUARIES

Ralph Waldo Downie, A.M.E.I.C.

The news of the sudden death of Ralph Waldo Downie, A.M.E.I.C., which occurred on January 21st, 1931, was received with regret by his many friends.

Mr. Downie was born at Melita, Manitoba, on July 7th, 1891 and received his early education at the public school at that place and in Toronto. In 1912 he entered the University of Toronto with the object of taking up a Science Course, but in his second year war was declared and he enlisted as a sapper with the 1st Canadian Engineers. He served eleven and a half months in England and fourteen and a half months in France, receiving his commission as lieutenant on December 22nd, 1916. The following spring he was returned to Canada and was appointed to the staff of C.R.C.E., M.D. 5, May 9th, serving as officer in charge of stores and accounts until his discharge in September, 1919.

Science again engaged his attention and he re-entered the University of Toronto and completed his course, graduating in 1921. During the summer of 1920 he worked in the office of the Canadian Inspection and Testing Company, Toronto, and upon graduation he joined the staff of the Welland Ship canal, in charge of the testing laboratory for cement and building materials, which position he held up to the time of his death.

Mr. Downie had a natural talent towards social organization and was widely known and respected for his untiring work in this direction. While at college he was president of the Engineering Society and shortly after arriving at the Ship canal, he was appointed Secretary-Treasurer of the Niagara Peninsula Branch of The Institute, which office he held for some nine years.

Mr. Downie joined The Engineering Institute of Canada as a Student on April 11th, 1914, and became an Associate Member on June 27th, 1922.

Alexander Brown Neilson, Affil.E.I.C.

Much regret is expressed in recording the death of Alexander Brown Neilson, Affil.E.I.C., which occurred at Winnipeg, Man., on October 19th, 1930.

RALPH WALDO DOWNIE, A.M.E.I.C.

Mr. Neilson was born at Winnipeg, Man., on January 12th, 1881, and received his early education at schools in that city. He was in the employ of the city of Winnipeg from 1904 until the time of his death, having been engaged on survey, well drilling, and in recent years as assistant engineer on maintenance.

Mr. Neilson joined The Institute as an Affiliate on September 20th, 1921.

Louis Gustave Papineau, A.M.E.I.C.

With the death of Louis Gustave Papineau, A.M.E.I.C., which occurred at Montreal on January 17th, 1931, The Institute loses one of its oldest members.

Mr. Papineau graduated in civil engineering from the Polytechnic School of Montreal in 1877, and in 1879 was made provincial land surveyor for Quebec. He was for many years in the employ of the Dominion government, serving with the Department of Public Works, the Department of Railways and Canals and the Department of Marine. From 1908 to 1912 he was in charge of the shipyard at Sorel.

Mr. Papineau joined the Canadian Society of Civil Engineers on February 24th, 1887, and was placed on the life membership list of The Institute on September 5th, 1930.

Paul Emil Mathias Rosenorn, A.M.E.I.C.

The death is recorded, on January 31st, 1931, of Paul Emil Mathias Rosenorn, A.M.E.I.C.

Mr. Rosenorn was born at Fredericia, Denmark, on September 25th, 1882, and received his education at high school and at the School for Officers of the regular army, Denmark, graduating from the latter institution in 1904.

Coming to Canada in 1907, Mr. Rosenorn became connected with the Canadian Pacific Railway Company, and acted as rodman, draughtsman and transitman on the Montreal terminals. From 1910 to 1912 he was transitman on the double tracking of the St. Lawrence river bridge at Lachine, Que., and from 1912 to 1913 was engaged on the construction of the Sortin yard, at Montreal. During the year 1913-1914, Mr. Rosenorn was resident engineer on maintenance of way at Fredericton, N.B. From 1914 to 1917 he was on active service in Canada and France, and returning to Canada in 1917 became supervisor of hydraulic test of h.e. shell for the Imperial Ministry of Munitions at Montreal. In 1919 and 1920 Mr. Rosenorn was again with the Canadian Pacific Railway Company as transitman on the rebuilding of bridges between Westmount and Windsor Station, Montreal; following this, in 1920-1921 he was assistant engineer on the Grand Trunk Railway valuation and in 1921-1923 he was estimator for Messrs. Graham and Windsor, general contractors, at Montreal. From 1923 to the time of his death Mr. Rosenorn was chief draughtsman at Chicoutimi, Que., for Price Brothers and Company Ltd.

Mr. Rosenorn joined The Institute as a Student on January 8th, 1910, and transferred to the class of Associate Member on January 17th, 1922.

Adlard Edward Welby, M.E.I.C.

Members will learn with regret of the death of Adlard Edward Welby, M.E.I.C., which occurred at Banff, Alta., on January 12th, 1931.

Mr. Welby was born at Tollerton, England, on November 10th, 1869, and was educated at Oakham School and the Crystal Palace School of Practical Engineering. Following graduation he was articled from 1887 to 1890 to G. Parry, M.Inst.C.E. From 1890 to 1896 he was assistant engineer on construction with the Great Central Railway, London, extension, and from 1896 to 1901 he was with the Uganda Railway, South Africa. From 1902 to 1907 Mr. Selby was with the East Indian Railway being engaged on construction and later maintenance. Leaving India in 1908 he spent several years in Chile on railroad and mining work for the Arauco Company. In 1911 he came to Canada and joined the staff of the Canadian Northern Railway. During the War, Mr. Welby served with the Canadian Engineers, and was with the Third Tunnelling Company at Ypres.

Returning to Canada after the War, Mr. Welby became connected with the Commission on Irrigation, Department of Interior, with headquarters at Calgary, and in 1921 was transferred to Banff, where he remained in the office of resident engineer with the Rocky Mountain Parks of Canada, until his retirement from active service about three years ago.

Mr. Welby joined The Institute as a Member on November 9th, 1912, and was also a Member of the Institution of Civil Engineers.

PERSONALS

A. E. Stewart, A.M.E.I.C., of the Canadian Pacific Railway Company, has been transferred from Bassano, Alta., to Winnipeg, Man., where he is division engineer of terminals.

E. J. Durnin, Jr.E.I.C., a graduate of the University of Manitoba of the year 1928, is now with the Saskatchewan Power Commission, and is located at Saskatoon, Sask.

H. V. Hagborg, S.E.I.C., has joined the staff of the Detroit Stoker Company of Canada, Ltd., at Toronto, Ont. Mr. Hagborg was formerly with the Detroit Stoker Company at Detroit.

A. G. Patterson, Affil.E.I.C., Works Manager of the Peterborough, Ont., works of the Canadian General Electric Company, Ltd., retired on December 31st, 1930, after forty-two years' service with the company.

Clarke W. Gamble, M.E.I.C., is now assistant district engineer with the Department of Public Works of British Columbia, at Alberni, B.C. Mr. Gamble was for a time with Messrs. Waddell and Hardesty, New York, and later resided at Victoria, B.C.

J. Portas, A.M.E.I.C., has become connected with J. W. Cumming Manufacturing Company at New Glasgow, N.S. Mr. Portas, who is a graduate of the University of London of the year 1921, was formerly designing engineer with Monsarrat and Pratley, Montreal.

A. W. Crawford, A.M.E.I.C., has recently been appointed Deputy Minister, Department of Labour, Toronto, Ont. In addition to his newly assumed duties, Mr. Crawford will continue to look after the welfare of apprenticeship throughout the province of Ontario. He was for five years director of technical education in the Department of Labour, Ottawa, and in 1928 accepted a position with the Ontario provincial government as inspector of apprenticeship, his duties being to administer the Apprentice Act of 1928.

O. A. Barwick, A.M.E.I.C., is leaving shortly on a six weeks trip to England, France and Germany for the purpose of studying architecture and obtaining a vacation. Mr. Barwick graduated from McGill University with the degree of Bachelor of Architecture in 1914. Following graduation he had extensive experience in various architectural works, and for a number of years has been in private practice as architect and structural engineer in Montreal. Mr. Barwick was construction supervisor of the head office building of the Royal Bank of Canada built in Montreal several years ago.

Dr. Ralph Modjeski, M.E.I.C., consulting engineer, New York, is to receive the Washington award for 1931 for his "contribution to transportation through superior skill and courage in bridge design and construction." This award is conferred by the Washington Award Commission, which represents five of the leading engineering societies. Last year Dr. Modjeski was awarded the John Fritz medal for distinguished engineering service. As designer, construction engineer and consultant, Dr. Modjeski has been identified with many of America's most notable bridges, including the McKinley bridge over the Mississippi river at St. Louis, Mo., the Columbia river bridge at Celilo, Oregon, the Keokuk bridge over the Mississippi river, the Ohio river bridge at Cincinnati, the Quebec bridge over the St. Lawrence river, and Manhattan bridge over the East river, New York, and so on.

R. B. Jennings, M.E.I.C., formerly general manager of Robert W. Hunt and Company, Ltd., inspection and testing engineers, has been appointed railroad representative of Crane, Ltd., with headquarters at Montreal. Mr. Jennings received his education at Humberside Collegiate Institute, Toronto, and the University of Toronto. Following graduation, he engaged in railway location and construction, and was appointed resident engineer, Canadian Northern Ontario Railway, in 1909. He served in this capacity on the various lines under construction until 1916, when he enlisted in the Canadian Overseas Expeditionary Force. He was appointed lieutenant and promoted to major in the 10th Battalion Canadian Railway Troops with active service in France and Belgium. On his return to Canada, Mr. Jennings became division engineer, Toronto division, Canadian National Railways, in 1919. In February, 1921, he became division engineer of the Ottawa division and in May, 1922, division engineer of the Montreal division of the Canadian National Railways. In 1926 Mr. Jennings took the position which he has recently resigned.


C. A. MAGRATH, M.E.I.C.

C. A. Magrath, M.E.I.C., Retires

C. A. Magrath, M.E.I.C., has retired from the chairmanship of the Hydro-Electric Power Commission of Ontario, which office he has held since 1925, when he succeeded the late Sir Adam Beck.

Mr. Magrath's professional experience has been varied, and, to a marked degree, of a public nature. In early days he practised the profession of land surveyor in the Northwest Territories, holding the titles of Provincial and Dominion Land Surveyor and Dominion Topographical Surveyor. He was land agent for the Alberta Railway and Coal Company, and later played an important part in the development of the sub-arid districts of southern Alberta as manager of the Canadian North West Irrigation Company. Mr. Magrath entered politics in 1891 as member for Lethbridge, Alta., holding the post of minister without portfolio in the Haultain ministry in Saskatchewan from 1898 to 1901. He also represented Medicine Hat in the House of Commons from 1908 to 1911. From 1911 to the present date Mr. Magrath has been chairman of the Canadian section of the International Joint Commission. This body, which has dealt with many important international questions, such as the Lake of the Woods levels, owes much to his indefatigable energy and executive ability. In 1913 Mr. Magrath was chairman of a temporary Ontario Highways Commission which presented a comprehensive plan of highway expansion for the Whitney government, on which all subsequent highway development in the province has been based.

During the War, Mr. Magrath was a member of the War Trade Board of Canada, and acted as fuel controller from 1917 to 1920. He has been a member of the Federal Advisory Fuel Committee since 1922. In 1920 he performed an important mission in acting as chairman of a commission appointed to investigate agricultural conditions in southern Alberta.

J. H. Wallis, A.M.E.I.C., has relinquished active management of the Dominion Welding Engineering Company, Ltd., Montreal, to become general manager of Dominion Hoist and Shovel Company Ltd. Mr. Wallis, however, retains his interest in the Welding Company as a director. Mr. Wallis has been engaged on 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 civilian life 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 engineer 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

J. H. WALLIS, A.M.E.I.C.

Company in 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 Ltd., and the Murray Bay Paper Company Ltd., resigning that position in 1928 to take over the management of the newly organized Dominion Welding Engineering Company Ltd., a company closely associated with the Dominion Bridge Company Ltd., and the Dominion Engineering Works, Ltd.

BOOK REVIEWS

Motor Vehicles and their Engines

By Edward S. Fraser and Ralph B. Jones. 4th ed., rev. by Lee A. Dunbar. Van Nostrand, New York, 1930, cloth, 5¾ x 9 in., 411 pp., illus., figs., tables, $3.00.

Originally written as a text-book for automobile schools, this book is now in its fourth edition. It has been brought up to date and covers the care and operation of the principal accessories of the leading makes of motor vehicles, and is particularly intended for owners, garage-men and chauffeurs who wish not only to understand the elementary principles of motorcar construction but who also desire an intelligent understanding of the operation of the complicated machines with which they are dealing. Although largely illustrated by catalogue cuts, the descriptive matter is well selected and clear, and like its earlier editions, this book will prove very suitable for its purpose. Little or no acquaintance with theory is assumed or required, and the book can be recommended as containing in concise form the information necessary for instruction in the operation and care of motor vehicles.

The Modern Steam Turbine

By E. A. Kraft. VDI-Verlag, GmbH., Berlin, 1931, cloth, 190 x 270 mm., 201 pp., figs., charts, tables, RM. 20.

This is the English translation of the second edition of a well-known German text-book issued in 1926. It consists of two parts, the first giving a general survey of the problems of turbine design and construction in the light of the most recent information, afterwards discussing methods for obtaining improved economy and the technical features limiting turbine design. The second part gives a concise and well illustrated account of modern practice in steam turbines, taken from data furnished by many leading firms. Chapters on turbines for very high pressures and on condensers and their auxiliaries have been added. Special attention is given to the materials now available for steam turbine construction, and to the modern shop processes which have had to be developed to deal with turbine parts, such as blades, labyrinth packing, etc. No attempt is made to expound the theory of steam turbines, for which the reader is referred to standard treatises, such as Stodola.

The book, however, makes available a great deal of very important technical information, and is noteworthy for the absence of redundant matter and for its clear manner of presentation.

Dr. Kraft has not only had teaching experience at the great engineering school of Charlottenburg, but has taken a leading part in the development of the modern steam turbine in his capacity as chief engineer of the turbine works at Berlin of the Allgemeine Elektricitats-Gesellschaft.

The book may be strongly recommended to the engineer or probable purchaser who wishes to familiarize himself with the latest practice in steam turbine construction and to understand the practical value of the new methods and ideas which have developed in recent years. It is admirably illustrated and furnished with a useful index.

The Salt Industry of Canada

By L. Heber Cole, M.E.I.C., Department of Mines, Ottawa, 1930. Paper, 6½ x 9¾, 116 pages, photos, diags. and maps. $0.20.

To meet the demand for information relating to the Canadian salt industry, the Mines Branch of the Department of Mines has recently published a report by L. Heber Cole, M.E.I.C., entitled "The Salt Industry of Canada," this report supplementing and bringing up to date the previous report on the same subject issued by the Mines Branch over fourteen years ago.

The present report consists of 116 pages, and is illustrated with photographs, diagrams, and maps. It covers the salt occurrences throughout Canada, takes up the mineralogy and technology of salt manufacture, and briefly describes the allied industries using salt in their process. A chapter is also devoted to the consumption and marketing of salt and includes general salt statistics.

Copies of this report, No. 716, may be obtained on application to the Director, Mines Branch, Department of Mines, Ottawa.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

PRESENTED BY THE SOCIETIES:

The Institution of Engineers and Shipbuilders in Scotland: Transactions, vol. 73, 1929-30.

The Junior Institution of Engineers: Journal and Record of Transactions, Vol. 40, 1929-30

The Royal Society of Canada: Transactions, 3rd Series, Vol. 24, Part 1:

Section 3, May, 1930: Mathematical, Physical and Chemical Sciences.

4, " " : Geological Sciences, including Mineralogy.

5, " " : Biological Sciences.

American Institute of Consulting Engineers, Inc.: Proceedings of the Special Meeting, Held Nov. 18, 1930.

University of Toronto, Engineering Society:

Transactions and Year Book, April, 1927;

" " " " , April, 1928;

" " " " , April, 1929.

Reports, etc.

DEPT. OF MINES, MINES BRANCH, CANADA:

Bituminous Sands of Northern Alberta: Operations During 1929.

GEOLOGICAL SURVEY, CANADA:

Memoir 163: Geology of Southern Alberta and Southwestern Saskatchewan.

Summary Report, 1928, Part C;

1929, Parts A and C.

Economic Geology Series No. 8: Zinc and Lead Deposits of Canada.

Summary Report for the Calendar Year 1908:—Presented by Library of Canadian Industries Ltd.

Summary Report for the Calendar Year 1909:—Presented by Library of Canadian Industries Ltd.

Summary Report for the Calendar Year 1911:—Presented by Library of Canadian Industries Ltd.

Summary Report for the Calendar Year 1913:—Presented by Library of Canadian Industries Ltd.

Summary Report for the Calendar Year 1915:—Presented by Library of Canadian Industries Ltd.

DEPT. OF LABOUR, CANADA:

The Employment of Children and Young Persons in Canada, December, 1930.

Wages and Hours of Labour in Canada, 1920 to 1930.

Prices in Canada and Other Countries, 1930.

DEPT. OF THE INTERIOR, TOPOGRAPHICAL SURVEY, CANADA:

[Map of] Calgary, Southwest Alberta.

DOMINION WATER POWER AND HYDROMETRIC BUREAU:

Water Power Resources of Canada (Mimeograph sheets).

Dept. of Mines, Ontario:
Thirty-ninth Annual Report, Vol. 39, Part 4, 1930: The Ceramic Industry of Ontario.
Thirty-ninth Annual Report, Vol. 39, Part 1, 1930: Statistical Review of Ontario's Mineral Industry in 1929, etc.

Bureau of Mines, United States:
Potash in 1929.
Salt, Bromine, and Calcium Chloride in 1929.
Slate in 1929.
Rare Metals: Cobalt, Molybdenum, Tantalum, Titanium, Tungsten, Radium, Uranium, and Vanadium in 1929.
Mercury in 1929.
Mine Report: Silver, Copper, Lead and Zinc in the Central States in 1929.
Sulphur and Pyrites in 1929.
Asbestos in 1929.
List of Publications of the Bureau of Mines, 1910-1930.
Bulletin No. 327: Potash Bibliography to 1928 (Annotated).
No. 328: Greensand Bibliography to 1930 (Annotated).
No. 330: Ventilation of the Large Copper Mines of Arizona.
No. 331: Permissible Methane Detectors.
No. 333: Refining of Light Petroleum Distillates.
No. 334: A Study of Refractories Service Conditions in Boiler Furnaces.
Technical Paper No. 480: Intensities of Odours and Irritating Effects of Warning Agents for Inflammable and Poisonous Gases.
No. 482: Toxic Gases from Sixty Percent Gelatin Explosives.
No. 483: Re-forming Natural Gas.
No. 485: Timbering Regulations in Certain Coal Mines of Pennsylvania, West Virginia and Ohio.
No. 487: Chemistry of Leaching Covellite.

Bureau of Standards, United States:
Supplementary List of Publications of the Bureau of Standards, July 1, 1925 to February 28, 1930.
Circular No. 388: Use of Bismuth in Fusible Alloys.
No. 390: American Standard Specifications for Dry Cells and Batteries.
Misc. Pub'n No. 112: Manufacture of Insulating Board from Cornstalks.
Misc. Pub'n No. 117: Units Used to Express the Wave Lengths of Electro-Magnetic Waves.
Commercial Standard No. CS22-30: Builders' Hardware (Non-template).

Geological Survey, United States:
Bulletin 821-B: A Geologic Study of the Madden Dam Project, Alhajuela, Canal Zone.
Water-Supply Paper 622: Surface Water Supply of the United States, 1926, Part 2: South Atlantic Slope and Eastern Gulf of Mexico Basins.
Water-Supply Paper 633: Surface Water Supply of the United States, 1926, Part 12: North Pacific Slope Drainage Basins, (b) Snake River Basin.
Water-Supply Paper 644: Surface Water Supply of the United States, 1927, Part 4: St. Lawrence River Basin.
Water-Supply Paper 649: Surface Water Supply of the United States, 1927, Part 9: Colorado River Basin.
Water-Supply Paper 650: Surface Water Supply of the United States, 1927; Part 10: The Great Basin.

The Port of New York Authority:
Report on Preliminary Investigation for Midtown Hudson Tunnel, Jan. 9, 1931.

University of California, Dept. of Geological Sciences:
The Gastropod Genus Galeodea in the Oligocene of Washington.
Cephalopods of the Genus Aturia from Western North America.
Critical Observations on the Phylogeny of the Rhinoceroses.

National Electric Light Association:
Organization Personnel: Administrative Year July 1, 1930 to June 30, 1931.
Prime Movers Committee, Eng'g National Section: Boiler and Turbine Room Instruments.
General Power Committee, Commercial National Section: Electric Service for Hotels and Office Buildings.
Joint Report, Accident Prevention Committee and the Overhead Systems Committee, Engineering National Section: Tree Trimming Practices.
Overhead Systems Committee, Eng'g National Section: Line Construction Organization Methods.

Purdue University, Engineering Extension Dept.:
Extension Series No. 25: A Report of Foremanship Conferences.

City and Guilds of London Institute, Dept. of Technology:
Report of the Work of the Department for the Session 1929-30.

The Shawinigan Water & Power Company:
Annual Report, 1930.

Technical Books, etc.

Presented by E. & F. N. Spon, Ltd.:
The Automobile Engineer's Pocket Book of Rules, Tables and Data.

Presented by V.D.I.-Verlag, GmbH, Berlin:
The Modern Steam Turbine.

Presented by Concrete Publications, Limited:
The Concrete Year Book, 1931: A Handbook, Directory and Catalogue of Concrete.

Presented by International Nickel Company, Inc.:
Literature and Patent References to Nickel, Vol. 3, No. 17, December 1930, pp. 272-330.

Presented by Canadian Manufacturers' Association:
Canadian Trade Index, 1931.

Presented by American Standards Association:
American Standard: Symbols for Photometry and Illumination.

Purchased:
American Society of Mechanical Engineers: Power Test Codes, Series 1929:
Test Code for Liquid Fuels.
Test Code for Atmospheric Water-Cooling Equipment.
Research Publication, 1930: A Bibliography of the Cutting of Metals.
Research Publication, 1931: Fluid Meters, Their Theory and Application, 3rd ed.
Lydiatt's Book of Canadian Market and Advertising Data, 1930.
Canadian Almanac and Legal and Court Directory for the year 1931.

Catalogues

Presented by Link-Belt, Limited:
Book No. 1125: Combined Lists Link-Belt Silent Chain Drives; Roller Chain Drives.

Presented by M. H. Detrick Co., Chicago:
Detrick Refractory Arches and Walls for Furnaces, 1930.

ELECTIONS AND TRANSFERS

At the meeting of Council held on February 17th, 1931, the following elections and transfers were effected:

Member

REDFERN, Charles Raimond, B.A.Sc., (Univ. of Toronto), President, Redfern Construction Company, Ltd., Montreal, Que.

Associate Members

BARNECUT, Reginald, B.Sc., (Univ. of Alta.), struct'l. checker, Dominion Bridge Company, Ltd., Calgary, Alta.

LONGSTAFF, John Calvin, C.E., (Univ. of Toronto), designer, Dominion Bridge Company, Ltd., Lachine, Que.

PITTAWAY, George Henry, asst. engr., The Shell Company of Canada, Ltd., Montreal, Que.

ULMANN, Hans, E.E., (Fed. Inst. Technology, Zurich), research engr., development dept., Dominion Engineering Works, Ltd., Montreal, Que.

WHITAKER, Albert William, Jr., B.S. (Chem.), (Univ. of Penn.), works supt., Arvida works, Aluminum Company of Canada, Arvida, Que.

Juniors

KNUDSEN, Sverre, C.E., (Norges Tekniske Hoiskole), dftsman and instr'man., Leonard E. Schlemm, M.E.I.C., Montreal, Que.

MARTIN, Frank John Ellen, B.Sc., (Univ. of Sask.), struct'l. engr., with Frank P. Martin, F.R.A.I.C., Saskatoon, Sask.

Transferred from the class of Junior to that of Associate Member

BOULTON, Beverley Knight, B.Sc., (McGill Univ.), elect'l. engr., Beauharnois Construction Company, Beauharnois, Que.

BURBANK, Jerome Douglas, B.A.Sc., (Univ. of Toronto), engr., Buffalo, Niagara & Eastern Power Corpn., Buffalo, N.Y.

CURRIE, Victor Robert, B.Sc., (Queen's Univ.), asst. engr., Trent Canal, Peterborough, Ont.

HANNA, Harold Benjamin, B.Sc., (Queen's Univ.), plant engr., Canadian General Electric Co. Ltd., Peterborough, Ont.

MARLATT, Charles Ewart, B.Sc., (Queen's Univ.), supt. of safety and fire insurance, Consolidated Mining and Smelting Co. Ltd., Trail, B.C.

MILLER, Wilfrid Laverne, B.A.Sc., (Univ. of Toronto), transformer engr., Canadian Westinghouse Company, Ltd., Hamilton, Ont.

Transferred from the class of Student to that of Associate Member

WEBSTER, Robert Chilion Peter, B.Sc., (McGill Univ.), engr. Canada Power & Paper Corporation, Montreal, Que.

Transferred from the class of Student to that of Junior

BERESKIN, Abraham Isaac, B.Sc. (C.E.), (Univ. of Man.), surveys engr., Topographical Surveys of Canada, Ottawa, Ont.

BLACKETT, Harold Wilfrid, B.A., B.A.Sc., (Univ. of B.C.), engrg. ap'tice., Canadian Westinghouse Company, Ltd., Hamilton, Ont.

DALTON, William Reginald, B.Sc., (Queen's Univ.), P.O. Box 623, Burlington, Ont.

LUSBY, Gerald W., B.Sc. (Mech.), (N.S. Tech. Coll.), mech'l. engr., engrg. dept., Ford Motor Company of Canada, East Windsor, Ont.

PHIPPS, Charles Ferdinand, B.Sc., (McGill Univ.), asst. engr. of transmission line design, Shawinigan Water & Power Company, Montreal, Que.

THICKE, James Ernest, B.Sc., (Queen's Univ.), engrg. dept., Aluminium Limited, Montreal, Que.

Students Admitted

BOWMAN, A. Lorne, (N.S. Tech. Coll.), 190 South St., Halifax, N.S.

CARSON, Mervyn Shannon, B.Sc. (C.E.), (Univ. of Sask.), instr'man., city engr.'s dept., Saskatoon, Sask.

CARSON, Robert Garfield, Jr., B.Sc. (E.E.), (Univ. of N.B.), Saint John Power Commission, Saint John, N.B.

HAMMOND, Rowland Ernest, (Univ. of Toronto), P.O. Box 124, Angus, Ont.

LITTLE, Harry, (Stud. Inst. M.E.), dftsman., Aluminum Company of Canada Ltd., Arvida, Que.

Undergraduates at McGill University, Montreal, Que.

BILLETTE, Roger, B.A., (Univ. of Montreal), 3699 Jeanne Mance St., Montreal, Que.

ELLIS, David E., 3434 McTavish Street, Montreal, Que.

MORRISON, Claude Wilson, 148 Portland Avenue, Mount Royal, Que.

PIMENOFF, Clement John, 2196 Old Orchard Avenue, Montreal, Que.

Undergraduates at Mount Allison University, Sackville, N.B.

ALEXANDER, Robert Lewis, Sackville, N.B.
BARNES, Robert Lockhart, Moncton, N.B.
CAMPBELL, George William, Windsor, N.S.
CURRY, Herbert Nicholas, Windsor, N.S.
DesBARRES, William Frederick Clyde, Sackville, N.B.
ELLIOTT, Roy Chipman, Middleton, N.S.
FIRTH, Angus Theodore, Doaktown, N.B.
FULLERTON, Roland McNutt, Truro, N.S.
GODDARD, Rolfe Alton, Elgin, N.B.
HARDY, William Edison, Sackville, N.B.
HAYMAN, Donald Hood, Moncton, N.B.
HICKEY, Winston Edward, Sackville, N.B.
HOLDER, Allan Scott, 12 Charles St., Truro, N.S.
LIPTON, Samuel, 127 Cottage Road, Sydney, N.S.
MacDONALD, Arden Morris, Londonderry, N.S.
MacLEOD, Bruce Garfield, Moncton, N.B.
MacPHERSON, Arthur Roland, Springhill Jct., N.S.
MURRAY, Robert Leslie, Vernon, P.E.I.
NICHOLS, Judson Timms, 81 Chesterfield Ave., Westmount, Que.
RAMSAY, Donald William, Moncton, N.B.
ROGERS, Carl Lemual, 354½ Cameron St., Moncton, N.B.
SIBLEY, Bertram Charles, Sackville, N.B.
STILES, George William, Matapedia, Que.
SUTHERLAND, William Collie, Westville, N.S.
WASHBURN, Walter James, Saint John, N.B.
WILLIAMS, Thomas Alexander, Sackville, N.B.

The Smart Turner Machine Company, Ltd., of Hamilton, Ont., has recently introduced into Canada the Pacific Deep Well Pump, which has been designed to eliminate the many problems which usually accompany present-day pumping of water from deep wells.

The operation and use of these pumps is described in a number of bulletins issued by the Smart Turner Machine Company, and may be had on request.

Three of the main features of this equipment are pump bearings, line shaft bearings and impellers. The bearings are "Edgewood" and are designed so that water may be delivered absolutely pure and uncontaminated by lubricating oil. The impellers are of the enclosed "Pacific" turbine type and are capable of maintaining high efficiency and high capacity over a wide variation of pumping head, and this without overloading the motor.

The design of these pumps was only adopted after exhaustive research and carefully tested both in the testing laboratories and in the field, and the results have in every way come up to expectations.

Frick Company (Incorporated), Waynesboro, Penn., U.S.A., has recently issued a new 8-page Ice and Frost Bulletin, No. 124-A, describing equipment for making carbonic ice. This bulletin may be secured free of charge by communicating with the company.

The Scientist and the Writing of Good English

Some years ago, the statement was attributed to Sir James Barrie that the man of science appears to be the only man who has something to say just now, and the only man who does not know how to say it. Without verifying the quotation, it may be admitted that it sounds like one of the remarks of that pleasant writer, though it does not seem to lie in his line of country. In the mouth of a literary man, the criticism looks rather as though it ought to have been made by Stevenson, who by his illustrious antecedents would have had the chance of observing any ground for such comments, and by his disposition would have been not disinclined to make it. It is, perhaps, not fanciful to imagine that the reason Stevenson made no such remark was that the scientific writing on which he was brought up did not suggest or justify it. At present, however, taking the statement to refer to the average scientific paper published in the English language, and to exclude some conspicuous exceptions, it cannot be denied that it is substantially true. Probably there is no country in which better scientific work has been done since science emerged from the dark ages than in the United Kingdom. Its quality does not seem to be falling off, and of late years its volume has been constantly increasing. Its immediate value, on the other hand, is suffering from the fact that a large number, and possibly a majority, of those who do the work do not succeed in describing it effectively or clearly.

The rules of good writing doubtless vary with the purpose of the composition. The late C. E. Montague, an admired master of the art, pointed out, for example, that in composition intended to stimulate the imagination of a reader, or perhaps even to persuade his judgment, writing may be too clear, and at its best should suggest a conclusion to the reader, rather than formulate it explicitly. An old advocate's trick is so to shape his argument as to lead the judge to form the desired conclusion for himself, without having the words put in his mouth. There is undoubtedly a pleasure to be obtained from reading such matter, in which the reader is set to co-operate with the author to a modest extent. At all times the writers of speculations upon scientific results have been able to give such pleasure to their readers, and the amazing developments of modern physics give greater opportunity than ever for such composition. It would be unfortunate if scientific men were precluded from publishing more than their definitely ascertained results, and could not communicate also their ideas of possible explanations or extensions before these had been demonstrated conclusively. Even in such writings, needless haziness or ambiguity is undesirable, but such works are to be distinguished from what may be called scientific writing proper, in which the writer is concerned to describe the observations and studies by which he has made additions to knowledge. It is of writing of this class that the present complaints are made, and, even in this primary or proper scientific writing, a distinction may be drawn between what is addressed to workers in the same field, and what is intended for other readers. No such distinction, however, can avoid the fact that in each class, while the primary business of the writer is to be clear, he allows himself too often to be obscure.—*Engineering.*

Sir Charles Algernon Parsons, to whom the development of the steam turbine is due, died on February 12th, 1931, at the age of seventy-seven. He was a son of the third Earl of Rosse, noted astronomer, and was educated at home and at St. John's College, Cambridge, later becoming eminent as a mechanical engineer. The Parsons compound reaction turbine was first introduced in 1884, for the purpose of driving electric generating machinery, and it was afterwards adapted for marine propulsion. Something of a sensation was created at a naval review at Spithead in 1897 when the "Turbinia," the first seagoing vessel to be propelled with turbine machinery, achieved the then almost incredible speed of 32 knots. The success of this small ship of 100 tons, with its 2,100 h.p., led to the general use of the steam turbine for naval purposes. The satisfactory trials in 1904 of the cruiser "Amethyst" demonstrated so conclusively the advantages of the turbine that all subsequent naval craft, from battleships to destroyers, were fitted with that type of engine. To attain the highest efficiency, the turbine should revolve quickly and the propeller slowly. To reconcile these requirements, single reduction and double reduction gearing was interposed between the turbine machinery and the screw shafts. The development of the steam turbine has been, perhaps, the most important step in steam engineering since the time of Watt, and Sir Charles lived to see his original scheme improved upon and utilized in the largest and fastest vessels afloat of 60,000 tons and 100,000 h.p. He died during a cruise to the West Indies on board the Canadian Pacific steamer "Duchess of Richmond," one of the most successful ships of recent design.

A pamphlet has been received from the Ottawa Paint Works Ltd. describing some experiments conducted at their plant on the corrosion of structural steel embedded in concrete, and on the effect of painting such steel. It was desired to ascertain whether paints giving satisfactory results when used upon exposed steel would give good service in contact with concrete. Results indicated that this was not necessarily the case, and that special paints are necessary to exclude moisture, withstand the action of the concrete, and insulate against stray electric currents. Further particulars can be obtained from the company.

BRANCH NEWS

Border Cities Branch

Harold J. A. Chambers, A.M.E.I.C., Secretary-Treasurer.

The regular monthly meeting of the Border Cities Branch was held on January 16th. The speaker of the evening was Captain A. F. Ingram, manager of the Canadian Airways, Limited. His subject was "Commercial Flying in Canada." In his talk, he dealt with the history, the difficulties encountered, the equipment and the prospect for development of air lines in the future.

The pilots and personnel, the speaker stated, were all men of long experience, the majority having served in the Great War. Sixty-two per cent of the Imperial Air Force in the Great War, Captain Ingram stated, were Canadians. At the end of the war 95 per cent of our Canadian pilots went back to their old positions held prior to the war. The remaining 5 per cent entered commercial flying, but not much progress was made until the boom in 1927.

In 1929, many companies amalgamated and the government gave assistance. Planes were given for turning out a certain number of pilots. The Department of Civil Aviation also co-operated. They established lights from Windsor to Toronto for night flying. The railways, namely, the Canadian Pacific Railway and the Canadian National Railways lent assistance in the promotion of flying, seeing the possibility in future air lines.

All the air routes in Canada were established by the giving of air mail contracts, which contracts were of three and four years duration. The difficulties encountered in the formation of an air line, Captain Ingram stated, are: first: To conform to the regulations the government has established to safeguard the public. Second: To meet the rigid requirements and rules of the Post Office Department, and third: To conform to all the requirements of the insurance companies.

The pilots, the speaker stated, have all flown continuously for over ten years and in their work fly approximately 75,000 miles each year. The air engineers must work on aircraft for at least two years and then pass examinations. The staff also includes mechanics helpers and recorders. The recorders are stationed at the various ports along the line. The company in addition has a statistical department. Each district has a district superintendant who must be capable of handling any situation which might arise and who must be a responsible person.

Night flying which is becoming essential is aided by the voice to voice radio and by lighted air ports which are most essential.

The address was illustrated by slides and motion pictures.

A hearty vote of thanks was conveyed to Captain Ingram by the chairman, Orville Rolfson, A.M.E.I.C., on behalf of the members of the Branch.

Calgary Branch

A. W. P. Lowrie, A.M.E.I.C., Secretary-Treasurer.
W. H. Broughton, A.M.E.I.C., Branch News Editor.

The Calgary Branch was favoured by a visit by our western vice-president, C. J. Mackenzie, M.E.I.C., on Friday, January 9th.

Dean Mackenzie met the Executive committee at lunch at the Palliser hotel and took part in a very interesting and informative discussion of Institute business both general and local.

In the afternoon a party, including the Dean, motored to the Ghost river power plant and made an inspection of the plant and dam.

At a special meeting held in the Board of Trade rooms in the evening about forty members and friends gathered and listened to a very interesting address entitled "Estimating Urban Population in Western Canada." As Dean Mackenzie spoke on the same subject at Lethbridge and Edmonton it is understood that a synopsis will appear elsewhere in The Journal.

Dean Mackenzie explained that his visit was arranged in conformity with the new policy of limiting the General Secretary's visits to once every two years instead of annually as heretofore, the vice-president for the Zone to visit in alternate years. The speaker also congratulated the Branch on having one of its members, S. G. Porter, M.E.I.C., elected to the presidential chair and expressed his confidence that the president-elect would prove a worthy successor to some of Canada's most illustrious engineers.

Dean Mackenzie then went on to the theme of his paper and propounded what were to many of the members who have not studied the subject some very novel theories regarding the inevitable limitations to the growth of urban populations in an agricultural country. He produced such a wealth of evidence based on a study of the growth of urban population in the country to the south of us and of some of the European countries as to convert his theories into practical certainties.

It is absolutely necessary, said the speaker, that we should have some basic theory and sound argument with which to curb the money-spending tendencies of the councils of some western cities when swayed by pictures of future populations based, very often, on nothing more solid than western optimism.

The paper was illustrated by a number of slides showing comparative areas in Canada and the United States and graphs of their comparative population growths at various stages of their development.

Town Planning is a subject of very live local interest just now and the discussion might have been expected to have developed along these lines. The inherent subject matter of the Dean's paper, however, was so interesting that this phase of it received scant attention.

A very lively and interesting discussion ensued, taken part in by J. A. Spreckley, A.M.E.I.C., L. A. B. Hutton, A.M.E.I.C., F. N. Rhodes, A.M.E.I.C., F. J. Robertson, A.M.E.I.C., J. H. Ross, A.M.E.I.C., Mr. Turner-Bone and the city planning engineer, among others. A hearty vote of thanks was tendered to the speaker by those present, on a motion by Mr. Porter.

About sixty members and friends gathered at the Board of Trade rooms at a special meeting of the Branch held on Friday, January 16th, to meet D. V. Canning, M.E.I.C.

The speaker gave a brief outline of the history of automatic control pointing out that the first automatic station typical of present design had been put into operation in 1914. Since that time progress along this line has been very rapid until at the present time automatic control has been applied to practically every kind of electrical machinery.

Mr. Canning stated that the rapid development of automatic control had been due to the necessity for finding some economical means of operating the numerous substations and generating stations that are being installed to meet the constantly growing demand for electrical energy.

The devices used in automatic equipments have been developed very carefully to meet the exacting requirements of this service.

The speaker described in detail the operation of several types of automatic equipment.

Synchronous converters require rather elaborate equipment for automatic operation on railway systems. They are usually started on the indication of low trolley voltage or they may be started by time switches or by supervisory control from a remote point. The converters automatically connected to low voltage taps on the transformer and brought up to speed. The field is separately excited to ensure correct polarity. The field is then connected across the converter armature and the polarity is checked. Full A.C. voltage is applied and the brushes are lowered on the commutator after which the machine is connected to the D.C. system through load limiting resistors which are then short circuited.

When the machine is starting and running it is protected against all the usual operating emergencies.

Automatic hydro-electric stations divide themselves into two classes. One class uses self-synchronizing of the unit with the system while the other class uses automatic synchronizing.

Self-synchronizing machines are connected to the system without field at a little below synchronous speed and are pulled into synchronism. This scheme of synchronizing is only used where the capacity of the system is large compared to the machine to be synchronized.

Automatic synchronizing is used in cases where the capacity of the system is too small to allow the use of the other method. In this case the machine is synchronized with the system by means of special relays.

The speaker described the operation of three types of supervisory control equipments, namely, the impulse audible system, the impulse visual system and the direct wire system.

The impulse audible system operates over two line wires, and may be used over comparatively long distances. The system is operated by means of a telephone dial which sends out a code series of impulses to pick up the proper selector relay at the outlying station. Signals are given to the operator by means of a howler located at the dispatcher's station.

The impulse visual system operates over four line wires. It may be used over long distances to control a great number of breakers or equivalents. Indications are given at the dispatchers station by means of indicating lamps and an alarm bell. This system combines accurate selectivity and high speed of operation.

The direct wire system requires a separate wire for each control and another wire for each indication. It is used up to distances up to two or three miles depending on the number of controls and the comparative cost of control cable. Indications are given by means of lamps and a bell at the dispatcher's station.

Mr. Canning said that the installed capacity of automatically controlled equipment has grown from 300 kw. in 1914 to over 2,000,000 kw. in rotating apparatus in 1929. In addition more than 10,000,000 kw. of static apparatus is controlled by automatic switching equipment.

An equally technical discussion ensued, taken part in by Mr. R. A. Brown, city electrical superintendent, F. J. Robertson, A.M.E.I.C., G. H. Thompson, A.M.E.I.C., W. Anderson, A.M.E.I.C., F. N. Rhodes, A.M.E.I.C., and others, at the conclusion of which a hearty vote of thanks was accorded the speaker on a motion by Mr. Brown, seconded by Mr. Thompson.

A general meeting was held in the Board of Trade rooms on Thursday, January 29th, at which about sixty members and friends were present.

The speaker of the evening, M. H. Marshall, M.E.I.C., was introduced by the chairman, B. Russell, M.E.I.C., and proceeded with an address on "The Island Falls Power Development on the Churchill River."

The development was undertaken by the Churchill River Power Company primarily to supply power in bulk to the Flin-Flon mine of the Hudson Bay Mining and Smelting Company Ltd. and the Sherriff Gordon Mine at Cold lake in Manitoba.

The plant itself, said the speaker, is of conventional design, but it has a special claim to interest because of its location in a sub-arctic district and its remoteness from usual means of transportation.

In its total length of 1,325 miles it passes through many lakes which will form excellent storage basins and its total drop of 1,300 feet is concentrated in numerous falls and rapids which make it very rich in power sites but add considerably to the cost of developing them on account of the numerous portages necessary.

Little is known, continued the speaker, of the flow of the river. During 1928-30 a minimum of 10,000 c.f.s. and a maximum of 35,000 c.f.s. were recorded and past high water marks indicate a maximum of, probably, 100,000 c.f.s.

The power site is 70 miles from the mine and a road had first to be constructed over which all material and supplies for construction and machinery could be transported. Summer transportation was by scows on the lakes with portages between them, and winter transportation by 100 h.p. tractors pulling about six sleighs and a caboose. An average trainload of 77 tons and a maximum of 120 tons of material was hauled in an average time of 36-40 hours.

It was necessary, the speaker pointed out, to develop a small power plant of about 2,000 kv.a. capacity at 600 volts to carry the construction load. This load was carried by two 1,250 h.p. turbines and the energy was transmitted about 14 miles to the main construction camp at 26,400 volts.

The general scheme consisted of:

1. A power house of concrete block construction supported by a massive concrete substructure.
2. A main power dam, 90 feet high, spanning the channel, with provision for ice shutes, undersluices and a spillway section.
3. An extension of the power house headworks to provide for additional units in the future.
4. Bulwark dams forming shore connections to the north and south banks.
5. A concrete main spillway dam, 44 feet high, one mile south of the power dam.
6. A number of earth dams or levees to prevent overflow along the margin of the head pond.

The cribs for the six cofferdams were constructed of lumber on shore, shaped to fit the contour of the river bottom, floated and sunk into position and faced with sheet piling and banks of clay.

Three main units of 12,000 kv.a. capacity at 90 per cent power factor, 3-phase, 60-cycle, 6,600 volts, driven by 14,000 h.p. single runner, vertical shaft, propellor type turbines operating at 56 feet head and 164 r.p.m. have been installed and provision made in the dam for three additional units when the load warrants. There are also installed two house turbines of 1,250 h.p. each direct connected to a 1,000 kv.a. 600-volt 3-phase, 60-cycle generator.

Climatic conditions, said Mr. Marshall, are extremely severe, the temperatures falling as low as 55 degrees below zero at times. These low temperatures caused many difficulties during construction and have necessitated the provision of special means for avoiding the formation of ice and of clearing it if it does form. The guides for the stop-logs are electrically heated.

The total length of the power dam is approximately one quarter of a mile with a maximum height of about 120 feet.

Some idea of the magnitude of the job may be gathered from the following approximate summary:

Excavation and earthworks	194,000 c.f.
Rock excavation	63,300 c.f.
Riprap	11,400 c.f.
Concrete	83,700 c.f.
Concrete blocks	134,800 pcs.
Reinforcing steel	11,400 tons.
Structural steel	200 tons.
Cofferdams	17,500 c.f.
Freight handled	35,000 tons.

The whole of the work was completed in two years, concluded the speaker, of which sixteen months was taken in building the permanent works.

The wide appeal of the paper to those present was shown by the large number who took part in the ensuing discussion, including F. J. Robertson, A.M.E.I.C., F. K. Beach, A.M.E.I.C., F. N. Rhodes, A.M.E.I.C., H. J. McLean, A.M.E.I.C. and Mr. Hobson.

A vote of thanks moved by Messrs. McLean and Beach was responded to very heartily by those present.

In the Halifax Branch news for October 15th, 1930, which appeared in the January, 1931, issue of The Journal, it was stated in error that Mr. McDonald was the speaker of the evening. Mr. George A. Richardson, technical lecturer of the Bethlehem Steel Company, addressed the Branch on that occasion.

Hamilton Branch

J. R. Dunbar, A.M.E.I.C., Secretary-Treasurer.
J. A. M. Galilee, Affiliate E.I.C., Branch News Editor.

A meeting of the Executive Committee was held in the Wentworth Arms hotel at 6 o'clock p.m. on February 11th. The chairman and five other members of the Executive were present.

The Secretary-Treasurer reported that two $500 bonds had been purchased.

Formation of an Aeronautical section was discussed but no action was taken.

On the motion of H. A. Lumsden, M.E.I.C., seconded by G. A. Colhoun, A.M.E.I.C., it was resolved that a letter of condolence be sent to the Niagara Peninsula Branch regarding the sad death of their Secretary-Treasurer.

Several applications for admission or transfer were considered.

The Executive committee confirmed their action in endorsing the following resolution adopted at the meeting held in the Engineers' Club, Toronto, on Tuesday, January 20th, 1931, at which were present representatives from the Professional Engineers of Ontario, American Society of Mechanical Engineers (Ontario Section) and The Engineering Institute of Canada (Toronto Branch), and in requesting the Secretary of the Toronto Branch of The Engineering Institute of Canada to transmit their recommendation to the Prime Minister:—

> "That, in view of the impending resignation of the Chairman of the Hydro-Electric Power Commission of Ontario, we, the Engineering Societies of Ontario, respectfully submit to the Prime Minister that the vacancy on the above Commission be filled by the appointment of an engineer of repute.
>
> Also, in the event of this suggestion being favourably considered, that these Societies would be glad to give any assistance in their power to the Prime Minister in this connection."

Immediately following the Executive committee meeting an informal dinner was held in the Wentworth Arms hotel, at which were present H. S. Finnemore, B.Sc., A.M.E.I.C., Canadian National Railways, who was to speak at the Branch meeting immediately following, together with members of the Executive Committee and members of the Branch.

After dinner the meeting convened in the auditorium of the Canadian Westinghouse Company. The chairman asked H. U. Hart, M.E.I.C., to introduce the speaker, who gave an address on the development and operation of oil-electric rail cars on the Canadian National Railways.

The Development and Operation of Oil-Electric Rail Cars on the C.N.R.

Mr. Finnemore prefaced his paper by saying that the unit rail car is not a new development in the railroad field, cars of this kind having been built and used twenty-five years ago.

The unit rail car operates in ordinary railway service by power furnished from a source within itself. This source may consist of storage batteries or some form of generating plant, consisting of a prime mover transmitting power to the wheels through either a mechanical or electrical transmission. The internal combustion engine is now in universal use.

Since the mechanically driven car of large size and weight has poor starting characteristics and involves a somewhat complicated gear shift, it is natural that the next development in rail cars should combine a gas engine with electrical apparatus. This type of car is called gas-electric. This combination gives good starting and an extremely flexible speed control system.

Storage battery cars have been tried for a time but limitations arose which showed conclusively that the car with its self-contained power plant was the solution for light traffic on branch lines.

After investigation and tests, the Canadian National Railways decided to build a number of unit rail cars using a diesel engine. These were the first oil-electric cars ever built for regular railroad operation on this continent. Two sizes of engines were chosen, a four-cylinder and an eight-cylinder. Seven cars were built using the smaller unit, the power plant comprising a Beardmore engine, 200 h.p., direct-connected to a 105 k.w. 600 volt d.c. generator. Two cars using an eight-cylinder Beardmore engine of 400 h.p. were also constructed. The engine is connected to a 200 k.w., 600 volt d.c. generator. These two cars are of the articulated type, that is, they consist of two separate car bodies connected together at one end and supported by a common truck at the joint. This truck contains no traction motors, the motors, four in number, being mounted two on the front truck and two on the rear. The car is 102 feet in length over all, weighs approximately 185,000 pounds and as constructed, seated 126 passengers and provided a large baggage space, as well as a smoking compartment. Since then the baggage space has been increased and the seating accommodation consequently reduced.

The four-cylinder cars are somewhat smaller and consist of the regular type of car body 60 feet over all, seating 57 passengers and with a good sized baggage compartment. These cars have proved especially satisfactory and have not been changed materially, being in service today practically as built.

The next type of car constructed by the Canadian National Railways was 73 feet 9 inches long, weighed approximately 140,000 pounds and seated 37 passengers with a liberal space for baggage. The engine is a Beardmore, developing 300 h.p. at 750 r.p.m. with six cylinders and, like the first two types of engines used, has an 8¼-inch bore by 12-inch stroke. The generator is 198 k.w., 600 volt d.c., with a single sleeve type bearing and is mounted on the same bedplate with and rigidly connected to the engine.

All electrical connections, including engine starting, are established through electro-pneumatic and electro-magnetic contactors from a master controller, which is combined with a mechanically connected engine throttle, and engine starting is accomplished by motoring the generator from a 64 volt storage battery.

After three years' operation with the six-cylinder cars, seven more were placed in service in 1930. These cars are practically duplicates of the first five, with the exception that a Westinghouse engine is used instead of a Beardmore.

A feature of the electrical equipments on all six-cylinder cars is the generator torque control. This device, in the form first developed for oil car application, consists of a small motor, the armature of which tends to revolve against the tension of a spring and whose shaft carries a contact-making arm. The field of this motor is proportional to that of the main generator and the armature is in series through a shunt with the main generator armature.

On future equipments, a more recent development, known as "engine torque control," will be used. This device prevents overloading of the engine by limiting the fuel to each cylinder to the amount corresponding to full load fuel at any one of several working speeds between idling and full speed positions. The engine throttle is mechanically connected to the control for the fuel admission and positively limits the amount of fuel for any given throttle position.

The tests made by the American Railway Association last year on unit rail cars, using gasoline, distillate and fuel oil (Diesel), showed an overall efficiency of the power plants, that is, from the fuel tank to the generator terminals, as follows:

Gasoline and distillate—approximately 12 to 15 per cent.

Fuel Oil or Diesel—23 to 26 per cent.

These tests were made on different railroads and the cars were tested exactly as found, without adjustment or change to any part of the equipment. The operators were told to carry on as usual and endeavour to forget that any tests were in progress. Expressing these results in another way, the output for gasoline and distillate average about 5 kw.h. per gallon, while for fuel oil (Diesel) the output averaged over 10, just double the amount.

A switcher locomotive was shown which proved the adaptability of the Diesel in this exacting service.

At the conclusion Mr. Hart, vice-president of the Canadian Westinghouse Company, pointed out that they had several engineers working on oil-electric cars and it would only be a matter of time when the Beardmore type of engine would be made in Hamilton.

E. M. Coles, A.M.E.I.C., moved a hearty vote of thanks to the speaker for his most interesting and instructive address, which was carried unanimously.

There were 75 present.

Lethbridge Branch

Wm. Meldrum, A.M.E.I.C., Secretary-Treasurer.

The regular meeting of the Lethbridge Branch was held at the Marquis hotel on Saturday, January 24th. There were 28 members and affiliates present. The meeting was preceded by the usual dinner, enlivened by Mr. Brown and his orchestra, following which a musical programme was enjoyed. Besides the community singing of the Branch, vocal solos by Miss J. McIlvena and E. J. Rannard were excellently rendered and enjoyed by all.

The speaker of the evening, N. H. Bradley, A.M.E.I.C., district engineer, provincial government of Alberta, was introduced by the chairman, C. S. Clendening, A.M.E.I.C. Mr. Bradley took as his subject "The Progressive Development of Highways." The speaker illustrated his paper by motion pictures shown with the Branch's new projector operated by Mr. C. M. Watson. The two reels of pictures were obtained from the Ontario Highways Branch.

Mr. Bradley pointed out how, in 1924, the average quantities in earth construction were, approximately, 4,000 cubic yards per mile; while in 1930, the average was approximately 8,000 cubic yards per mile, and not infrequently additional right-of-way is required for the extra material. In 1924 no attempt was made to eliminate sharp turns and corners, while in 1930, 10-degree curves were laid down as standard for all such places. In 1924, diversions in the alignment were resorted to with the idea of saving yardage at hills and coulees, etc. In 1930, a straight alignment was adhered to where at all possible with possibly steeper grades and with the idea that future traffic will warrant hard-surfacing, thereby justifying this additional increase in cost.

In 1924, the gravel placed on roads was the ordinary pit-run gravel passing a 1½-inch grizzly; in 1930, the gravel was crushed to pass a circular screen, with 1-inch round holes.

The maintenance of main highways in 1924 was done by occasional dragging; in 1927 by regular horse patrol on gravelled sections; and in 1930 by regular motor patrol graders. Also the government is now attempting to keep 750 miles of main highway free from snow, as compared with 550 miles during the winter of 1929-1930.

Realizing the comparatively short life and expense of maintaining even the best of gravelled roads, the government has been conducting tests with a number of oil and asphaltic materials.

Mr. Bradley pointed out how Alberta is faced with a tremendous problem in providing highways throughout the province with its sparse population. Alberta has 2.5 people to the square mile, compared with 183 in the New England and mid-Atlantic states and 389 in the British Isles. The rapid advancement of motor transportation and remote scattered settlements has necessitated the building of roads, at times possibly beyond the limit of economic justification.

Alberta by July, 1931, will have a total of 1,875 miles of standard grade road and 1,429 miles of gravelled highway.

The replacement cost of gravel in some sections runs as high as $600 per mile annually, while surface maintenance costs approximately $350 per mile and the laying of an oil coating to settle the dust runs the cost to another $500 per mile.

Gravelled roads differ from the water-bound macadam formerly in vogue, not only in the smaller size of aggregate used, but in the variety of materials utilized, and to secure a compact thickness of road metal, the use of a drag or grader under traffic rather than a road roller. Under constant and intelligent maintenance these roads present a much smoother surface than was formerly the case.

The costly part of the maintenance of untreated surfaces is the replacement of aggregates blown off the road. When traffic increases much over 400 vehicles per day, this item may run so high as to make it advisable to use some sort of a treated surface. The treatment of gravel roads with light oils is economical and can be justified where traffic runs more than 500 vehicles per day. It is known that traffic running 1,000 vehicles per day will throw off the road, as dust, 300 cubic yards of gravel per mile per season. The placing of gravel on roads is costly. Materials must be conserved; to conserve materials they must not be allowed to blow away.

The speaker pointed out that no matter what material is used to surface a road, the major body is gravel or crushed rock—hence the added necessity of conserving our gravel deposits.

The paraffin base residual oils obtainable from Alberta refineries have no intrinsic value for road purposes as they have no adhesive properties. An oil with a tar or asphaltic base is absolutely necessary.

Mr. Bradley's talk evoked quite an interest in his audience which was shown in the lively discussion which followed.

R. S. Winter moved a hearty vote of thanks to the speaker.

The Lethbridge Branch held its regular meeting on February 7th, in the private dining-room of the Marquis hotel, thirty-six members attending. Following the dinner two excellent solos were rendered by Mr. and Mrs. Meldrum much to the delight of those present. Mr. Brown and his orchestra, as usual, were at their best and enlivened the dinner hour with many appreciated selections.

A telegram from The Institute headquarters was received by the Secretary, announcing that two charter members of the Lethbridge Branch, S. G. Porter, M.E.I.C., and Major H. G. Muckleston, M.E.I.C., had been elected president and vice-president respectively of The Institute. The Branch immediately passed a motion that telegrams be sent to these honoured members congratulating them.

The Branch was favoured by a visit from K. R. Jallings, chemical engineer, Maple Leaf Oil and Refining Co., Ltd., Coutts, Alberta. Mr. Jallings took as his subject "The Story of Gasoline," and illustrated his talk by motion pictures of the Standard Oil Refineries of Indiana kindly lent by the Bureau of Mines.

Mr. Jallings said that in order to operate an internal combustion engine in a satisfactory manner a fuel must meet certain requirements. These requirements will vary from year to year as the design of the motor is changed to give greater operating economies. Thus a fuel which gave complete satisfaction when used in the motor of 1910, would be quite unsuited to the high compression motor of to-day. In the early days, specifications were written in a more or less haphazard fashion. At present there is an intensive research programme being conducted, to determine the qualities which are necessary to a good motor fuel.

In the early days of the industry, before the advent of cracked gasoline, the colour of a gasoline was taken as an index of the care used in its manufacture. Mr. Jallings said that as far as he had been able to determine there is no sound technical reason for retaining this specification. Another quaint custom is that of specifying the gravity of a gasoline. The speaker pointed out that there are cracked gasolines on the market to-day with gravities as low as 50 degrees A.P.I. and that they will start a car in any sort of weather.

There are three qualities that do determine the value of a motor fuel that meets the needs of an internal combustion engine. First, the fuel must not corrode any of the metal parts with which it comes in contact. Second, it must have a sufficiently low gum content to prevent the sticking of valves. Third, and most important of all, it must be sufficiently volatile to burn cleanly and start the motor easily without producing vapour-lock at the highest temperature at which the motor will be operated.

There are standard methods of testing a gasoline for these qualities. A freshly polished strip of copper is placed in a test tube immersed with the gasoline to be tested; the tube and contents are then maintained at a temperature of 122 degrees F. for three hours. The copper strip is then examined, and if it only shows a slight discolouration the gasoline is non-corrosive. There are a number of tests for gum, none of which are entirely satisfactory. Hence when the gum content is specified, the method of making the determination must also be specified. The volatility of a gasoline is indicated by the standard A.S.T.M. distillation test.

The principal sources of motor fuel are: first, normal or straight distillation of crude petroleum; second, thermal decomposition or cracking of heavy petroleum hydrocarbons; third, extraction from natural gas; fourth, carbonization of coal; fifth, hydrogenation of petroleum and coal; six, synthesis from carbon monoxide and hydrogen; seventh, retorting of oil shale; eight, the fermentation of carbohydrates. Of these methods only the first three have been of any great commercial importance in the past.

In 1929 the United States produced a total of 434,920,495 barrels of motor fuel. Of this 56.27 per cent was made by the straight distillation of crude petroleum; 33.03 per cent was made by cracking, and 10.70 per cent was extracted from natural gas.

The retorting of oil shale is not at present an economical possibility, save under the most favourable conditions.

A great deal of methyl alcohol is made by synthesis from carbon monoxide and hydrogen. However, a very small amount of it is used as motor fuel because of the relatively high cost of manufacture.

Hydrogenation of coal and petroleum promises to become a very important source of not only gasoline but of kerosene and lubricating oil as well. However, it has still to prove what it can do on a large scale. The carbonization of coal furnished the United States, in 1929, with 2,920,000 barrels of benzole, most of which went into the chemical industries.

The gasoline which is extracted from natural gas is very volatile and as a result finds little or no use directly as motor fuel. It is practically all sold to refineries who blend it with their straight run and cracked products to give them the necessary volatility to render them saleable.

Cracking of petroleum hydrocarbons was developed when the demand for light products became so great that it was impossible to supply it by normal distillation of crude petroleum. In October, 1930, 38.91 per cent of the gasoline produced was made by this method. It has certain properties, due to its chemical composition, which render it especially desirable for use in the modern high compression motor.

Crude petroleum falls naturally into three major classifications. Paraffin base oils are formed largely of hydrocarbons of the paraffin series having the empirical formula C_nH_{2n+2}. Asphalt base oils are composed largely of hydrocarbons having the empirical formula C_nH_{2n} and leave a heavy pitch or asphalt as residue when they are distilled. Mixed base oils, as the name indicates, are a mixture of these two classes of hydrocarbons.

Using the destructive distillation method on a paraffin base crude we obtain as our crude distillates, light naphtha, heavy naphtha, high test burning oil, tar distillate, wax tailings and coke. Such a distillation is usually conducted in a batch or shell still which is a steel cylinder, although sometimes several of these stills are connected in series.

The crude gasoline obtained by these distillation processes have to be subject to a chemical treatment to remove objectionable sulphur compounds. The chief sulphur compounds present in freshly distilled crude gasoline are hydrogen sulphide, mercaptans, alkyl sulphides, disulphides and thiophenes; the type present controlling the subsequent chemical treatment.

In the acid treatment, the crude gasoline is mixed with 66 degrees sulphuric acid, and then neutralized with caustic soda and washed with water. This treatment dissolves out the sulphur compounds. This treatment is objectionable because if unsaturated hydrocarbons are present they are dissolved in the acid and lost; this treatment also lowers the antiknock value of the gasoline.

The doctor or plumbite process is most used. In this method the raw gasoline is pre-treated with a weak solution of caustic soda to remove the hydrogen sulphide. It is then mixed with enough doctor solution to remove the mercaptans. Just enough free sulphur is then added to cause the dark-coloured mercaptides to precipitate out. When the precipitate has settled it is drawn off and the gasoline finished with a water wash and allowed to settle clear. Mr. Jallings illustrated this method on a sample of crude gasoline. He then went into the possible chemical reactions that probably take place in this treatment.

The Edelnau process approached the ideal in that it furnishes a solvent which has a selective action on the sulphur compounds present. The cold distillate is mixed with cold liquid sulphur dioxide which dissolves the most of the sulphur compounds but has no effect on the pure hydrocarbons. However, the cost of installing the process has prevented its general adoption.

The meeting was then thrown open to discussion, after which N. Marshall, M.E.I.C., moved a very hearty vote of thanks to the speaker. The meeting adjourned at 10.30.

London Branch

Frank C. Ball, A.M.E.I.C., Secretary-Treasurer.
John R. Rostron, A.M.E.I.C., News Editor.

A special meeting of the Branch was held on January 15th, 1931, at the London Life Insurance Company auditorium, the speaker being Captain A. F. Ingram, operating manager, Air Mail Division, Canadian Airways Ltd., and his subject "Commercial Flying in Canada."

W. G. Ure, A.M.E.I.C., chairman of the Branch, presided and introduced the speaker.

Captain Ingram's talk was illustrated by lantern slides and a moving picture film.

He said that within three years there should be a trans-Atlantic commercial air line linking North America and Europe, via Greenland, feeding the great territory of mid-western, far-western and southern states. The course will be from Greenland, along the north shore of the St. Lawrence to Montreal and from there to Toronto, London, Detroit and the west.

The British Government is working hard on such a project at the present time, he declared.

By the time the trans-Atlantic line is in operation, however, there should be an all-Canadian transcontinental line.

The northern route as mapped out above is favoured by Captain Ingram for the Atlantic flight ahead of the southern course, via the Azores, as is strongly boosted in the United States.

Developments in this direction mean that great improvement will of necessity be seen in Canadian airports, Captain Ingram said. Night flying was sure to be greatly increased along many sections of the line and for night flying airports must be lighted. He was sorry to say that Western Canadian cities had shown the way to Ontario centres in that respect. At the present time the Government was offering to pay half the cost of installing floodlights at airports; but that offer would not last for ever, the speaker said.

He also predicted a great advance in the equipment and capacity of airports, and said that at the present time Maritime points were showing the way to Ontario cities in upbuilding of their flying fields.

The speaker described how fast mail planes might meet the incoming boats at Father Point, at the mouth of the St. Lawrence, take mail off them and then beat the steamer by almost a day to Montreal. Next year they were going to meet them at Belle Isle straits, almost a third of the distance from Montreal to Europe, and then the saving in time would be increased.

One of the most romantic of Canadian air mail lines is the 1,600-mile journey from Edmonton right up to the mouth of the Mackenzie river. A trip that used to take 72 days by dog team is made by plane in two days. Mail is now delivered to points in Quebec and along the north shore of the St. Lawrence twice a week, where it formerly was not delivered at all during the winter.

Colonel Ibbotson Leonard, M.E.I.C., moved a vote of thanks to the speaker, which was seconded by W. Raywood Smith, A.M.E.I.C.

The annual dinner meeting and election of officers for the year 1931 was held at the hotel London, on Wednesday, the 21st of January, 1931.

The retiring Chairman conducted the proceedings, the speaker for the evening being Dr. A. E. Berry, Ph.D., C.E., M.A.Sc., M.E.I.C., of the Ontario Department of Health.

Dinner was served at 7.15 p.m., to which full justice was done in a thoroughly engineering manner, and was followed by a session of community singing with Mr. Archie McCulloch at the piano.

The first part of the evening was devoted to the business of the Branch and the Secretary's and auditor's reports were read and adopted. W. P. Near, M.E.I.C., Branch Councillor for 1930, who was absent owing to illness, deputed the Secretary to read his report of the discussion and findings of the Plenary Meeting of Council at Headquarters.

This was accordingly done by F. C. Ball, A.M.E.I.C., and the report was adopted without discussion.

The election of officers for the year then took place and the results were as follows:

Chairman	Wm. Raywood Smith, A.M.E.I.C.
Vice-Chairman	D. M. Bright, A.M.E.I.C.
Executive	G. E. Martin, A.M.E.I.C.
	J. Ferguson, A.M.E.I.C.
	John R. Rostron, A.M.E.I.C.
	W. C. Miller, M.E.I.C.
	F. Y. Harcourt, M.E.I.C.
Secretary-Treasurer (Acclamation)	F. C. Ball, A.M.E.I.C.

A pleasing feature during the above business was the presentation by the incoming Chairman, W. R. Smith, A.M.E.I.C., to the retiring chairman, W. G. Ure, A.M.E.I.C., of the silver badge pin of The Institute as a mark of the appreciation and thanks of the Executive and Members for his services during the past year. Mr. Ure in returning thanks also expressed his appreciation of the help given to him by the members of the Executive, particularly Mr. Ball, the Secretary, whose aid had been invaluable. He also called the attention of the meeting to the presence of Robert Angus, M.E.I.C., of London, who at 89 years of age was the oldest living member of the Branch, and said how pleased the Branch was to welcome him. Three hearty cheers were given followed by the singing of "For He's A Jolly Good Fellow."

W. C. Miller, M.E.I.C., city engineer of St. Thomas, then introduced the speaker.

Dr. Berry, in opening his address, said that he proposed to speak of the part played by engineers in public health work. The doctors were chiefly concerned with the cure while the engineers were engaged in the prevention of disease. In the latter class came the control of communicable diseases largely effected by environment and the resistance of the human system. The part of the engineer was seen in the construction and control of healthier conditions of environment, such as the destruction of refuse, proper heating, ventilation and lighting of buildings, sanitary plumbing and drainage and the efficient disposal of sewage; and in the resistance of the human system by the control of supplies, such as water purification, milk and other food supplies.

In the early days organization along these lines was not known nor was the germ theory until this was discovered by Dr. Pasteur.

The Massachusetts Board of Health, in 1876, was the first public body to acknowledge and determine the allocation of the parts played by the medical men and the engineers. That of the former being to cure and that of the latter to prevent.

The efforts of the engineer—civil, mechanical, hydraulic, electric, chemical, etc.—in this direction naturally led to specialization in the various branches and today the term "specialist engineer" is well known in the Departments of Public Health.

Some of the beneficial results from these engineering precautionary measures might be judged by taking the case of epidemics—say typhoid fever, for instance; it was generally known that this disease was largely spread by contaminated drinking water. Before the efforts of the engineer were put forth in the water purification plants and sanitary supplies, forty to fifty cases of typhoid fever occurred to every 100,000 population per year whereas at the present time two to three cases per 100,000 per year is the rate. The waterworks engineer must make the water to conform with three requirements. It must be: 1, safe; 2, palatable; and 3, attractive.

Referring to the organization of the Department of Public Health the speaker referred to the several parts played by the federal and provincial governments and the municipal bodies. The federal government was concerned with pure food and drug supplies and cleanliness in transportation, particularly with regard to vessels and their cargo. The provincial governments, as instanced by Ontario, by engineering in the effort to prevent disease—Child and Mothers' Welfare, Laboratories, Industrial Hygiene (Factory workers), Dentistry, and Vital Statistics. The municipalities appoint a Medical Officer of Health, who is responsible for the administration of all matters pertaining to the health of the community. The city of London, with its activities in these matters, stands second to none.

In the field of nose and throat diseases the engineers' activities were again manifest in such matters as the perfection (not yet reached) of sanitary drinking fountains, swimming pools, sterilization of dishes, etc.

Regarding the milk supply, the speaker, while admitting that the medical man and the veterinary surgeon had their fight to make in the struggle for pure milk, was still of the opinion that the major part of the work came upon the mechanical engineer in perfecting the machinery for the proper sterilization and pasteurization of the milk itself and in the sanitary control and distribution of it. In some of the United States, an engineer was appointed to take charge of this work.

In the matter of vital statistics the engineer was again in the forefront as his training in mathematics, the use of the graph and the slide rule enabled him to deal with statistics in a more efficient way than the doctor, whose training was not so much on these lines.

In conclusion the speaker emphasized the fact that there was a distinct field for health engineers and recommended that more students specialize in this direction rather than that of constructional work, which is overcrowded.

The meeting was well attended and three doctor were amongst those present: Dr. Hugh A. Stevenson (former M.P.P. for London), Dr. A. J. Slack, Dean of the Institute of Public Health of Western Ontario University, and Dr. W. S. Downham, Medical Officer of Health.

All of these gentlemen spoke in approbation and approval of Dr. Berry's remarks.

Dr. Stevenson spoke at length on the germ theory and cited the work of Dr. Pasteur in this direction. He averred that the germs themselves were harmless but they, like other organisms, required food to flourish on and unless they found suitable ground in the animal body on which they could feed no harm would result; on the other hand, if they did find suitable ground the inoculation started and the disease became manifest. In this connection he made the rather startling announcement that if Adam and Eve could come back again and live upon this earth they would be dead in less than a week, his reason for making this announcement being that the various epidemics which had attacked the human race through the ages had rendered the blood of the present generation almost immune to the attack of the germs of many of these diseases.

E. V. Buchanan, M.E.I.C., in proposing a vote of thanks to the speaker, spoke of the broader field which was now open to engineers, such as heating and ventilation, ultra-violet rays, artificial sunlight, town planning and the motor car with the facilities it afforded the people of obtaining the advantage of purer air in the country, etc.

G. E. Martin, A.M.E.I.C., seconded the vote of thanks, which was unanimously carried by all present.

Moncton Branch

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

Commercial aviation was the subject of an extremely interesting address given before a supper meeting of the Branch, on February 18th, by Captain A. F. Ingram, manager of the Canadian Airways, Montreal. In addition to a large attendance of branch members, there were present a number of officials from the local airport and also the chairman of the civic airport committee. L. H. Robinson, M.E.I.C., chairman of the Branch, presided. During the course of the supper, the St. John's male quartette entertained the gathering with several vocal selections.

Commercial Aviation

The close of the great war found Britain supreme in the air, with vast numbers of fighting planes and a large force of trained airmen, over sixty per cent of whom were Canadians. With the cessation of hostilities, however, ninety per cent of the pilots were forced to return to ground occupations, while the remainder earned a very uncertain living with forest patrols or small aviation companies. The reasons for this were that war machines were not suited for commercial use, and the public had not, as yet, become air-minded. Only within the past three or four years has civil aviation come into its own.

In the United States, for example, the country is now covered with a huge network of air lines, whose operation has reached a high state of efficiency. Captain Ingram referred at some length to the American passenger air service as illustrative of what might shortly be expected in Canada.

Passenger planes are of the all-metal, tri-motored type and nothing is left undone to ensure the safety and comfort of travellers. Pilots, during flight, are at all times in two-way radio voice communication with the airports, and are constantly informed as to weather conditions ahead. Planes are equipped with lavatories having hot and cold running water. Regular meals are served en route. Magazines and fruit are supplied free of charge. An individual reading lamp and ventilator is placed above each seat. In order that the most frequently asked questions may be answered at a glance, a speedometer, an altmeter and a clock are mounted within easy view of the passengers. Every plane carries a stewardess, who must be, among other things, a fully qualified nurse. Both a day and night service is maintained. When a passenger wishes to "retire," he is given a pillow and a rug. His chair is then tilted back much after the manner of a barber's chair, and it is remarkable how easily slumber is induced.

In Canada, up to the present time, the progress of aviation has been mostly along the line of the development of a highly efficient air mail service which covers not only the more thickly populated areas but also extends into the northerly regions. Frequently, over these latter routes, mail deliveries are a matter of hours, where months were required in the past. In conjunction with the air mail, a passenger service is now being developed and it is expected that in the course of a very short time it will be the equal of any in the world.

At the conclusion of Captain Ingram's address, he was tendered a very hearty vote of thanks on motion of T. H. Dickson, A.M.E.I.C., seconded by G. E. Smith, A.M.E.I.C.

Ottawa Branch

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

Joint Luncheon with Queen's University Alumni Association

A joint luncheon meeting with the Ottawa Branch of the Queen's University Alumni Association was held at the Chateau Laurier on Thursday noon, January 29. At this meeting the speaker was Colonel D. S. Ellis, M.A., M.C.E. (Cornell), D.S.O., A.M.E.I.C., head of the Hydraulics Department of Queen's University, Kingston. The subject of the address was "Engineering Methods of Former Days."

In dealing with his subject the speaker made copious references to a rare book published in French in 1729 by an engineer of the name of Belidor under the title of "Engineering Science in Fortification and Architecture." The author of this book, stated the speaker, was a pupil of Sebastian Vauban, Marshal of France, a great engineer and soldier of the time of Louis XIV.

This great engineer and soldier was a builder of fortresses, defender of cities and capturer of both if need arose, builder of canals, harbours and bridges and everything else of the kind. It might well be stated that Vauban was instrumental in lifting the work of engineering from out of the ranks of a very humble pursuit to that of one of the learned professions. In fact, Vauban was one of the great engineers of history and was the leader of an engineering school of thought which continued long after him.

The book, from which Professor Ellis made his own translation, was a very extensive volume and dealt with such topics as elementary mechanics of levers and forces, stability of retaining walls, earth pressure, arches, materials of construction, masonry construction, designing of military buildings, town planning, costs, writing specifications and methods of letting a contract.

The greater part of the address dealt with a brief résumé of the contents of this book. Some very interesting points of difference with present practice were revealed and, on the other hand, in some few features it could be seen that practice has changed but very little up to the present day. Belidor throughout the work emphasizes the value of experimentation for determining methods of procedure and to confirm the results obtained by working out his theories.

In dealing with materials of construction the author of the book did not forget to include human material as well as what is more generally understood by the term. With regard to the physical materials discussed, which included all the masonry material, sand, lime, mortar, various special cements, stone, brick and timber, iron and even glass one could readily realize that the science of chemistry had not up to that time advanced very far. For instance, in regard to stone this was classified as either hard or soft. The former before use was to be left out all winter to see if the frost would chip it. Freshly quarried stone was not to be used as frost would damage it. But frost was not the only destructive agency "for," stated the author, "it is believed that moonlight alters certain kinds of rocks, particles of which the moon rays can dissolve from more compact parts."

A good brick clay was described as one which would stick to one's shoes in ever increasing quantities after the rain. Apparently good brick was made in those days by methods which have only been little improved by machinery, though the author bitterly laments that, due to the decadence of modern times, the brick were not as well made as they used to be.

An interesting comment with regard to the qualities of sand is contained in the statement that "sand should not be left lying around because due either to drying out in the sun or being soaked by rain it will lose its volatile salts and hence be no good."

The oak he characterizes as pre-eminent above all other woods where permanence and strength are desired. The trees should be cut between October and March during the last quarter of the moon so the effect of the humid rays of the moon may be as little as possible. After cutting it should be dried for two years. Iron was of course the structural metal and was used for hinges, bars, tie rods, etc. Of all the iron in France that from the Berry district in the valley of the Loire was most highly esteemed, next to it was that of la Fere. With regard to sheet glass, Belidor mentions a clever means of securing it in a frame which is superior to wedging with paper or using lead. It was by mixing a "pâte" of Spanish white and linseed oil which was pasted around the edge of a frame with a knife and in a day or two set very hard. This seems to be the origin of our putty both in name and in substance.

In describing foundations and mentioning the use of the hammer, the expression "driving to refusal" is given. This indicates that this expression is a very old one and was probably in use much before Belidor's time.

A considerable amount of the address was taken up with the question of construction details, labour, lands and the ethical side of the contractors' part in the work of construction. In carrying out large construction work, three methods were available, namely, the method of a general contract, a special contract, or day labour impressed from the adjacent countryside or by soldiers. This latter was called the corvee. The best means, of course, was a general contract if a competent firm could be found. Failing this the special contract was next to be preferred, and the most difficult manner of doing the work was the corvee.

Among the formalities connected with the awarding of the contract was one which took place after the lowest figure had been reached. Then in succession three tapers or candles would be lighted during the burning of which another contractor could offer a still lower bid.

In concluding his address, Colonel Ellis stated that the practice of engineering has not altered so very much in the past 200 years. The fact that a man wore a tri-corne hat, knee breeches and buckles on his shoes of plain steel did not remove him from his modern counterpart as widely as might be supposed.

The luncheon was very well attended. At the commencement of the meeting the chairman of the local branch of The Engineering Institute of Canada, G. J. Desbarats, M.E.I.C., called upon A. E. MacRae, A.M.E.I.C., chairman of the Ottawa Branch of the Queen's Alumni Association, to introduce the speaker. Among those at the head table were: Victor Meek, M.E.I.C., R. F. Howard, M.E.I.C., W. H. Losee, J. B. Hunter, Group Captain E. W. Stedman, M.E.I.C., C. R. Coutlee, M.E.I.C., Senator Andrew Haydon, A. E. MacRae, A.M.E.I.C., Senator H. H. Horsey, J. McIntosh Bell, Dr. H. M. Tory, John McLeish, M.E.I.C., Professor Kirkpatrick and R. Meldrum Stewart, M.E.I.C.

The annual ball of the Ottawa Branch, always one of the most interesting social events of the winter season, was held in the ball room of the Chateau Laurier on the evening of Thursday, January 29th. Four hundred guests were present at the ball, and the event proved to be one of the most delightful ever held under the auspices of the local branch.

The guests of the evening were received by Mrs. G. J. Desbarats, wife of the chairman of the Ottawa Branch; Mrs. John McLeish, wife of the immediate past-president, and Mrs. J. A. Melville, wife of the chairman of the Committee of Arrangements. Each of these ladies wore a shoulder knot of roses and lily-of-the-valley which had been presented to them by the committee.

Supper was served in the Jasper room at 11.30 o'clock, the long tables being adorned with tall vases of cut flowers. The committee in charge of the arrangements, to whom much of the success of the evening was due, was composed of Colonel J. L. Melville, A.M.E.I.C., chairman, Captain G. A. Browne, A.M.E.I.C., and Philip Sherrin, A.M.E.I.C.

H. D. Henion, of the C. A. Dunham Company, Ltd., of Toronto, was the speaker at the noon luncheon held by the local branch on February 12th at the Chateau Laurier. Mr. Henion spoke on "Developments in Steam Heating," and in the course of his talk outlined the early history of steam heating and the progress made up to the present day.

The luncheon was presided over by G. J. Desbarats, C.M.G., M.E.I.C., chairman of the local Branch, and among those at the head table, in addition to the chairman and the speaker, were R. F. Howard, M.E.I.C.; John McLeish, M.E.I.C.; W. J. Jeffrey; William Gore, M.E.I.C., and Dr. George Nasmith of the firm of Gore Nasmith and Storrie, Toronto; John McKinley; Col. J. L. H. Bogart, A.M.E.I.C., G. A. Gray of the C. A. Dunham Company; Dr. R. M. Stewart, M.E.I.C., Dominion Observatory, Ottawa; A. F. Macallum, M.E.I.C., Commissioner of Public Works, Ottawa; W. E. MacDonald; S. Bray, M.E.I.C., and Group-Captain E. W. Stedman, M.E.I.C.

Before introducing the speaker, Mr. Desbarats, on behalf of the local Branch, congratulated Group-Captain Stedman upon winning the Past-Presidents' prize of The Institute, as recently announced at the Annual Meeting held in Montreal. The paper which was awarded this prize was upon the subject of "Rigid Airships," and was presented at the annual meeting of The Institute held in February, 1930, at Ottawa.

Mr. Henion, in commencing his address, stated that steam heating was first tried out in a more or less experimental manner in the year 1745. In 1890, the one-pipe system came into general use, in which the water of condensation flowed back into the pipe. In order to overcome certain annoyances due to deficiencies in this system, the two-pipe system was invented whereby a separate return pipe allowed the water to be carried away from the radiator. A trouble with this system was that the steam very often was carried off by the return pipe also, and to obviate this the vacuum return line system was designed, steam driven vacuum pumps being employed at first and electric driven pumps later.

In 1903, Dunham invented and produced his first thermostatic trap, a step toward the present-day method of maintaining a positive pressure and of varying the pressure control by different devices, and in 1927, he introduced a differential system of circulation.

Mr. Henion at this point outlined briefly the various steps in a modern steam heating system for maintaining control and for the prevention of excessive fuel waste. Details were given with regard to the construction of control valves for reducing and for regulating pressure, of radiator traps, etc.

An important way of saving fuel and keeping fuel costs down was by the prevention of heat waste. Evidences of inefficiency in this regard could be seen in the large number of windows which have to be opened with some systems when there is a sudden rise of temperature following a period of very cold weather. For about 5 per cent of the heating season the heating systems in Ottawa must be worked at their maximum, and such systems must be designed for a range of radiator temperature extending over about 85 degrees.

An efficient temperature control system, stated the speaker, costs considerably more to instal then other systems but the amount saved as a return on the investment justifies the additional expense of installation.

Saint John Branch

A. A. Turnbull, A.M.E.I.C., Secretary-Treasurer.

A joint dinner meeting was held by the Branch and the Association of Professional Engineers of the province of New Brunswick on Thursday, January 22nd, in the Georgian ball room of the Admiral Beatty hotel.

This dinner followed the Annual Meeting of the Association of Professional Engineers of the province of New Brunswick held during the afternoon. It was largely attended by members of both societies and their guests. A very energetic and capable committee under the chairmanship of J. L. Feeney made excellent arrangements for one of the most enjoyable engineering functions of the season. A very artistic and attractive menu was provided and enclosed in a Polar Forcite gelatin cartridge of the Canadian Industries Ltd., which made a novel as well as an excellent holder. A four piece orchestra supplied music during the dinner interspersed with singing.

The dinner was presided over by W. J. Johnston, A.M.E.I.C., chairman of the Branch. The following toasts were honoured: The King, The Engineering Institute of Canada, The Association of Professional Engineers of the Province of New Brunswick, Our Guests and the Press.

The toast to The Engineering Institute of Canada was proposed by S. R. Weston, M.E.I.C. He recalled the formation of the Canadian Society of Civil Engineers in 1887, which was changed in 1912 to The Engineering Institute of Canada and extended to include all the various branches of the engineering profession. In Canada today, he said, there were over 4,800 members of The Institute, and 3,862 registered engineers. The Association of Professional Engineers in the various provinces was formed at a later date. C. C. Kirby, M.E.I.C., replying to the toast, sought to show the difference between the two bodies of engineers. He stated that The Institute was a body with a voluntary membership organized for the interchange of professional knowledge and interests, to encourage original research and develop and maintain high standards in the engineering profession, extending throughout the Dominion, while the Associations of Professional Engineers were provincial bodies membership compulsory to anyone doing engineering work within the provinces in a professional capacity. The Association of Professional Engineers of the Province of New Brunswick was founded in 1920. It was from The Engineering Institute he said that the first action came toward the creation of the Association of Professional Engineers under government status in the several provinces.

The Institute brought together in 1919 a representative committee from all parts of Canada and charged them with the duty of finding a practical way to bring about a uniform body in the various sections, which resulted in similar legislation being passed in seven of the eight provinces. The form and framework of the bill passed by the various legislatures had been drawn up in New Brunswick and proved itself a model Act used throughout the Dominion.

The toast to the Association of Professional Engineers of the Province of New Brunswick was proposed by the new president of the Association, Dr. John Stephens, Dean of the Engineering Faculty of the University of New Brunswick. He thanked the members for the honour bestowed upon him in being elected President of the Association. The retiring president of the Association, F. P. Vaughan, M.E.I.C., in responding to this toast, reviewed the past year and claimed that the engineer had occupied an enviable position in the large amount of engineering work in progress throughout the Dominion. He expressed the opinion that the engineer had a wonderful heritage in the undeveloped resources of Canada. In reference to power development, he told of projects either under construction or in immediate prospect that would add some 7,000,000 h.p. to the already developed resources of Canada. According to most recent government estimates, he said, it has been shown that of the water power resources in Canada of about 43,700,000-h.p. the existing installation is only slightly more than 13 per cent. The rise of the engineer as a leader in thought development has been rapid and has come through proof of his ability to analyze, deduce and put these findings into action to express energy in terms of fact, he concluded.

The toast to Our Guests was proposed by C. S. G. Rogers, A.M.E.I.C., and replied to by Hon. J. B. M. Baxter, K.C., LL.D., Premier of New Brunswick; His Worship, Dr. W. W. White, M.L.A., Mayor of Saint John; Thomas Bell, M.P., and Hon. L. P. D. Tilley, K.C., president of the executive council. All paid high tribute to the engineering profession and extolled the responsibility shouldered by engineers. They pictured engineers as foremost factors in the advancement of civilization and held out to members of the profession the vision of a great future in Canada through the development of great natural resources.

The toast to the Press was proposed by J. L. Holman, Jr.E.I.C., and responded to by F. X. Jennings, managing editor of the Telegraph Journal and The Evening Times-Globe. Both expressed the need of co-operation in order to reap the prosperity which they believed was in the offing.

Immediately following the dinner, Professor H. W. McKiel, M.E.I.C., Professor of Engineering, Mount Allison University, delivered an excellent address on the "Autobiography of the Earth."

Professor McKiel reviewed various ways and means which have been employed in attempting to determine the age of the earth which can be measured only in hundreds of millions of years. The earth in reaching its present condition has passed through many stages of change in its climatic, geographical and biological relations. These changes have been recorded and preserved in successive layers of rock. It is by a study of these rocks that the history of the past condition of the earth can gradually be obtained. He depicted the many and great changes that have taken place in the globe and its inhabitants during these various stages and illustrated his remarks with many interesting and well prepared lantern slides. The speaker pointed out that of all the animals of unsurpassed ferocity and size that roamed and ruled the earth some millions of years ago, none now remained. All had given way to man, who, while miserably inferior to them in physical strength and stature, had what they had not, superior power of brain, which then as now, was the deciding factor in the struggle for existence. A vote of thank moved by C. C. Kirby, M.E.I.C., and seconded by V. S. Chesnut, A.M.E.I.C., was extended to the speaker for his very interesting address.

Saskatchewan Branch

R. W. E. Loucks, A.M.E.I.C., Secretary-Treasurer.

The January meeting of the Branch was held at the Kitchener hotel in Regina, Sask., on January 23rd, 1931, and was attended by 35 members and guests. The guests included three officials from the General Motors Corporation, Messrs. H. R. Wolf and A. A. Catlin of the Research Department, Detroit, Michigan, and Mr. J. L. Arthur of the Delco-Remy Company of Anderson, Indiana.

General Motors Research Laboratories

Mr. H. R. Wolf of the Research Department of General Motors, in a short address described the work of the research laboratories where some 400 employees are engaged in the operation of a separate unit for the benefit of General Motors alone. Of this number 110 are trained engineers and 125 are engaged purely on research work. Some 5½ storeys of the new General Motors building is given over to the research department, thus providing a floor space of approximately 200,000 square feet for this work.

In this department three general types of work are carried out, viz:—

1. The correction of something that is wrong in methods used in the manufacturing plants, e.g. trouble in drying enamel.
2. The evolution of some new product or an improvement on existing products, e.g. the evolution of a new type of crank shaft.
3. Research as applied to the future progress of the industry, e.g. the production of ethyl gas.

The laboratory is divided into sections dealing with such matters as:—

(a) Chemical research into the physical properties of materials.
(b) Examination of the physical properties of all materials entering into the manufacture of a car, to secure uniformity, etc.
(c) Paint and enamel—the development of duco.
(d) New methods of plating.
(e) The application of rubber mounting.
(f) Fuels—methods of refining and effect on anti-knock properties.
(g) Metallurgical department.
(h) Electrical section dealing with ignition, lighting, etc.
(i) Sound measurements to eliminate noises.
(j) X-ray work examining materials for flaws, etc.
(k) Wind tunnel for the study of fans, radiators, etc.
(l) Head lighting—to conform to various state requirements.
(m) Power plant—to study existing and new types of motors.
(n) Special problems not included in the foregoing such, as balancing of machinery in the car and in the plant.
(o) Machine shop—employing about 200 men in building parts, etc.

Proving Grounds

Mr. Wolf next described the proving grounds operated by General Motors. These grounds consist of some 1,242 acres about 25 miles from Detroit, Michigan, and midway between the various manufacturing plants of that company.

Mr. P. B. McEwen, engineer in charge of specifications at the Regina plant of General Motors, showed a series of moving picture films illustrating the nature, extent and value of these proving grounds.

The proving grounds are situated on property somewhat broken in topography where all types and conditions of roads have been constructed, such as sand, mud, gravel, concrete, macadam, block paving, etc. A total of approximately 60 miles of roads have been constructed and are constantly in use. All traffic is one-way traffic and many of the cars under test are driven 24 hours per day in all kinds of weather, including rain, snow, etc. Hills having standard grades of from 7 per cent to 11 per cent are in use and speedways where the outer edge of the curved roadway allows speeds of from 90 to 125 miles per hour to be attained. These proving grounds exist for two purposes—one to furnish engineering data on the new models of General Motors cars as compared with past models and the other to furnish data on competitors' cars. For this purpose a large number of cars both of their own make and samples of cars from every other manufacturer of cars in Europe and America are purchased from recognized dealers and driven on these proving grounds, where a complete record of their performance is charted. This information is available to the various departments of General Motors corporation but is not made public, neither is it available to salesmen.

The cost of maintaining these grounds amounts to a considerable sum but when distributed over the total number of cars sold by General Motors it is found to add but 45 cents to the selling price of each car.

Discussion

At the conclusion of Mr. Wolf's address a number of questions were asked by the members present.

On the motion of H. S. Carpenter, M.E.I.C., and R. N. Blackburn, M.E.I.C., a hearty vote of thanks was tendered Mr. Wolf and Mr. McEwen for the entertaining and instructive programme of the evening.

The chairman called upon Mr. Arthur and Mr. Catlin for a few words. These gentlemen expressed their pleasure at attending this meeting of the Branch.

On motion of D. A. Smith, A.M.E.I.C., the meeting adjourned at 10.30 p.m.

Sault Ste. Marie Branch

A. A. Rose, A.M.E.I.C., Secretary-Treasurer.

A regular meeting of the Branch was held on January 30th, at 8.30 p.m., following the monthly dinner. The chair was occupied by A. H. Russell, A.M.E.I.C., and the speaker for the evening was Mr. A. H. Sikes, who had taken for his subject, "Natural Gas." Mr. Sikes is connected with the Great Northern Gas Company in Sault Ste. Marie, but has had many years experience in the gas and oil fields. A summary of Mr. Sikes' address follows.

In the earliest beginning of the use of natural gas, it was connected with religious life, the early Greeks seeking omens in the flame of gas escaping from the earth. Similarly in America, burning gas flames played a part in the Indians' religious ceremonies.

The earliest commercial use of gas in America was in Pennsylvania and Virginia, it being piped to Pittsburg, in a wooden pipe line. In these early days piping of the gas was a difficult problem. Many farmers in these regions had gas flares burning day and night in their backyards. Indeed, one of the characteristics of the use of natural gas has been the tremendous waste. During the last century and in particular the last decade, the use of natural gas has grown to a national industry, using billions of feet of gas supplying several millions of consumers and with pipe lines up to 1,000 miles long and 24 inches in diameter.

Natural gas is found in nearly every state of the union, in most of the provinces of Canada and in nearly every large country. In Ontario the flow is not sufficient and so is mixed with artificial gas. In Alberta the Turner field is one of the greatest in the world.

Scientific methods of exploration have been developed, employing the trained geologist. It is believed that gas found at shallow depths is from stray pockets of gas which has escaped through faults in the rock. The deeper wells give a much higher pressure and are more difficult to control. In the control of a gas well the first essential is to extinguish the fire which is done with explosive—the flame is literally "blown out." The second stop to cap the well—a cap with a gate valve being clamped over the casing and the gate valve slowly closed. The life of a gas well depends on its area, thickness and grain of sand from which it comes and the pressure. Its life may be shortened by letting the gas escape into the air, or by going too deep and letting water into the sand. Many wells which give gas with no oil are left to run unstopped.

The largest pipe line in use is 24 inches. The joints are welded and in certain places couplings are used and the pipe is buried to a depth of about 3 feet.

To prevent corrosion, modern practice is to have the soil analysed in order to decide on what treatment to give the outside of the pipe. Pipe lines operate at various pressures and if it is too low pumping stations are put in at suitable intervals. It is difficult to change a line from natural to manufactured gas as the latter dissolves all the tarry matter from the natural gas which has sealed the pipe and leaks are frequent. By-products of gas have the prospects of being a great chemical field as yet undeveloped. In industry gas is used in manufacture of brick, cement, in chemical works and in California it is even being used to dry alfalfa. Residential use alone can never pay without industrial uses. There are about 5,000,000 consumers in Canada and the United States.

Workers in gas and oil fields have a hard life. The speaker related some of his own experiences in the fields of Wyoming and Montana, which most realistically showed how "hard boiled" is the oil man.

Discussion followed, a number of those present being able to give further information on the subject out of their own experience.

A hearty vote of thanks was tendered the speaker for his most interesting address on motion of J. Hayes Jenkinson, A.M.E.I.C., and Wm. Seymour, M.E.I.C.

Institution of Civil Engineers

Address of Sir George William Humphreys, K.B.E., President, at Opening Meeting of Session, November 4th, 1930

At the opening meeting of the Session, on the 4th November, 1930, the President delivered an Address to the Members, of which the following is an abstract. The complete Address will be printed in Volume 231 of the "Minutes of Proceedings."

The President reviewed the activities of the premier municipal body of the Empire from his standpoint as Chief Engineer and Administrator of Housing of the London County Council—a body with which he had been associated for the past 28 years. During this period the population of Greater London had increased from 6,600,000 in 1901 to nearly 8,000,000 to-day, while that of the county had shown a slight but steady diminution. The problems which arose from this growth and redistribution of the population concerned both the administrator and the engineer in close relationship and were of wide interest to every Londoner. In describing what had been done in the past and what remained to be done the address illustrated the dependence of administrative ordinances on the advice and counsel which the engineer alone could give.

The following table illustrated the wide extent of the principal services:

	Sq. Miles
London County contained	117
London main drainage area contained	180
London water area contained	574
London telephone area contained	735
London and home counties electricity area contained	1,797
London traffic area contained	1,820

The principal physical feature, cutting each of these areas in half, was the tidal estuary of the river Thames.

These problems included all the modern requirements of so large a community: adequate means of communication, whether by road, railways or water, water-supply and drainage, refuse collection and disposal, telephone and telegraph services, electricity and gas, housing and town planning, all on a very extensive scale.

The drainage of London presented many remarkable features inherited from the days when sewage was discharged crude into the nearest stream, such as the Fleet, Westbourne, Tybourne or Wallbrook, or direct into the Thames itself. An important factor was that the contents of the tidal river throughout London could not reach the sea on an ebb tide, being met by the incoming tide after a passage of about 12 miles down the river. These conditions, the continual discharge of crude sewage, and the tidal oscillations, in time had their effect until, in the early fifties of last century, the condition of the Thames constituted a nuisance and the Metropolitan Board of Works was created to intercept the London sewage and discharge it by artificial sewers to outfalls beyond London. After much controversy the outfalls were ultimately fixed at Barking and Crossness. At these outfalls the sewage was originally stored in tanks and discharged only on the ebb tide; since 1887, however, it had been sedimented in tanks and the sludge deposited at sea about 48 miles below Gravesend. This system had hitherto proved sufficient, though the increase in volume, and consequent abstraction of oxygen from the river, had directed attention to the necessity of obtaining a better effluent, and it was decided last year to install at Barking an activated-sludge unit to treat a portion of the flow at that station, the construction of which was now proceeding.

The area surrounding the county within a radius of 25 miles of Charing Cross contained as many as 200 separate sewage-works, the effluents from which found their way to the tidal Thames, and the problem of making provision on a comprehensive system for these and additional areas within the catchment-area was now engaging the attention of the Ministry of Health.

To cope with the conditions which arose when very intense rainfalls occurred at about the time of high water, as also to provide for the large areas below high-water level, the county council had carried out a scheme of storm-relief sewers and pumping-stations now nearly completed.

The greater part of the water used in London was drawn from the river Thames, and the remainder from its tributary the river Lee and from wells, by the Metropolitan Water Board, which was constituted in 1903. The Board had to-day available storage-reservoirs of a total capacity of 19,657 million gal., and despite some restriction of use in 1929, it successfully maintained a supply of about 100,000 million gal. of good water a year to a population of about 7¼ millions.

Another authority which literally lived upon the river Thames was the Port of London Authority, constituted in 1908. The capital expended since that date included £17,000,000 spent on improvements, the most notable of which were the King George V dock, the extensions at Tilbury, and alterations at the India and Millwall docks. In addition, systematic dredging of the river had been undertaken, and a channel 1,000 feet wide, giving 30 feet at low water, was being obtained from the Nore to Coldharbour Point.

A brief review of the bridges and later tunnels across the river concluded with reference to the completion, during the present century, of new bridges at Vauxhall and Southwark, a new bridge at Lambeth now in course of construction, and proposals for a new bridge opposite St. Paul's cathedral.

Two vehicular tunnels under the river at Blackwall and Rotherhithe and two tunnels for foot passengers at Greenwich and Woolwich had been constructed in recent years. The development of the internal-combustion engine had produced difficulties in the way of ventilation to a degree not contemplated when the tunnels were made.

Transport was an industry in which a huge amount of public funds was invested in the provision of streets and improvements; only one class of vehicle, however, was administered out of public funds, namely, tramways. It had been announced that a proposal for the pooling of public passenger services was now receiving the renewed consideration of the Ministry of Transport.

There were other services depending upon the work of the engineer in which public funds were concerned. The government was responsible for the network of telephone and telegraph wires and cables, and possessed deep-level tubes for its postal service. The London and Home Counties Electricity area was only surpassed in size by the London Traffic area, and large developments were about to take place in the way of an increase of generating units and transmission facilities. The gas service, on the other hand, was entirely in the hands of private enterprise. The increase in numbers, speed, and weight of vehicles had increased the liability to fracture of both gas- and water-mains, and the advisability of placing gas-mains in subways had been questioned.

A Greater London Regional Planning committee, constituted in 1927, issued its first report last December. The area under the committee's review was the London Traffic area (1,820 square miles). In dealing with the framework of these large conceptions for the future there was scope for the best counsels of the expert and the administrator.

The last activity described in the address was that of housing-accommodation for the working classes. The contributions of the London County Council and the Borough Councils since the war amounted to about 40,000 and 11,000 dwellings respectively. The London County Council since 1920 had been able to create what were small townships, namely:—

	Dwellings
In Lewisham Borough—Bellingham Estate	2,000
" " Downham Estate	6,000
At Hendon—Watling Estate	4,000
Near Morden—St. Helier Estate	10,000
" Dagenham—Becontree Estate	25,000

The St. Helier estate was still under construction, and the figure for Becontree included 6,000 houses for which orders had now been given to the contractor.

The address concluded with observations on the relationship between policy as interpreted by the legislator and administrator, and action, the special function of the engineer; and pointed out that at present there appeared to be a waste and overlapping of effort as far as the labours of the engineer in Greater London were concerned.

Preliminary Notice

of Applications for Admission and for Transfer

February 21st, 1931.

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, 1931.

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

BALLARD—BRISTOW GUY, of Ottawa, Ont., Born at Fort Stewart, Ont., June 19th, 1902; Educ., B.Sc., Queen's Univ., 1924; 1924-25, graduate students' course, Westinghouse Engineering School, Westinghouse Electric & Mfg. Co.; 1925-30, heavy traction section, railway motor engrg. dept., Westinghouse Electric & Mfg. Co., at East Pittsburgh. During last four years was asst. to section engr. in charge of design of heavy traction direct current railway motors. Full responsibility for design and constrn. of many types of rotating machines; at present, elect'l. engr. with the National Research Council, Ottawa, directly responsible to the Director for all elect'l. work pertaining to applied science as apart from pure science.

References: R. W. Boyle, J. H. Parkin, D. M. Jemmett, J. L. Foreman, L. M. Arkley, H. A. Dupre, W. A. Steel.

BARTEAUX—ROSS M., of Bedford, N.S., Born at Port Maitland, N.S., Nov. 6th, 1901; Educ., B.Sc. (Mech. and E.E.), 1924, N.S. Tech. Coll.; 1924-25, statistical dept., Stone & Webster Inc.; 1925-26, asst. to gen. supt., Western United Gas & Electric Co. Inc.; 1926-27, engrg. dept., and 1927-29, asst. to gen. supt., Tampa Electric Co. Inc.; 1929 (7 mos.), elect'l. engr., The Avon River Power Co. Ltd.; 1929-30, supt., Barrington Electric Co. Ltd.; at present, asst. to gen. supt., Nova Scotia Light & Power Co. Ltd., Halifax, N.S.

References: J. B. Hayes, R. R. Murray, K. L. Dawson, J. L. Busfield, F. R. Faulkner.

BIZIER—JOSEPH LIONEL, of Quebec, Que., Born at Thetford Mines, Que., March 25th, 1900; Educ., B.A.Sc. and C.E., Ecole Polytechnique, Montreal, 1927; 1925-26 (6 mos. each), geodetic surveys; 1927-30, asst. engr., Asbestos Corporation Ltd., Thetford Mines, Que., gen. work, mtce., constrn., underground workings, surveys, etc.; June 1930 to date, dredging engr., Quebec Harbour Commission, Quebec, Que.

References: T. L. Tremblay, H. E. Huestis, L. Beaudry, A. Lariviere, A. E. Doucet.

GEROW—CARLYLE, of Montreal, Que., Born at Bloomfield, Ont., July 14th, 1896; Educ., B.Sc., Queen's Univ., 1922; 1916-19, overseas, signaller, C.F.A., Cadet, R.A.F.; 1920 (summer), with Spanish River Pulp & Paper Mills, Sault Ste Marie; 1921 (summer), asst. to field engr., highways dept., Govt. of Sask.; 1922-24, technical asst. to chief steam engr., Spanish River Pulp & Paper Mills, Ltd., at Espanola, Ont.; 1924-25, asst. mech'l. supt. and chief steam engr., Canadian Industrial Alcohol Co. Ltd., Corbyville, Ont., in charge of redesigning entire boiler plant, and complete charge of operation of completed plant; 1925-31, chief steam engr. and tech. asst. to gen. supt., Bathurst Power & Paper Co. Ltd., Bathurst, N.B., complete charge of all steam generating equipment and steam turbo generators, and all steam distribution, etc.; at present, asst. gen. mgr. and technical advisor, coal sales dept., Dominion Coal Co. Ltd., Montreal, Que.

References: A. W. McMaster, L. M. Arkley, F. S. B. Heward, H. G. Thompson, J. A. H. Henderson, J. V. Fahey.

GOODMAN—JAMES EDWARD, of Kingston, Ont., Born at Perth, Ont., Mar. 19th, 1901; Educ., To pass one exam. to become eligible for B.Sc., Queen's Univ.; 1916-21, rodman, rigger, carpenter and inspr., H.E.P.C. of Ontario; 1921-22, material and equipment supply man, Sinclair Construction Co.; 1922-23, installn. of large generators, Can. Gen. Elec. Co.; 1924-25, instr'man. on surveys, H.E.P.C. of Ontario; 1926 (summer), engr. in charge of erection of substation and transformer footings at Fort William, H.E.P.C. of Ontario; 1927-29, instr'man., second in charge of precise levelling party, Geod. Survey of Canada; 1930 (summer), chief inspr. on black base pavement, engr. in charge of 300' reinforced concrete arch bridge and two miles of new road, Dept. Public Highways Ontario; at present on research work for the Dept. Public Highways Ontario.

References: W. P. Wilgar, W. F. Noonan, A. L. Malcolm, W. L. Malcolm, D. S. Ellis.

HAWKINS—WILLIAM HARVEY, 38 Belmont Avenue, Ottawa, Ont., Born at Norton, Derbyshire, England, May 31st, 1892; Educ., Evening classes, King Edward VII Technical School, Sheffield; 1907-13, ap'tice, struct'l. dept., Thos. W. Ward Ltd., Sheffield; 1913, shiphldg. designs and templates, Polson Ironworks, Toronto; 1917, Lieut., Engrg. Officer, 2nd C.R.T.; Overseas; 1919-29, archt'l. practice, London, Ont.; as subsidiary to practice in London owned and operated the Erie Construction Co. and Parkhill Planing Plant; 1929-30, arch't. and engr., to E. B. Eddy Co. Ltd., Hull, Que.; 1930, supt. of mech'l. and sub-trades on Aldred Bldg., Montreal, for Foundation Co. of Canada, Ltd.; at present, senior asst. engr., Penitentiary Branch, Dept. of Justice, Ottawa, Ont.

References: F. F. Clarke, W. A. Ewing, B. Griesbach, W. S. Lawson, W. R. Hughson, W. S. Kidd, R. J. Fuller.

LARSEN—ANDREAS, of Kapuskasing, Ont., Born at Kolvereid, Norway, Sept. 11th, 1898; Educ., 1921-23, Trondhjem Technical School; 1924, diploma in mech'l. engrg., Engineering School, Zwickau, Germany; 1924-27, dftsman, and asst. supt., at "Salsbrukets Tresliperi," Norway; 1929 to date, dftsman., Spruce Falls Power & Paper Co., Kapuskasing, Ont.

References: C. W. Boast, C. R. Murdock, S. Wang, B. Grav, A. K. Grimmer.

MILLAR—PETER, of 57-24th Ave., Lachine, Que., Born at Lochwinnoch, Scotland, Sept. 10th, 1903; Educ., Royal Technical College, Glasgow (continuation classes), 1917-23; 1924-25, evening classes in struct'l. design, Dominion Bridge Co.; 1918-23, ap'ticeship, 3 years shop, 2 years drawing office, Mechans Limited, Glasgow; 1923-28, detailing and checking struct'l. and mech'l. details, and from 1928 to date, squad leader, in charge of detailing of plate and tank and struct'l. work, with Dominion Bridge Company, Limited, Lachine, Que.

References: D. C. Tennant, F. P. Shearwood, F. Newell, A. S. Wall, A. Peden, F. C. White.

McPHERSON—ALEXANDER FERRIER, of 121 Emerald St. So., Hamilton, Ont., Born at Paris, Ont., Dec. 5th, 1904; Educ., B.Sc. (Elec.), Univ. of Alta., 1927; 1923-24, elect'ns asst., Marlboro Cement Co. (summers); 1925-26 (summers), forest surveyor, Forestry Branch, Coalspur, Alta.; 1927-29, student ap'tice, and from Oct. 1929 to date, layout and design of manual and semi-automatic switchboards, and gum-filled switch gear; also substation layout work, Canadian Westinghouse Company, Hamilton, Ont.

References: W. F. McLaren, D. W. Callander, H. U. Hart, J. C. Nash, E. G. Grant.

SHELDRICK—KENNETH DOUGLAS, of Montreal, Que., Born at Kingston, N.B., Oct. 19th, 1907; B.A., Univ. of N.B., 1927. 1929-30 (7 mos.), completed Cadet Course, Bailey Meter Co. Ltd.; 1927-29, preparation of steam and power plant efficiency reports, and mtce. of metering equipment, Nashwaak Pulp & Paper Co. Ltd., Saint John, N.B.; 1930-31, sales and service engr., and at present mech'l. engr., Bailey Meter Co. Ltd., Montreal, Que.

References: O. F. Bryant, J. C. Nutter, H. G. Thompson, K. S. LeBaron, A. F. Baird.

STEWART—CHARLES JOHN RAPHAEL BARNEWALL, of Fraserdale, Ont., Born at Hill St. House, London, England, July 17th, 1904; Educ., B.A. (Eng.), Peterhouse, Cambridge Univ., 1926; 1926, junior engr., Lochaber water power scheme; 1926-28, junior asst., Lochaber water power scheme, charge of setting out, measuring up, and agreement of quantities for power house foundations, factory excavations, access roads, rlys., bridges, and tail race tunnel; 1928, asst. engr., checking tunnel line, charge of diving operations at intake; 1928-29, Grampian Electricity Supply Co.'s Rannoch development, triangulation and location of tunnel (portal end), and surge shaft, supervision of erection of contractor's plant and initial works at pipe line and power house, design of temporary structures, layout work, etc.; 1930, asst. res. engr., Glasgow Inverness road; at present, dftsman., Dominion Construction Co. Ltd., Abitibi Canyon development, Fraserdale, Ont.

References: G. Mitchell, R. L. Hearn, T. V. McCarthy, W. J. Bishop, P. C. Kirkpatrick.

TJONNAAS—OLE HANSEN, of Coronation, Alta., Born at Gransherad, Norway, March 25th, 1891; Educ., 1919-21, Kristiana Technical Institute; Grad. in 1921; 1913-14, instr'man., Rjukan town plants, Norway; 1914-15, rodman and instr'man., Norwegian State Railways; 1915-16, instr'man., Rjukan town plants; 1917-18, topog'r. on location and dftsman in dist. engr.'s office, Norwegian State Railways; 1918-19, in charge of field work, location of streets and water mains, triangulation, etc., Municipality of Notrodden, Norway; 1921-24, asst. to chief engr., Kongsvinger divn., Norwegian Govt. Railways, cost estimates, designing, road surveying, etc.; 1926-27, instr'man. on transmission line location, Shawinigan Engineering Co., Montreal; 1928 to date, dftsman. on location and constrn., C.P.R. engin'g. dept., Winnipeg, Man.

References: T. C. Macnabb, J. A. McCoubrey, A. E. Sharpe, D. A. Livingston, C. H. Larsen, M. R. Murray.

WRANGELL—KJELL FREDERICK, of Ottawa, Ont., Born at Kristianssand, Norway, June 11th, 1902; Educ., 1920-22 (day course), Horten Technical School; 1922-24, helper in paper mill, Norway; 1924-26, filing, tracing and dfting., Riordon Pulp Corpn., Temiskaming, Que.; 1926-27, dfting. and estimating, Solvay Process Co., Solvay, N.Y.; 1927 (Sept.-Dec.), supt. mtce., International Fibre Board Ltd., Midland, Ont.; 1928-29, designing, estimating and dfting., Link-Belt Ltd., Montreal; Oct. 1929 to date, designing, estimating and dfting., E. B. Eddy Co. Ltd., Hull, Que.

References: W. S. Kidd, L. S. Dixon, J. C. Day, P. N. Libby, A. N. Ball.

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

HOLE—JOHN, of 48 Havelock Street, Toronto, Ont., Born at London, England, Jan. 23rd, 1874; 1890-94, 2 years, Finsbury Technical College, and 2 years evening engrg. and bldg. constrn., L.C.C. centres, London; 1892-98, six years prelim. work; 1898-1907, with E. C. Christmas, Forest Hill, London, England, and others, sole charge laying out estates, roads, sewers, and designing and supt'g. bldgs.; 1907-10, subordinate positions with Darling & Pearson, Storey & Van Egmond, architects, and as asst. drainage engr. on road diversions and ditches for P.W. Dept., Sask.; 1910-12, engr. in charge, for the Elias Rogers Coal Co. Ltd., Toronto, remodelling their coal handling plants, also continued to execute all engrg. work required by this firm until 1923 (in addition to salaried positions); 1912-16, asst. chief dftsman., Toronto Harbour Commrs.; 1916-18, asst. supt. of constrn.; 1919-20, arch't. and engr. to Toronto Housing Comm. (City of Toronto and Dominion Govt.); 1920-22, in sole charge of constrn. of Sunnyside Bathing Pavilion and Sunnyside Pavilion, as res. arch't. and engr. for Toronto Harbour Commrs.; 1922 to date, in private practice as architect and engr., specializing on design and superintendence of housing development, designing and organizing for industrial layouts, valuation of bldgs. and supt'g. erection of bldgs., etc. Consultant to Toronto Terminals Railway Co., Property Commission; Assessment Dept. and Parks Dept., City of Toronto, C.N.R. (constrn.), etc. (*A.M. 1923.*)

References: N. D. Wilson, A. E. K. Bunnell, E. L. Cousins, A. H. Harkness, J. G. R. Wainwright.

WHITTAKER—DAVID, of Edmonton, Alta., Born at St. Helens, Lancs., England, Sept. 23rd, 1884; Educ., 1903-05, Univ. of Liverpool. Extensive reading, study and travel in Great Britain and France; 1900-02, ap'ticed to constrn. work; 1905, dftsman and instr'man., and 1908-09, transitman on location of branch lines, Prairie Divn., Grand Trunk Pacific Rly.; 1909-10, reconnaissance engr., Lac la Biche to Fort McMurray, A. & G.W. Rly., Alta.; 1910-12, locating engr. and res. engr., on constrn. of 13 miles of heavy rly. work, Western Coal & Coke Co.; 1912-15, res. engr., C.P.R., suptg. bldg. and laying of double track on main line between Whitewood and Broadview, Sask., etc.; 1915-17, Canadian Overseas Constrn. Corps; 1917-19, Lieut., Royal Engrs.; 1919 to date, asst. hydraulic engr., Dominion Water Power Branch and Hydrometric Bureau, Dept. of the Interior, Edmonton, Alta. (*S. 1909, Jr. 1913, A.M. 1919.*)

References: J. S. Tempest, P. J. Jennings, F. M. Steel, J. G. Reid, G. Monkman, G. F. Richan, L. C. Charlesworth, R. W. Jones.

FOR TRANSFER FROM THE CLASS OF JUNIOR TO A HIGHER CLASS

BURCHILL—GEORGE HERBERT, of Halifax, N.S., Born at Nelson, N.B., May 12th, 1899; Educ., B.Sc., N.S. Tech. Coll., 1923; 1917-19, overseas, C.E.F.; 1923-24, testing dept., and 1924-28, asst. engr., alternating current engrg. dept., Can. Gen. Elec. Co. Ltd., Peterborough, Ont. (design of A.C. generators and synchronous motors); Sept. 1928 to date, asst. prof. of elect'l. engrg., and from Sept. 1930, acting-professor, Nova Scotia Technical College, Halifax, N.S. (*S. 1923, Jr. 1926.*)

References: F. R. Faulkner, C. H. Wright, L. DeW. Magie, B. L. Barns, R. R. Murray.

CAMPBELL—ELLIOT STIRLING, of 92 Beech Street, Halifax, N.S., Born at Moncton, N.B., Sept. 25th, 1897; Educ., 2 years engrg., Dalhousie Univ.; 5 years night classes at Nova Scotia Tech. Coll., 3 in elect'l. engrg., 1 in civil with special cert. of merit, 1 in auto work; 1917, rodman and dftsman on city survey, Pickings & Roland, Halifax; 1917, dftsman., rly. dvn., Halifax Ocean Terminals; 1918, 10th Can. Engrs.; 1918, dftsman.; 1919, asst. on constrn. of dam ($40,000) and flume line power house layout, etc., Halifax Power Company; 1919-26, chief dftsman and purchasing agent, Dept. of Highways, Prov. of Nova Scotia; 1926-29, senior dftsman., supt'g. magazine constrn., and from 1929 to date, asst. engr. in charge of magazine constrn., Mil. Dist. No. 6, Department of National Defence, Halifax, N.S. (*Jr. 1921.*)

References: H. F. Laurence, G. R. Chetwynd, C. A. MacNearney, G. N. Dickenson, R. R. Murray, H. W. L. Doane.

KINGSMILL—CHARLES GRANGE, of Beauharnois, Que., Born at Toronto, Ont., Mar. 25th, 1903; Educ., B.A.Sc., Univ. of Toronto, 1924. Grad., 1st class cert., Royal Naval College of Canada, 1921; 1924-25, asst. engr. on power house constrn., Quebec Development Co., Isle Maligne, Que.; 1925-26, asst. engr. on constrn., Aluminum Co. of Canada, Arvida, Que.; 1927, engr. on paper mill constrn., group of bldgs., Lake St. John Power & Paper Co.; 1928-29, res. engr. for Foundation Co. of Canada, at Halifax and Liverpool, N.S., on cold storage constrn. and paper mill constrn.; 1930 to date, res. engr. on portion of canal, Beauharnois Construction Company, Beauharnois, Que. (*Jr. 1927.*)

References: F. H. Cothran, R. E. Chadwick, M. V. Sauer, W. S. Lee, H. G. Cochrane, J. Stadler.

KINGSTON—THOMAS M. S., of Chatham, Ont., Born at Penetanguishene, Ont., Oct. 11th, 1900; Educ., B.A.Sc., Univ. of Toronto, 1921; 1920-22 (summers), Toronto Harbour Commn.; 1925-26, office engr. for E. P. Muntz Inc., Buffalo, (field engr. for constrn. of The Seneca Iron & Steel, Blasdell, N.Y., and res. engr. on constrn. of D.L. & W. coal trestle in Buffalo); 1926, asst. to divn. engr., Lehigh Valley Railroad; 1926-27, field and office engr. for the Federal Portland Cement Co. during constrn., Buffalo; 1927-28, asst. engr., and from 1928 to date, city engr. and supt. of water works, Chatham, Ont. (*S. 1921, Jr. 1927.*)

References: T. R. Louden, E. P. Muntz, C. H. Mitchell, G. A. McCubbin.

KIRKPATRICK—HAROLD THOMPSON, of Parrsboro, N.S., Born at Advocate, N.S., July 18th, 1896; Educ., B.Sc. (Mech.), McGill Univ., 1920; 1912-15 (summers), running engines in tow boat, surveying lumber and land, etc.; 1915-16, inspection of shrapnel forgings, Candn. Locomotive Works; Candn. Inspection & Testing Labs.; 1918-19, i/c field party and inspr. on reinforced concrete highway bridges, Toronto-Hamilton Highway Commn.; 1920-21, engr. i/c physical testing, Northern Aluminum Co., Shawinigan Falls; 1921-22, senior concrete inspr. on Queenston-Chippawa development, H.E.P.C. of Ont.; 1922-23, foreman on installn. of equipment at Great Falls, Man., Fraser Brace Ltd.; 1923-24, res. engr., bridge dept., Michigan Central Railway; 1924 (Jan.-Sept.), dftsman., Dominion Tar & Chemical Co., Montreal; 1924-25, dftsman., Price Bros. & Co. Ltd., Kenogami; 1925-27, field engr., International Paper Co., Hawkesbury, Ont.; 1927-28, supt. of shops, Canadian Celanese Ltd., Drummondville, Que.; 1928-30, res. engr., LaFrance Fire Engine & Foamite Ltd., Toronto, Ont.; at present, executor of estate, R. E. Kirkpatrick, Parrsboro, N.S. (*S. 1920, Jr. 1924.*)

References: W. S. Orr, B. S. McKenzie, J. B. D'Aeth, C. H. McL. Burns, C. B. Shaw, S. A. Cummiford.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

ALLISON—JESSE GRAHAM, of 5961 Cote St. Antoine Road, Montreal, Que., Born at Cincinnati, Ohio, May 18th, 1903; Educ., B.Sc., Univ. of Southern California, 1927; 1927 to date, estimator with H. C. Johnston Co. Ltd., Montreal, Que. (*S. 1924.*)

References: J. P. Anglin, W. S. Atwood, H. C. Johnston, W. M. Reid, A. L. Harkness.

DILWORTH—EDWIN L., of Montreal, Que., Born at Bowbells, No. Dakota, U.S.A., June 17th, 1902; Educ., B.Sc., Queen's Univ., 1925; 1922, survey work, Dept. Interior; 1923, Wilson Foundry & Machine Co., Pontiac, Mich.; 1924, city survey and inspection, St. Thomas, Ont.; 1925-26, heating and ventilating engr., Buffalo Forge Co., Buffalo, N.Y.; 1926 to date, district sales manager, in charge of Montreal office, Canadian Blower & Forge Co. Ltd., of Kitchener, Ont. (*S. 1924.*)

References: E. A. Ryan, F. A. Combe, F. S. B. Heward, H. G. Thompson, L. M. Arkley, H. H. Snyder.

GOBY—THOMAS, of Bloomington, Indiana, U.S.A., Born at London, England, Aug. 13th, 1899; Educ., B.Sc. in C.E., Tri-State College of Engrg., Angola, Ind., 1925; 1919-20, chainman, rodman, C.N.R.; 1920-22, concrete inspection, C.N.R.; 1924-28 (with exception of 5 mos.), project engr. and senior engr., bridge dept., Indiana State Highway Comm.; 1928 to date, sales engr., The W. Q. O'Neall Company, Crawfordsville, Indiana. (*S. 1921.*)

References: C. H. N. Connell, W. H. B. Bevan, W. A. Ewing, W. G. Perks, C. B. R. MacDonald, S. McIlwain.

GRANT—ALEXANDER JAMES, Jr., of Montreal, Que., Born at Port Colborne, Ont., May 4th, 1904; Educ., B.Sc. (Civil), McGill Univ., 1929; 1923-24-25 (summers), gen. constrn., A. W. Robertson Co. Ltd.; June 1926 to Oct. 1927, dftsman. and field engr., Steel Gates Co. Ltd.; Summer 1928 and from 1929 to date, drawing office and field engr., Dominion Bridge Co. Ltd., Montreal, Que. (*S. 1925.*)

References: E. S. Miles, D. C. Tennant, F. J. McHugh, F. Newell, E. S. Mattice, D. B. Armstrong.

MOOGK—ERNEST GEORGE, 211 Main St. North, Weston, Ont., Born at Waterloo, Ont., Sept. 6th, 1906; Educ., B.A.Sc., Univ. of Toronto, 1928; 1927 (summer), instr'man., with James, Proctor & Redfern, Ltd., Toronto; 1928 to date, asst. in supt.'s office, University of Toronto. (Work includes preparation of plans and specifications for new and alteration work in old bldgs., and direction and supervision of certain phases of this work). (*S. 1928.*)

References: A. D. LePan, W. H. Bonus, G. D. Maxwell, C. R. Young, J. Hvilivitsky, W. D. Proctor.

PATTERSON—IAN STEWART, of 3534 University Street, Montreal, Que., Born at Thomson, N.S., Sept. 21st, 1907; Educ., B.Sc. (Elec.), N.S. Tech. Coll., 1928; 1928-29, test course, and 1929-31, commercial and design work at Toronto, Peterborough and Schenectady, with Can. Gen. Elec. Co. Ltd.; at present, industrial control specialist, Can. Gen. Elec. Co. Ltd., Montreal, Que. (*S. 1928.*)

References: F. R. Faulkner, W. M. Cruthers, W. E. Ross, A. B. Gates, G. Kearney.

TAYLOR—FRANK DENZIL, of East Angus, Que., Born at Barbados, B.W.I., Dec. 1st, 1903; Educ., B.Sc. (Chem.), McGill Univ., 1928; 1928-30, asst. chemist, Canadian International Paper Co., Hawkesbury, Ont.; 1930 to date, mill chemist, Brompton Pulp & Paper Company, East Angus, Que. (*S. 1926.*)

References: J. Tomkins, S. Wang, C. R. McCort, R. DeL. French, E. Brown, G. E. Shaw.

THOMPSON—HARRY ALEXANDER, of Fitzroy Harbour, Ont., Born at Thornton, Ont., Nov. 2nd, 1903; Educ., B.A. and B.Sc. (C.E.), Univ. of Sask., 1927; Summer work: 1924, junior, arch'ts. office, Ottawa Civic Hospital; 1925, instr'man., Geol. Survey, Alta.; 1926, dftsman and timekeeper, bldg. constrn.; 1927, dftsman and estimator, bldg. constrn.; 1927-29, engrg. designer, Backus Brooks Paper Co.; 1929 (Jan.-May), engrg. designer, Fraser Companies; 1929-30, builder and contractor, Toronto; Feb. 1930 to date, engr. on constrn. Chat Falls power development for Morrow & Beatty, Fitzroy Harbour, Ont. (*S. 1927.*)

References: C. J. Mackenzie, H. A. Jones, H. B. Brehaut, J. J. White, T. R. Cooil.

TIMLECK—CURTIS JAMES, of 2190 Northcliffe Ave., Montreal, Que., Born at Pittston, Ont., June 16th, 1903; Educ., B.A.Sc. (Mech.), Univ. of B.C., 1926; 1924-25 (summers), Britannia Mining & Smelting Co.; 1926-28, with Ingersoll Rand Co. Ltd., as follows: 1926, shop work, Phillipsburg, N.J., Easton, Pa., and Painted Post, N.Y., 1926-27, service engr., New York office; 1927-28, service engr., Buffalo office; 1928-29, representative at Rouyn, Que., and from Mar. 1929 to date, in charge of contract service dept., Canadian Ingersoll Rand Co. Ltd., Head Office, Montreal, Que. (*S. 1923.*)

References: H. V. Haight, E. Winslow Spragge, S. R. Newton, A. A. Bowman, G. Kearney, S. Troop, W. H. Powell, S. R. McDougall.

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ENGINEERING REPRESENTATIVE. Experienced civil and mechanical engineer wishes to communicate with engineering or equipment manufacturing firm with a view to becoming Ontario or Quebec representative. Apply to Box No. 334-W.

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SCOTS ENGINEER, 28 years old, desires situation as junior executive or some similar situation. Wide experience in mechanical, civil and hydraulic fields and four years as junior executive; A.M.I.C.E., exam., Jr.E.I.C. Will go anywhere. Apply to Box No. 381-W.

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ELECTRICAL AND MECHANICAL ENGINEER, S.E.I.C., educated Oundle and Manchester, age 24. Student course, Brit.-Westinghouse. Three years design, production, advertising, sales and control of sales force on mechanical and electrical goods. One year outside plant engineering leading public utility company. Desires work in sales, production or engineering capacity. Available immediately. Location immaterial. Apply to Box No. 415-W.

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Situations Wanted

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (McGill Univ. '27), age 26. Fifteen months outside plant engineering with large public utility. Twenty months' sales engineering experience with electrical manufacturing company. Available on reasonable notice. Apply to Box No. 463-W.

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CIVIL ENGINEER, B.Sc., six years experience in paper mill and hydro-electric work, desires position with paper or power company. Paper mill experience covers design, layout, some estimating, and construction. Hydro experience covers preliminary and flowage surveys, transmission line location, design, and six months as resident engineer on construction. Available at once. Apply to Box No. 482-W.

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WEST INDIES, Engineer, A.M.E.I.C., etc. Experience with engineers and contractors, railway, harbour and concrete construction, desires position in West Indies. Apply to Box No. 518-W.

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ELECTRICAL ENGINEER, married, graduate of McGill University, desires position in Ottawa, Montreal or Toronto. Experience includes four summers with a building concern as instrumentman and assistant engineer, two and one-half years with the Canadian Westinghouse Co., this time being distributed between tests, design and sales. At present employed but available on short notice. Apply to Box No. 533-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C., age 32. Seven years general experience in hydro-electric power investigations and construction. Has been in charge of high power transmission lines location, also in charge extension surveys. Experience in office and field. Thorough knowledge of French. Best of references from former employers. Apply to Box No. 537-W.

STRUCTURAL ENGINEER, A.M.E.I.C., B.A.Sc. Wishes to join established firm of consulting engineers. Age 37. Married. Ten years experience design of reinforced concrete and steel on buildings. Two years practical contracting experience. Apply to Box No. 540-W.

CIVIL ENGINEER, McGill '20, A.M.E.I.C., P.E.G., age 31, single. Experience includes general engineering, especially reinforced concrete work, and eight years of pulp and paper mill construction and layout. Best of references. Available on short notice. Apply to Box No. 547-W.

The Sampling of Coal

The sample plays a leading part in a large majority of buying and selling transactions. It enables the qualities of the product to be ascertained and the value of the consignment to be deduced in advance, while it also forms a basis of reference, any departure from which is admitted to be good reason for the rejection of the whole or for appropriate compensation. Thus, steel, wheat, tobacco and many other commodities are all bought and sold in this way without difficulty, and any disputes which may arise in dealing with them are easily confined within very narrow boundaries of both fact and opinion. When, however, we come to one of this country's most important natural resources, coal, the position is different and much more complicated. For coal is not a material of simple composition and, in spite of many attempts, it has not yet been possible to isolate more than a few of its constituents. It therefore follows that a condition precedent to the important task of discovering of what coal consists, is some method of ensuring that the samples tested shall bear some definite and fixed relationship to the whole.

A step towards the achievement of this end was taken some three years ago when, at the suggestion of Dr. C. H. Lander, the British Engineering Standards Association convened a conference of bodies interested in coal, with a view to preparing specifications for its sampling and analysis. A Technical committee, together with a number of sub-committees, was appointed and, with the co-operation of the Fuel Research Board, issued draft specifications covering the export and home markets in July, 1929, and August, 1930, respectively. These specifications, which dealt with both sampling and analysis, were widely circulated for criticism and suggestion both at home and abroad, and the latter (No. 404-1930), has now been issued by the Association.

Turning to the specification itself, this lays down that coal shall be divided into five classes, with ash contents of 6, 10, 15, 20 and 25 per cent respectively. The sample taken for consignments of more than 50 tons shall vary from 40 to 925 pounds, according to the ash content, three weights being specified in each class, depending on the size of the coal. The number of increments taken to make up the gross sample is to be 20, 45, 85, 130 and 185 in the five classes, and these are to be collected by plunging a ladle into a flowing stream of coal when it is being discharged from a chute or by careful selection in accordance with specified methods when it is taken from conveyors or wagons. The coal is then to be crushed, so that it will pass through a ¼-inch square mesh aperture, and reduced either in a riffle or by successive manual quartering until about 10 pounds are left. This residue is next to be crushed, so that it will pass through a sieve with an aperture of 0.05-inch and is again to be reduced until about ½ pound is left. This residue is to be ground until it will pass through a sieve with an aperture of 0.0166 inch and reduced to a quarter of a pound. It is then to be ground again so that it will pass through a sieve with an aperture of 0.0083-inch after which it is to be mixed and bottled for testing purposes. Where the consignments are less than 50 tons the weight of the gross sample is to be half the above figures, the subsequent procedure to be adopted being the same. The methods of analysis recommended in the specification are the simple practical ones used in sound commercial practice and do not call for special comment, except to say that alternative ways of determining the moisture, volatile matter and sulphur are included, and that it is recommended that the analysis on the air dry-coal shall be reported—*Engineering*.

The Modern High-Pressure Locomotive

At no time during the history of the steam locomotive have such radical changes been introduced as during the past ten years. These changes have been introduced more or less simultaneously in countries supplying the locomotives of the world, and have no doubt been stimulated by the competition of electricity and oil engines which offered more efficient, and in some cases cheaper motive power. Twenty years ago it was thought that the steam locomotive had attained practically its maximum development, as it had nearly reached the limits imposed by the load gauge. The radical changes necessitated by the adoption of extra high pressures seem to have opened up a new era. Not only do these changes render possible an increase in tractive power, but they should at the same time increase the overall efficiency.

In Great Britain alone there are 23,000 locomotives, and a sum of approximately £45,000,000 per annum is spent on their maintenance, renewal, and running. Of this sum, nearly £12,000,000, or 25 per cent, is the cost of fuel burnt by these locomotives, and another £12,000,000 has to be spent on their maintenance and renewal. The purpose of the novel forms of locomotive which have been introduced during the last five years has been to effect economy principally in fuel consumption, but the author wishes to draw attention to the importance of the cost of maintenance, and the necessity for designers of new and improved forms of high-pressure locomotives to remember that the expense incurred in maintaining locomotives is equal to the cost of the great quantity of coal which they consume. It will be seen what a large field there is for economy if both cost of fuel and maintenance can be reduced, and what an influence such economy can have on the cost of transportation on railways.

From the early days of the locomotive it has been recognized that increase of boiler pressure results in decrease of coal consumption, but with the conventional type of locomotive boiler this has generally resulted in increasing the cost of firebox repairs, and reducing the life of boilers and fireboxes. When the Rocket was built by George Stephenson a boiler pressure of 50 pounds per square inch was employed, and pressures have gradually increased until now there are many engines running in this country with a boiler pressure of 250 pounds per square inch. Pressures up to 325 pounds per square inch have been experimentally tried for locomotives in Germany and America, but 250 pounds per square inch can be looked upon as approximately the maximum pressure which can be carried in a boiler of the Stephenson type, having regard to the cost of boiler maintenance. It has taken 100 years to increase the pressure of locomotives from 50 pounds to 250 pounds per square inch, but during the last five years pressures have leapt up to 450 pounds, 900 pounds, and now to 1,700 pounds per square inch.

The use of pressures above 250 pounds per square inch has necessitated the design of a completely novel form of boiler built up of tubes and circular drums in which, generally, all flat surfaces have been eliminated. Ingenious means have been adopted for transmitting the heat from the fire to the water. The use of very high pressures, and the consequent high temperature, result in conditions which are much more exacting to the materials used in the construction of the boilers. These conditions are aggravated unless the heat transference is very rapid.

In striving for economy by the use of higher pressure, designers of locomotives are only following the lead which has been set by the designers of large stationary plants and marine engines. Their problem, however, has been made more difficult by loading-gauge and weight restrictions, and for these reasons they are unable to take advantage of condensers, and have had to extend the pressure gradient upwards to a greater extent. It does not necessarily follow that the use of high pressures in boilers is more dangerous than that of low pressures. An explosion of a boiler at a presure of 50 pounds per square inch can have disastrous results, and there is no reason, if proper precautions are taken both in design and maintenance, to assume that there is any greater liability to explosion or failure as a consequence of increase in pressure.

Whilst high steam pressure gives greater economy in fuel consumption, it demands complication in design, and care must be taken that the economies in fuel are not absorbed in the increased cost of maintenance of the boiler and of the machine as a whole. Simplicity of design is an important factor, because simplicity generally results in accessibility. Time alone can prove which of the designs, if any, that have been recently produced, will result in such overhead economies as will justify their general adoption. The results which may reasonably be expected from the use of high steam pressures on locomotives are so attractive that encouragement should be given to the production and development of designs by which these results can be attained.—Mr. H. N. Gresley in *Engineering*.

Radio for Air Pilots

Aids to Safety

The high speed of airplanes and their great dependence on weather make it necessary for pilots to have reliable communication with the ground stations. Bell Telephone Laboratories has been a pioneer in developing radio apparatus for this purpose, now standard on several great airlines. To obtain the necessary data on transmission and reception and to test apparatus in flight, two planes are operated by the laboratories.

Radio installations in airplanes presented many difficulties not met elsewhere. First, it was necessary to reduce generators, transmitters, receivers, antennas and other apparatus to light-weight, small volume, and minimum interference with the plane's operating meters and controls. The apparatus must be absolutely reliable, as it is usually out of reach of the pilot, and repairs during flight are out of the question.

Due to the noise on most planes, mouthpieces of special design are necessary. In the hand-type microphone developed for this use, the rubber mouthpiece is held tightly over the lips and practically all noise is excluded from the transmitter. The closed cavity into which the speaker talks is so shaped as to avoid serious distortion of speech. In some planes it is possible to employ transmitters with much less shielding.

Head telephone receivers similar to those worn by telephone and radio operators may be used in airplanes. A more satisfactory headset has been developed, however, employing a phonette type of receiver originally devised for the hard-of-hearing. These receivers, which weigh less than an ounce, are connected with small ear moulds fitted to the ear of the individual pilot.

Another feature of the headset is required for occasions when it becomes necessary for the pilot to leave the plane in a hurry. It would be quite embarrassing to be dangling by the cord of his telephone headset. This cord is consequently attached by means of a plug which will pull out at any sudden jerk and yet will provide good electrical contact.

Power for both filament and plate supply of the radio receiver is produced by a tiny wind-driven generator only three inches in diameter, weighing seven pounds complete with propeller. This generator, in a stream-lined casing, is mounted on a wing or strut. To generate sufficient power, the propeller must revolve one hundred times a second.

Anyone who has heard the noise caused in a radio receiver by a vacuum cleaner or a violet-ray machine will appreciate how necessary it is to shield the ignition system of the plane's motor. Shielding should include the magneto, the low-tension magneto circuits, the high-tension leads, and the spark plugs.

In addition to the shielding, it is also necessary to bond electrically all metal parts of the plane in order to avoid noises in the receiving equipment from intermittent contacts between metal parts of the plane. If transmitting equipment is installed, bonding is necessary to protect against the possibility of high voltages between adjacent parts producing sparks or arcs.

Two types of radio apparatus are used in planes: a long-wave receiver for the weather and radio-beacon signals sent out by government stations on the band between 285 and 350 kilocycles; and a short-wave two-way radiotelephone system for use in the short-wave region between 1,500 and 6,000 kilocycles.

The transmitter developed by the Laboratories is rated at 50 watts, and weighs 32 pounds, while the long- and short-wave receivers weigh about 13 pounds apiece. In both receivers, remote control is accomplished by means of small units within reach of the pilot. This permits the receivers to be as much as 40 feet away.

To operate the transmitter and receiver the pilot uses a master switch having three positions. In the first position everything is "off"; in the second, which is normal during flight, the receiver is capable of picking up messages; in the third, the apparatus is made ready for transmission. In the third position, reception is still possible, but in order to talk, the pilot must press a push-button which starts the oscillations in the transmitter. This button may be in the hand microphone or on the "stick," whichever is convenient to the pilot.

Many installations of this apparatus have been made on airplanes throughout the country. A large number of ground stations also have been equipped with the 400-watt transmitter and its associated receiver.

Francis M. Ryan in Research Narratives of The Engineering Foundation.

THE

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Breakwater Construction in Port Arthur Harbour

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Paper presented at the Annual General and General Professional Meeting of The Engineering Institute of Canada, Montreal, Que., February 4th, 5th and 6th, 1931.

SUMMARY.—Port Arthur is a harbour of national importance, one of the world's leading grain-handling and shipping ports, and with Fort William, forms the Canadian western terminus of the Great Lakes and St. Lawrence water transportation system.

Two distinct types of breakwater, with their variations, have been constructed at Port Arthur, namely the timber crib and concrete type, and the rubble mound type.

Harbour protection in Thunder Bay began in 1883-1886, when a breakwater of rock-filled timber cribs (a portion of this is still in existence) was built in front of the main part of the town. In 1908 a period of more rapid progress commenced, when a breakwater of similar construction was constructed in the south part of the harbour; this was completed in 1911. At that time a general plan of further development and improvement was prepared and adopted, which will ultimately protect the whole water front from Bare Point on the north to the mouth of the Kaministikwia river on the south, the works constituting a continuous line of breakwaters some five miles in length, with three entrances.

In 1913 the first extension southerly was commenced, nearly 3,000 feet of breakwater being built in that year, and another portion, some 2,500 feet long, in 1914 and 1915. These sections were of the same general type and dimensions as the work completed in 1911 but were placed on a pile foundation. They are not designed as wharves or piers, and vessels do not moor to them.

Later a northerly extension was found desirable and some 7,000 feet of rubble mound breakwater have been built in the northern area of the harbour. This consists of a core of quarry run, covered by an armour course of large trap rock weighing from 4 to 6 tons, an irregularly laid covering which is very efficient in breaking up wave action. A number of settlements have occurred, due to the peculiar formation of the lake bottom, but no serious damage resulted.

The paper gives details of the construction methods employed, both for the timber-crib and for the rubble mound type, and describes the methods of transportation and handling adopted to meet special conditions in the various localities.

One of the chief factors in the growth and progress of a country is the complete scientific and economic development of its natural transportation routes. In this country, the natural advantages of the St. Lawrence river and the Great Lakes, as a means of transporting goods by water, were, partly through necessity, realized from the earliest days. Previous to 1829, the Northwest and Hudson Bay Companies had at least five sailing vessels plying on Lake Superior and trans-shipping cargoes in Thunder bay at the north-westerly end. The first steamer arrived in 1846.

So it may be presumed that, even before the year 1883, when the pioneer cargo of 10,000 bushels of western wheat was loaded on the steamer "Erin" by wheel-barrows and pushcarts, and shipped east, the ultimate possibilities of Port Arthur as a harbour of national importance were to some extent recognized.

Its geographical position on the gently sloping shore of the natural roadstead of Thunder bay near the Canadian western end of Lake Superior, 1,215 miles inland by water from Montreal, was as suitable as could be found, and its location on a slightly crescent-shaped section of water front some 7 miles in length was ideal for the development of the protected type of open harbour.

To afford the required artificial protection, however, extensive breakwater construction has been necessary, and in order that these structures might be intelligently and economically planned, both as to type and location, a thorough knowledge of physical and climatic conditions in the Thunder bay district was a first essential. This knowledge was of great importance also to all those responsibly engaged in their construction.

Physical and Climatic Conditions

Thunder bay itself is a natural roadstead, approximately 15 by 30 miles in extent and capable of providing

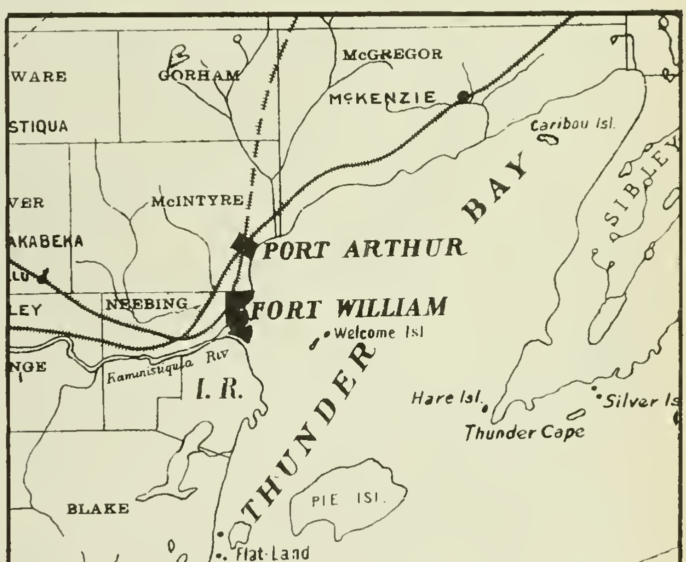


Fig. 1—Location of Port Arthur and Fort William.

secure anchorage for the largest vessels. (See Fig. 1.) The depth ranges from 3 to 49 fathoms. There are no appreciable regular tides, any fluctuations in the water level being the result of rain and snowfall, of heavy continuous winds from one direction piling up the water, and of "seiches" resulting from variations of the barometric pressure on the lake surface. These latter are occasionally of considerable extent, a rise of several feet and a return to normal in a few hours, having been observed at various times.

As the longest effective "fetch" is really only 16 miles, the maximum wave action is not large, 10 feet being the figure that has been used in all breakwater design in the harbour.

The highest recorded monthly level for Lake Superior since 1860 was 604.08 feet above mean sea level in September, 1869, and the lowest 599.9 in April 1926. The average monthly mean from 1860 to 1929, inclusive, varies from 600.10 to 604.08. The greatest annual fluctuation, as shown by the highest and lowest monthly mean of any one year, was 2.67 feet, and the least 0.45 feet.

At present, Canada and the United States, through joint action, by establishing compensating works in the St. Mary's river, at Sault Ste. Marie, at the easterly end of the lake, are endeavouring to control this fluctuation within an ordinary range of 1.5 feet. The highest water usually occurs in the late summer and early autumn months, and the lowest in the spring. The prevailing wind affecting construction during the open season is south-westerly, and often blows with great regularity.

The average navigation season lasts about eight months, opening near the middle of April and closing in December, the earliest opening in recent years being April 7th, 1921, and the latest closing, December 23rd, 1921.

Ice breaking tugs are employed late in the season when the ice is forming, and early in the spring when it is going out, to aid the movement of vessels in the harbour when necessary. The thickness of ice in Thunder bay averages about 36 inches, and depends upon the severity of the winter and the amount of snowfall. January and February are the heaviest ice forming months.

The lake bottom consists of sand, silt and clay overlying rock. Sand, gravel and rock suitable for construction purposes are readily obtainable.

Early Breakwater Construction

Breakwater protection at Port Arthur was considered essential as early as 1883, and in that year the first work of this nature was started. This first structure, completed in 1886, was located in front of the main part of the town at an average distance of one-half mile from the shore, in 11 to 16 feet of water, a location that may have seemed entirely suitable to meet conditions existing and anticipated at that time, but as events have proved, did not provide at all adequately for the future. It was constructed of native timber cribwork, hand-hewn and secured with wooden dowels. The cribs were rock-filled, with a timber superstructure, the whole rip-rapped with large stone on the outer face. It is said that many of these were field stone drawn out over the ice by horses and stone boats. It was built in two sections, the northerly 3,650 feet and the southerly 1,500 feet in length, with an entrance between 350 feet wide. It is still in existence with the exception of the southerly 1,000 feet, which was removed in 1909-1911. The substructure of the section removed was found to be in a good state of preservation. As the remainder is much too close to the harbour line and docks, to meet modern conditions, and as the superstructure is in an extreme state of decay, it will be removed eventually in conformity with the general plan of improvement that has been adopted for the harbour. Its cost was approximately $97.00 per lineal foot.

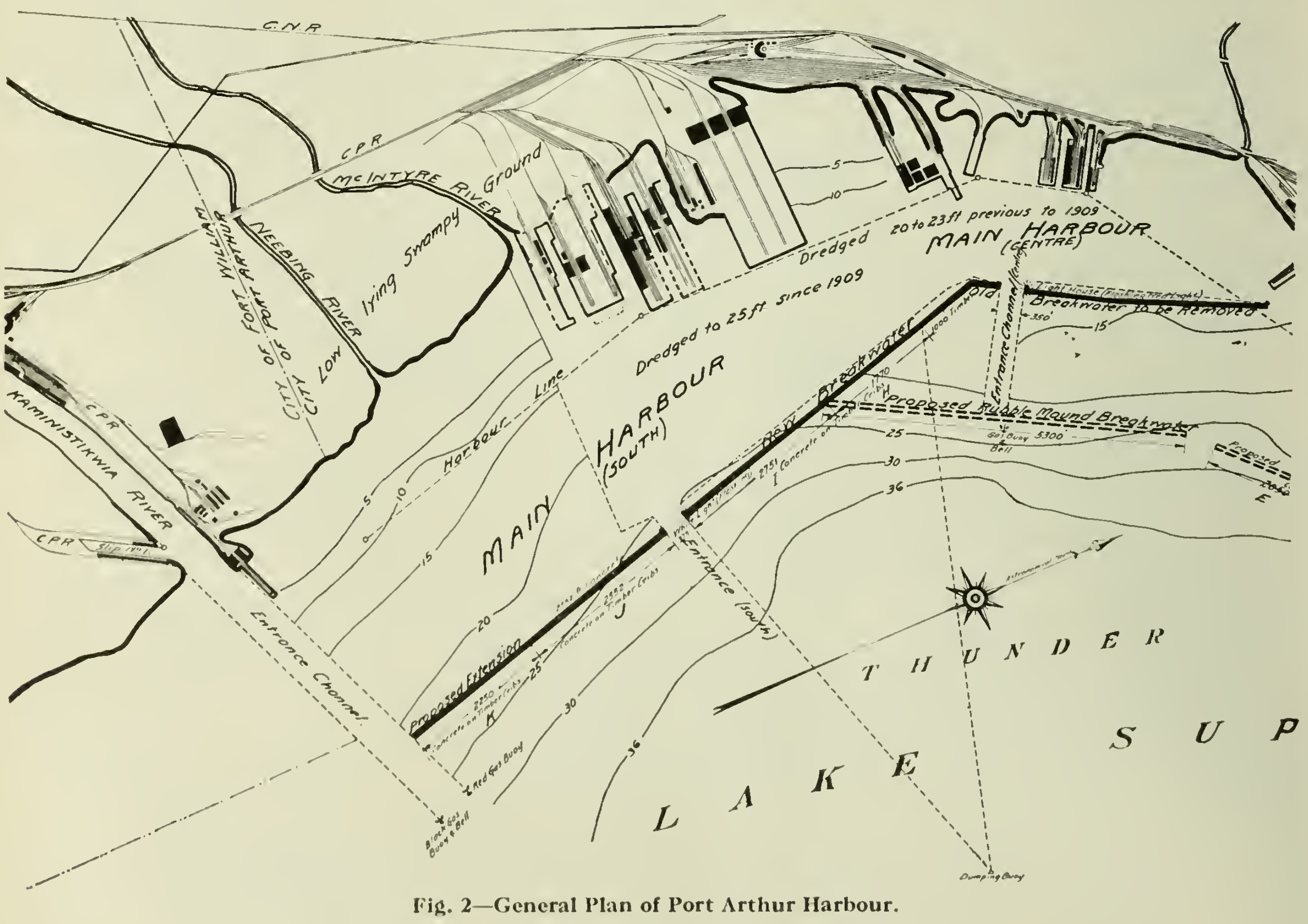


Fig. 2—General Plan of Port Arthur Harbour.

First Breakwater Extension

From 1886, the time when the first or "Old Timber Breakwater" was completed, development at Port Arthur was slow until 1908, when a period of more rapid and extensive progress commenced. As a result, additional breakwater construction was resumed to give protection to industrial plants already located and proposed in the south part of the harbour. This work is 2,780 feet long, 30 feet wide and 8.5 feet above normal water level, with a batter of two to one on the outer face of the superstructure, a slope which experience had indicated as most suitable to meet prevailing wave and ice conditions. The average depth of water was 16 feet. It consists of dimension timber cribwork, stone and gravel filled, with a superstructure partly timber and partly concrete, placed on a natural bottom of sand and clay, after a few feet of the softer overlying material had been removed by dredging to form a crib seat. This foundation was found inadequate, however, as the southerly 600 feet settled considerably, while in course of and immediately after construction. This settlement, besides giving the work a poor appearance, necessitated expensive alterations and repairs. The total cost was over $400,000, or $148 per lineal foot. It was completed in 1911.

General Plan of Development

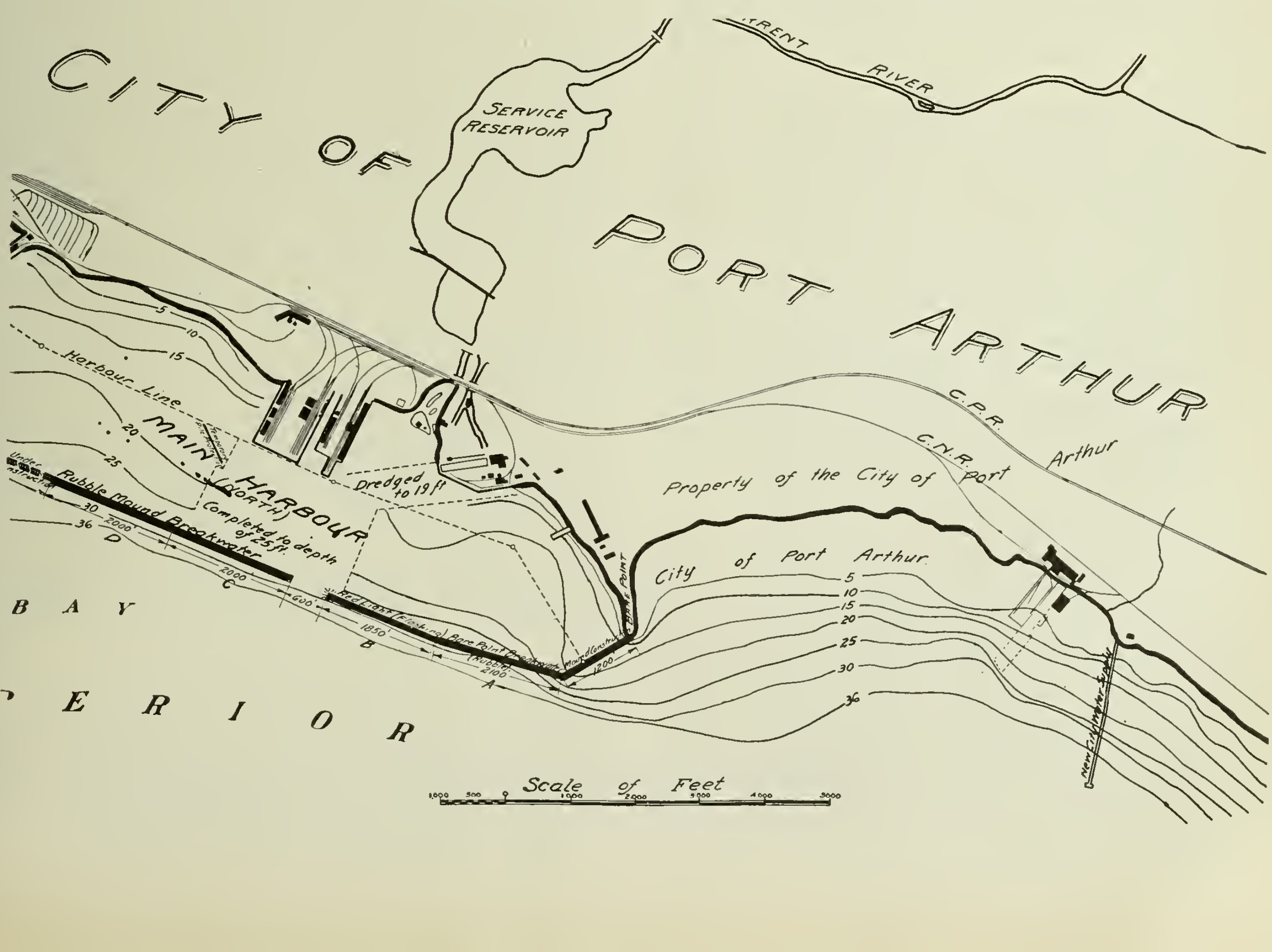
By 1911, it was evident that future harbour work would have to follow some well-defined scheme, and a general plan of development and improvement was prepared and adopted. This plan, in which an endeavour was made to foresee and meet future requirements as far as possible, is intended ultimately to protect the whole waterfront from Bare point on the north, to the mouth of the Kaministikwia river on the south, by a continuous line of breakwaters, with three entrances, as well as the removal of the old timber breakwater, and all dredging necessary for adequate fairways, docks and berths. This means the eventual construction of five miles of breakwater, three of which have been completed. The type chosen was to depend upon the nature of the foundation and prevailing costs of construction.

The general location of the breakwater was governed by the depth of water, for economic reasons, and the distance from the harbour line beyond which no wharf or dock construction is permitted. This harbour line was laid down sufficiently far from the shore line, wherever possible, to allow an industrial and shipping plant of maximum size to be built behind it. In general, an attempt was made to leave at least 1,200 feet between the shore and the harbour line for wharves and docks, and 2,400 feet, or four times the length of the largest vessels, for a basin or fairway between the harbour line and the breakwaters.

The harbour divides naturally into three sections, known as the Main harbour, North, Centre and South, each with its own entrance. It admits readily, in addition, of unlimited future expansion to the north, if and when required. (See Fig. 2.)

Additional Extensions Southerly—Design and Location

As the Main harbour south continued to expand, due mainly to grain elevator construction, the breakwater was pushed rapidly southward, to meet the situation. Two additional sections were built of practically the same general type and dimensions as the one completed in 1911, and on the same centre line, but profiting by previous experience, they were placed on a round timber pile foundation, cut off a few feet above the lake bottom, the cribs having a grillage of longitudinal timbers for bearing, and were riprapped on both sides. One section 2,730 feet in length was built in ten months, February to November, 1913, and the pile foundation was driven and cut off from the ice. The other section, 2,550 feet in length, was built during the summer season of 1914 and 1915, the pile foundation being driven and cut off by a floating plant. The average cost of these two sections was $200 per lineal foot.



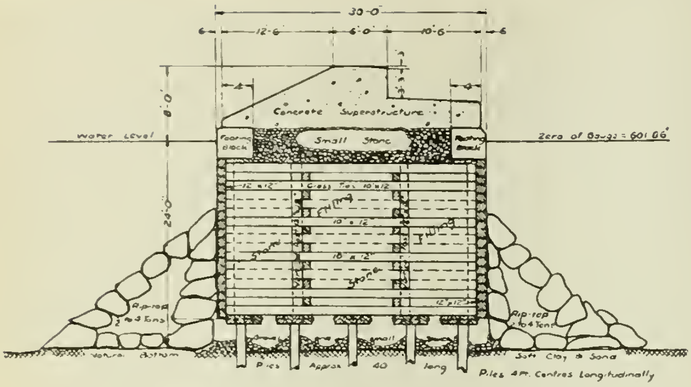


Fig. 3—Typical Section—Concrete Breakwater.

These breakwaters were not designed as wharves or piers, and vessels are not allowed to moor to them.

An additional portion, 2,250 feet long, is still to be constructed before the general plan of development will be completed at the southerly end. The typical section of this part of the work is shown in Fig. 3.

Extensions Northerly—Design and Location

In the meantime a modern ship-building plant and dry-dock was constructed in the Main harbour north, and breakwater extension was consequently necessary there also. The location of the first section having been selected, namely, starting at Bare point and running southerly, the bottom was thoroughly tested by means of wash borings and test piles. These showed that the lake bottom here was particularly unsuitable as a foundation, as it was composed of a thin layer of hard packed sand, a few feet thick, overlying a layer of silt or soft clay, 30 to 60 feet deep, and having no consistency, overlying the rock, as this soft material covered the whole area on which it was possible to locate the work, as it could not be confined, and offered no frictional or lateral resistance for piling, and as unlimited quantities of suitable rock were immediately available, the rubble mound type of breakwater was adopted.

In order to reduce the cost of construction, the design of these structures, which have to withstand only a moderate wave action, but a severe frost action, as well as a heavy scour from the large ice fields moving out and breaking up in the spring, has been made as simple as possible. They consist of a core of quarry run, taking its natural slope, on an average about 1½ to 1, which is covered from below the line of wave and frost action by an armour course of large trap rock, ideal for the purpose, weighing 4 tons and upward on the land side, and 6 tons and more on the lake side, and laid without too much attempt at uniformity provided the core is adequately protected. This irregularly laid armour course has been found to be more efficient in breaking up the waves and withstanding the suction due to recession, than if laid with the uniformity of a pavement, and can be maintained and repaired, if necessary, at much less expense.

The depth of water in which these northerly extensions have been built, with the exception of the first leg 1,000 feet long, connecting with the shore, averages from 24 to 32 feet. In order to reduce the weight as much as possible, the dimensions, particularly in the sections built since 1919, have been reduced to a minimum, a height of 7 feet above normal water level, a top width of 14 feet, and a width at the water's edge of 32 feet, having been found by experience to meet all requirements. A breakwater of this type theoretically, and not taking into consideration the numerous settlements that occurred, has a base of 116 feet in 28 feet of water, and weighs about 110 tons to the running foot, using average weights of approximately 95 pounds per cubic foot of core and 180 pounds per cubic foot of armour stone, weights which were found by actual trial at different times to be fairly representative. Its typical cross-section is shown in Fig. 4.

In practice, this design has been found to be practical and efficient, is permanent, requires little maintenance, achieves its purpose as a breakwater, and considering the very soft bottom the cost is economical.

As had been anticipated, numerous settlements, however, took place, particularly after the core had been brought near to and above the surface. They presented a variety of problems, occurring at times suddenly, so suddenly, in fact, that it was barely possible to save plant and equipment, and at others, slowly. In length, they varied from a few feet to 400 feet, and in depth from 2 to 14 feet. Sometimes the rock went straight down, with a consequent bulge upward and outward at the toe of the slope; at others, it sideslipped to one side or the other, but always with the one inevitable result, namely, more delay to the work and more rock to increase costs. Occasionally they did not take place until long after they were due, which of course compelled the greatest care in carrying on. Usually they gave sufficient warning and could, to a certain degree, be foreseen. If indications pointed to an imminent subsidence, the core was usually constructed higher than grade to make the necessary allowance or to induce the occurrence artificially. Fig. 5 shows a subsidence of this kind.

On one occasion the necessity for doing this formed the basis of a slight but peaceful difference of opinion with the contractors. As a compromise it was agreed to attempt to artificially force settlement by means of a shock representing as nearly as possible natural causes. Accordingly, five cases of 60 per cent dynamite were placed in 16 feet of water at the toe of the slope on each side and immediately opposite each other, and at the station selected, and exploded simultaneously. The results were small and purely local, nor did any settlement occur there at any future time.

From 1911 to 1930, 7,150 lineal feet of this type of breakwater, running in a general southerly direction, to connect with the construction already finished to the south, have been completed. The work has been carried out under contracts let as occasion demanded, to keep pace with the growing demands of the harbour. The cost per lineal foot has varied naturally with the unit prices obtained and the depth of water, and has ranged from $167 to $290.

CONSTRUCTION METHODS—TIMBER AND CONCRETE TYPE—ON PILE FOUNDATION

Foundation—Pile Driving

Before making plans and specifications for a structure of this type, test piles were driven on the centre line of the

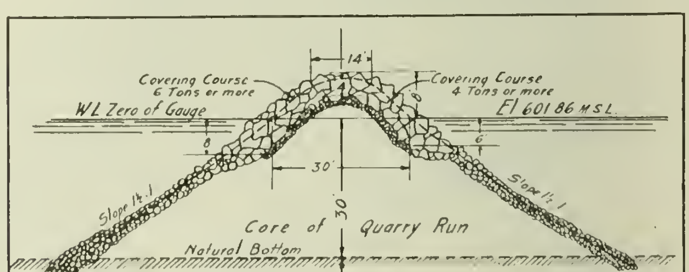


Fig. 4—Typical Section—Rubble Mound Breakwater.

Fig. 5—Settlement—Rubble Mound Breakwater.

proposed location, so that the foundation could be properly designed. The accuracy of the tests was later confirmed by the result of the actual driving. The piles were of spruce, pine and tamarac, varying in length from 30 to 65 feet, and having a least diameter at the cut-off of not less than 12 inches, and at the top, under the bark, a diameter of from 6 to 8 inches, depending on the length. They were driven in bents of five per 30-foot width of crib, the bents being spaced 4 feet centre to centre, longitudinally. They were driven either to refusal or until the final penetration was not more than 2 inches from the blow of a 3,000-pound hammer falling 20 feet. The load per pile was calculated to be 24.5 tons, on the assumption that the timber in the crib supported its own weight and that the stone filling under the cribs and between the bottom chords would support a portion of the weight sufficient to bring the actual loading under 20 tons. The results in any event prove the load was not excessive.

Piles were driven both from the ice in winter, and from a floating plant in summer. Winter work was commenced when the ice had formed to a thickness of 18 inches, and was carried out by three drivers, each capable of a side shift of 15 feet, or sufficient to drive three of the five piles in each bent. Pile centres were marked by 6-inch spikes driven in the ice, but the alignment was carefully checked instrumentally to guard against shifting. Holes for the piles were carefully cut and the latter after being driven to the bottom of the leads, were followed home by a chaser. A minimum length of one foot above the cut-off was left to provide against brooming. An average number of 53 piles, foundation and service, were driven per day. The piling cost from 10 to 14 cents per foot.

Summer work was carried out by one floating driver, and as this plant could only work in comparatively still water, it was used at all times both day and night when weather permitted. The greater part of the work was done from daylight until noon, and from 5 o'clock p.m. to midnight, as the afternoons usually proved too rough. The average day's work was eleven hours, and the average number of piles driven per day was 44. The working hours included towing the driver to and from the work.

Alignment was kept by means of transverse and longitudinal ranges set at sufficiently close intervals and checked by instruments. In all cases a jet was used to start the piles when considered necessary.

Pile Cutting

All foundation piles were cut off on a horizontal plane from 20.5 to 23.5 feet below normal water level, which left the tops projecting from 1.5 to 4 feet above the bottom of the lake. The winter cutting was done by a machine especially constructed for the purpose, consisting of a trussed swinging platform, 14 feet by 55 feet carrying a 30 h.p. boiler, one double drum, double cylinder (8 inches by 10-inches) hoist, one single cylinder (8 inches by 12 inches) driving engine, and vertical leads 40 feet long supporting the shafting and arbor to drive a 40 to 45-inch circular saw. This machine was originally intended to work on bearing timbers laid on the ice, but the ice was so weakened by the pile holes that two rows of service piles had to be driven 15 feet apart transversely and 16 feet longitudinally, to support its weight. The sweep of the saw covered the full width of the foundation.

To place the saw at the proper elevation for cutting, a water gauge was fastened to the arbor, the zero set the cut-off distance from the saw. This gauge was constantly checked.

In order to permit the saw to work, the ice was cut for a width of 27 feet. The removal of the ice presented the greatest difficulty in this operation, the progress being governed by it. The ice breaking was done by means of plows, ice-saws and wedges, the ice cakes being rafted back after enough had been pulled from the water up an inclined platform, by horses, to leave a clear working space. Work was carried on both by night and day shifts, and on an average eleven piles were cut per hour.

Cutting off during the summer season was done by an ordinary scow pile-driver, with one extra single cylinder driving engine, a 3-inch shaft and 12-inch by 15-inch arbor working in the leads to operate a 48-inch circular saw. The saw was kept set to grade by an observer with an instrument mounted on a series of stationary platforms supported on piles, at intervals which gave a maximum sight of 250 feet.

This cutting machine, when operating, was warped lengthwise along a floating fender 110 feet long, anchored longitudinally on the side ranges, and cut twenty-two piles in one move. If it was found that all the piles were not cut, the saw was shifted one foot sideways, and the ground covered a second time. The fender was then moved to the next row of ranges and the process repeated. As the piles were usually all cut in one move, it would appear that they must have been driven with considerable exactness. By

Fig. 6—Finished Portion—Concrete Breakwater.

Fig. 7—Deck Dumping Scow, unloading.

this method, as many as ninety-five piles were cut in one hour, although the average throughout was only sixteen. As absolutely still water was imperative, every advantage was taken of suitable weather conditions during the hours of daylight.

Generally speaking, equally successful results were obtained by the winter and summer driving and cutting, and the respective costs did not vary substantially, although an unusually favourable summer as regards calm weather, undoubtedly contributed to this result.

Substructure

The substructure consisted of dimension timber cribwork, each crib being 100 feet long, 30 feet wide and from 18.5 to 22.5 feet high, with the top 2 to 3 feet below normal summer water level. They were close faced on all sides, with vertical posts or binders, and bottom chords to give a bearing surface on the piles. These chords were so spaced as to allow the crib ballast to run through and fill the space underneath the crib around the piles. All cross ties were through sticks and all longitudinals and cross ties were dovetailed to the face and end timbers. All timbers were thoroughly secured by 1-inch drifts and 1-inch screw bolts of proper lengths. All timber was British Columbia fir, 10 inches by 12 inches and 12 inches by 12 inches in 18-, 20-, 22- and 30-foot lengths.

After the cribs were built on a suitably located platform, to five or six courses, including the binders, and launched, the remaining courses were added, the whole operation taking from three to four days.

As soon as the work permitted, the cribs were towed to position and sunk in place. When light, they floated from seven to eight courses out of water. While being set, they were held in place by means of tackle, controlled from the crib adjacent. They were weighted to their final bearing on the pile foundation, by the concrete footing blocks, approximate weight 9 tons, some 30 to 40 blocks being required for the purpose. In order that the best weather conditions might be obtained, this part of the work was usually done in the very early morning. The operation, on an average, occupied six hours. Very exact preliminary alignment was secured by means of ranges, the final set being checked by a transit. The general result attained was good, as the tops of the cribs were always level, and the driver who made an examination of each crib after it was set, reported that they were all bearing firmly and truly on the piles.

Fig. 8—Rubble Mound Breakwater as Constructed.

The filling consisted of gravel and small stone, the former being put in the bottom to ensure the space around the piles being compactly filled, and on top between the footing blocks to make a good bed for the mass concrete superstructure. Each crib required about 3,100 cubic yards of filling, and it was insisted that each one be at least three-quarters filled before the next one was set. Mass concrete also was not allowed to be placed until there had been ample time for the filling to settle and consolidate.

Superstructure

The precast footing blocks having been placed and lined up, the forms were set for the mass concrete superstructure in 40- and 60-foot lengths, with similar spacing between to ensure breaking joint on the cribs. These forms were in 20-foot lengths, removable without taking down, resting on a waling 8 by 8, secured to the outside of the blocks by bolts running through grooves left for the purpose in the ends. Further, a concrete core, running the full length of the form, approximately 9 feet wide and 2.5 feet high, was first poured down the centre, which had the effect of lessening the quantity and ensuring that each form was poured in one run, of helping to pack the concrete more firmly against the somewhat flat outer slope and of forming a solid anchor to which the forms could be very rigidly wired.

Fig. 9—Dumping Cars from Scow.

The concrete was mixed on a floating plant and placed by means of chutes. The mix was specified as 1:3:5, the sand and gravel aggregates were carefully selected and proportioned, and every effort was made to secure a dense, impervious mixture, a monolithic finish, and a tight bond with the blocks on the outside faces. Considering the difficulty of doing this, without extreme delay and additional cost in a very open and exposed position, the results, for the greater part, were good, as is evidenced by the fact that very little deterioration has taken place since the work was completed. The appearance of a finished portion of the timber and concrete type is shown in Fig. 6.

CONSTRUCTION METHODS—RUBBLE MOUND TYPE

Four different sections of the rubble mound type have been completed from 1911 to 1930, differing considerably not so much in general design, as in the plant and equip-

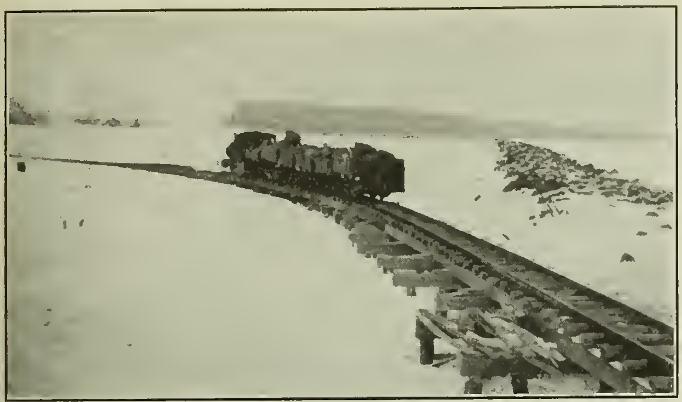


Fig. 10—Work Train on ice.

ment employed, and the manner in which they were constructed. As these changes were the combined result of different conditions, greater labour costs, more modern methods and a species of evolution based on local experience, a brief description of each as a separate unit will be given so as to indicate the difficulties encountered and the results obtained.

The first contract let in 1911 called for the construction of 3,200 lineal feet of rubble mound breakwater, starting at Bare point in the Main harbour north, and running in a southerly direction with an angle 1,200 feet from the shore. The plan and specifications called for a height above low water level of 8 feet, a width at the water line of 48 feet, and side slopes of 1½ to 1, the whole composed of three classes of stone, as follows, paid for at different unit prices:

1. Core of quarry run to 8 feet below water, 50 per cent not less than 1 ton.
2. A protecting course on top and sides of large rubble stone—4 to 6 tons—30 per cent not less than 6 tons.
3. A covering course of 3 to 3½ feet thick over the top, formed of large closely laid stone, 6 to 10 tons, 50 per cent at least 8 tons, and 25 per cent at least 10 tons.

As soon as the first settlement was encountered this classification was found to be impracticable, as the first two classes then merged and as a result the higher price was paid for stone occupying the quarry run position, so consequently, by agreement, the second class was eliminated.

As Bare point, at that time, consisted of rocky bluffs with no buildings adjacent, it was decided to open a quarry there and built the inner half by train-filling from a trestle. Three derricks were set up, and the stone, trap intershot with shale, was chained, shovelled and manhandled, labour being cheaper, into scale boxes, deposited into dump cars having an average capacity of 8 to 10 tons, hauled over a trestle to the work by dinky engines, and dumped. The trestle was kept about 400 feet ahead of the fill. By this means the structure was brought up to approximately the right size and shape, room still being left for the covering course. The average length of haul was 1,800 feet.

The tare of the core rock handled in this way was obtained by passing the trains over a 40-ton Fairbanks scale, sufficient loaded cars being weighed to give a fair daily and monthly average.

At the same time, starting at the outer end, rock was brought and placed in the work by pocket dump scows and side-dumping deck scows. For purposes of alignment over this section, four trestle bents, 130 feet wide, 20 piles to a bent, were driven at right angles to the centre line, approximately 400 feet apart longitudinally. On these, the centre line width at water's edge, and toe of slope, were marked by flags. These bents were carried away by ice each spring and had to be renewed. Heavy concrete anchors were set also at proper distances on each side of the fill and marked by buoys so that the scows, which were equipped with winches at each end, could be placed and held in position while being dumped. The weight of the rock handled by the deck dumping scows was obtained by displacement. In the case of the dump scows, an actual determination on a large scale was made to get a transposition factor from yards to tons. This factor, 2,530 pounds per cubic yard of stone, loose, was satisfactory at this time as the rock in the quarry was very uniform.

The pocket dump scows were of the usual type. The deck dumping scows. meant to handle larger stone, were 110 feet by 32 feet with a draught of 7 feet. They required a depth of from 10 to 14 feet, depending on the load, in which to dump. The decks were protected and friction minimized by strips of iron sheathing running transversely. When the stone was not too small they worked very successfully and dumped rapidly, although some time was occupied in lining them up and securing them in position. (See Fig. 7.)

These scows were built with three compartments running longitudinally. Into either of the side compartments the water could be admitted by two 10-inch pipes located 1.5 feet above the bottom and controlled by valves operated from the deck. The weight of the water when one compartment was filled depressed that side sufficiently to allow the load to slide off, after which the valves were closed and the scow pumped dry. Gauges were set at each end in the centre compartment, and as the scows had been carefully measured and tables prepared, the tare load was easily and closely obtained. As the scow method had to be abandoned when the rock was brought to a depth almost equalling their draught, the work had to be completed by the shore quarry and trestle-fill method. Work proceeded from May to December each year and the contract was not completed until September 1915, a length of 3,330 feet having been constructed in the four years during which operations had been carried on. Fig. 8 shows this type of breakwater.

Extension 1919-22

In 1915, owing to the war, all permanent breakwater construction was suspended until July, 1919, when a further length of 1,600 feet, increased later to 1,850 feet, or to the northerly side of the north entrance, was put under contract. This addition was built in 28 feet of water and had a top width of 16 feet, a width at water level of 48 feet, a height above water of 8 feet, and side slopes of 2 to 1. The cover course extended downward on each side as far as the limit of wave action, or 6 feet vertically on the inside and 8 to 10 feet vertically on the outside or lake face. Both core and cover rock were paid for under one unit price.

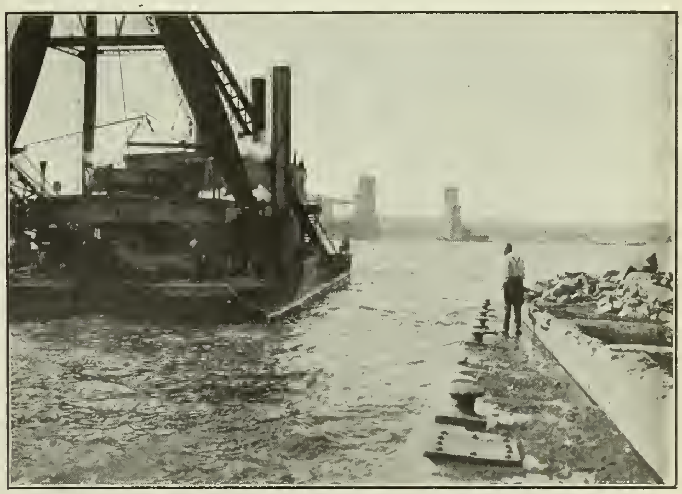


Fig. 11—Derrick Dredge.

Fig. 12—Five-fingered Grabs handling cover rock.

After some investigation, the contractors decided to utilize the partially developed quarry at Bare point, which was the closest available. The rock in the portion of the quarry now brought into use was very heavy trap interspersed in places with thin layers of shale. This shale was always carefully dumped below the limit of frost and wave action. The quarry face varied from 10 to 30 feet, and a level seam or floor of shale, fortunately encountered at a suitable elevation, formed a natural bench as a guide to drilling and blasting.

A portion of the quarry was covered with an earth and boulder overburden varying from 1 to 8 feet thick. This was shot and deposited in the work with the rock, it not being considered necessary to strip it as it was not in sufficient bulk to begin to fill the voids in the core. Care was taken, however, to dump rock containing it in deep water and at spaced intervals so that there would not be any undue accumulation in one place. This overburden was trenched also and cross-sectioned, and the weight of earth deducted in making up quantities for payment.

Drilling was carried on during the winter months in order to have a sufficient quantity of blasted rock on hand in the spring to ensure that the summer drilling could keep pace and allow the work to proceed without interruption from this cause. The whole face was shot at one time and the holes were so spaced and loaded that the rock was broken into a suitable size for handling with a steam shovel. Air drills were used, and the holes, after being sprung, were loaded with about 7 pounds of 60 per cent dynamite to the foot. The cover course was obtained from the talus lying at the foot of the bluffs on Caribou island, some 15 miles distant. This rock was loaded by land derricks onto derrick scows, which after being towed to the work. placed their own loads in position. This placing was done by chaining, the scows working, whenever possible, on the lee side. The tonnage was obtained by displacement and on one occasion when the scales were used as a check, the error was found to be well within allowable limits, or one in one hundred.

The core rock, after drilling and blasting, was loaded on side dumping cars of 6 to 7 tons capacity, by means of a steam shovel with a 2½-yard dipper, and conveyed to the work. This was done by three different methods at different times. During the summer seasons and until the core had reached an elevation that made it impossible, two flat deck scows were used, fitted with tracks capable of accommodating eight cars on each side. A dock, or slip, protected by a temporary pile breakwater, was constructed as near the quarry as possible, and into this the scows were pushed endways. A specially devised drawbridge, adjusting itself to the change in level as the trains were run on the scows, made connection between them and the shore. The cars having been hauled from the quarry and placed on the scows, were chained to the deck and a tug towed the scow to the site of the work. An average net load of rock was 90 tons and the length of tow was less than one mile. The sixteen cars were tripped from the ends towards the centre and both sides simultaneously, as shown in Fig. 9, the whole operation taking about one minute. As this dumping could be performed so quickly, it was found that, under ordinary weather conditions, the scows, once manœuvred into position by the tugs, could be unloaded without anchoring. The whole process of loading the scows, towing to the work, placing in position, dumping and returning empty, averaged twenty-five minutes, or much less time than required to load the two eight-car trains at the quarry.

During the first winter, the experiment of laying a railway on the ice was tried. After the ice had formed to a thickness of 14 inches, some 3,000 feet of steel carried on 12-inch by 12-inch stringers, 20 feet long, with 2-inch by 6-inch cross-ties or sleepers 6 feet long, was laid on the ice from the shore to the work, where it was led on to a pile trestle driven on the centre line. This method was adopted mainly to avoid snow but was difficult to keep in alignment. The snow, however, did not cause as much trouble as had been anticipated, and it would appear that under similar conditions a better method would be to lay the steel on standard ties placed directly on the ice. Trains were run over this track when the ice had thickened to 24 inches, as shown in Fig. 10.

The equipment consisted of four small 20-ton locomotives, 36-inch gauge, and the side dumping cars used during the summer. On account of the grade from the quarry to the shore, which reached 6 per cent in places, each train was limited to eight cars. The gross weight per car was 12 tons, which, with the weight of the engine, gave a total load of 116 tons distributed over a length of 120 feet. This method presented little difficulty, and during forty-six actual days worked between January 27th and March 24th, a very good performance for that time of year, 48,181 tons of rock were placed, giving a daily average of 1,050 tons loaded on 157 cars, or an average net weight of 6.7 tons per car. The best day's work was 206 cars, with a net load of 2,021 tons. As time was not a paramount object, as the number of days the ice was sufficiently thick, in spite of a severe winter climate, was limited, and as extra expense was involved in laying, maintaining and salvaging the track, this experiment, while successful, was not repeated.

After the core had been brought to an elevation 10 to 12 feet below the surface, or a depth in which the scows could not be unloaded with safety, the train-fill from a trestle operation employed on the first section, had to be adopted again and continued until completion. The

Fig. 13—Train loading old Beach Deposit for Core.

Fig. 14—Loading Scows from train by chute.

rolling stock consisted of three engines and 50 cars, a train averaging six cars, with a gross weight of 75 tons and a net weight of 40 tons. A fair daily average was one hundred and seventy cars of 6.5 net tons each, although as many as two hundred and sixty were dumped in one day. The best month's run was 26,000 tons.

About sixty men were employed on an average, about 60 per cent of whom were skilled labour. The items making up the greater part of the actual construction costs, outside of equipment, were coal, powder and labour. This contract was finished in October, 1922, three years having been required to complete it.

Extension 1923-26

The breakwater already constructed at the northern end of the harbour gave fairly adequate protection against the winds from the north and east, but not any against those from the south, which are more prevalent during the open season, consequently it was necessary to continue construction southward, and a new contract was let late in 1923, starting on the south side of the north entrance, and running on the same alignment, for 2,000 feet. Guided by experience, the cross-section was considerably reduced, its general dimensions being as follows:—Top width, 14 feet, width at water's edge, 30 feet, height above mean level, 7 feet with side slopes of 1½ to 1. The general lake depth here was 29 feet. This cross-section, while not so imposing in appearance, answers all requirements.

A new method of obtaining the rock was attempted with success. A dipper dredge working in suitable selected locations in shallow water along the shore, and digging in boulder deposits, or the talus fallen below water from the bluffs adjacent, loaded this material into dump scows, which were towed to the work, lined up and dumped in the usual manner to form the core. The length of haul varied from 7 to 30 miles. The dipper of the dredge was bored and slotted so that when fines or overburden were encountered, they could be washed out by raising and lowering the dipper several times through the water, with a satisfactory result, although the rate of loading decreased.

After the core had reached the elevation above which scows could no longer be used, the method of placing was necessarily different, as the impossibility of bridging the north gap, or crossing the fairway, precluded the use of a train. As a substitute, a powerful clamshell dredge, equipped with spuds and a long boom, was anchored bow on to the breakwater, and working along the centre line, clammed the material placed by the scows in the deeper water left on one side and transferred it to the other, thus building up the core to the section specified. This machine, with its winches and cables, was also used to align the dump scows and hold them securely in position while being dumped. It was employed also to make a berm on each side as a base for the lowest underwater course of covering rock.

As this clamshell or derrick dredge performed so satisfactorily, on this work, in so many different ways, the following general description is given: The hull is steel, 44 feet wide, 100 feet long and 10 feet deep, with a draught of 6 feet and a registered tonnage of 619; the main engines are 16 by 18, the swinging engine 10 by 10. She carries two transferable steel booms 75 feet and 45 feet long, respectively, and is equipped with two Scotch marine boilers 8 feet 6 inches by 12 feet with a steam pressure of 127 pounds. The anchors are 60 feet long and the anchor engines 8 by 8. (See Fig. 11.)

The rocks forming the armour course, which consisted of the larger boulders and larger pieces of talus rock, were collected along the shores within a radius of 75 miles, by a double derricked barge, with specially constructed 5-fingered grabs and whose normal capacity was 630 tons. (See Fig. 12.) The cover rock was unloaded also by means of these grabs, each one being securely placed before being released and very few were lost. All rock was still paid for by one unit price per ton in the work. This contract was completed in September, 1926, an average quantity of 300,000 tons having been placed during each of the two years worked in which work was actively carried on.

Extension 1928-30

The fourth or last extension followed the lines of the previous one, and had the same length and alignment. The following points of difference between it and its predecessors may, however, be given.

The use of an old beach deposit, consisting of small boulders and a very coarse gravel, was permitted as a core, as shown in Figs. 13 and 14. This material was loaded by a steam shovel into trains which were hauled to a chute and unloaded into dump scows, which were towed to the work and dumped. The haul from the quarry to the chute averaged a mile and a half, and the tow from the chute to the work averaged 13 miles. Instead of the clamshell dredge before-mentioned, the core material was rehandled to build up the required section by an ordinary dipper dredge, making transverse cuts and piling up on each side.

The core and the armour stone were paid for under two separate unit prices, the former by the yard and the latter by the ton. Very extensive settlements, greatly delaying the work and increasing the quantities, were encountered. This extension was commenced late in 1928 and completed in 1930.

General

Generally speaking, the situation met with in this north end rubble mound breakwater construction at Port Arthur resolved itself into depositing sufficient rock on a very soft foundation, until the material, after frequent settlements, compacted this underlying material to such an extent that it would bear the superimposed load. No other method seemed feasible. The use of a mattress, while seriously considered, was deemed impracticeable, as the very soft material forming the foundation covered too large an area. The extent of this soft material, both laterally and in depth, and its very soupy nature, also precluded the possibility of dredging to firmer strata.

Outside of procuring, handling and placing the rock, the main features contributing to economy of construction, were the nature of the core material, with due regard to its cost, and the necessity of not leaving any of the smaller rock above water unprotected in the fall, as it would be displaced and lost by the ice. Almost any material not too light, from a coarse gravel up, will do for the core fill below the limits of frost and wave action. Three samples of shale were actually tested, with the following results:—

	No. 1	*No. 2*	*No. 3*
Specific gravity	2.67	2.66	2.66
Weight per cubic foot	165.00	165.00	165.00
Pore space, per cent	3.21	1.46	2.08
Ratio of absorption, per cent	1.22	0.54	0.84
Coefficient of saturation, 1 hour	0.91	0.98	0.82
Coefficient of saturation, 2 hours	0.15	0.01	0.02

0.80 being considered the maximum co-efficient of saturation that could be allowed.

A system of rigid inspection of all phases of the operations, was always maintained, and every effort was made to secure economy, both in material and methods of handling and disposal.

The only description of a similar structure, obtainable when the work began, was a paper entitled "The Breakwater at Buffalo, New York," by Emile Lowe, Member of the American Society of Civil Engineers, contained in the Transactions of that society for 1904.

All the breakwater construction at Port Arthur was carried out by contract, under the supervision of the engineering staff of the Chief Engineer's Branch of the Department of Public Works of Canada, who were responsible also for the design and preparation of all the necessary plans and specifications.

Discussion on "Breakwater Construction in Port Arthur Harbour" Paper by F. Y. Harcourt, M.E.I.C.[1]

G. E. Bell, m.e.i.c.[2]

Mr. Bell observed that the paper had been of great interest to him, because he had had some connection with thd breakwater construction at Port Arthur during the last two or three years. The author deserved a great deal of credit for employing the material that had been used in the last section of the breakwater. The beach deposit to which he referred on the last page of his paper was material readily accessible to the breakwater, and the department had been able to place it in the breakwater at a very economical figure.

The author had made reference to the settlements which had occurred. These settlements were very extensive, both in the last section constructed and the section constructed previously. To anybody familiar with conditions in that locality it would readily be seen why these occurred. The bottom of the lake was of very soft material and the hard material was at considerable depth. Settlements, however, were just about the same in the last section as in the previous one. The actual quantities in the last section did not differ greatly from the estimated quantities, the difference being only about ten per cent. The settlements, occurred altogether during construction. At times the breakwater was brought up practically to completion—for a length of a hundred feet or more—before a settlement occurred. Generally it was found necessary to pile up the core to 5 or 6 feet or more above the surface of the water level to provide for settlement. The general plan was to bring the core up as high as possible to force the settlement, so that the more expensive cover stone would not be lost. There were a few thousand yards of cover stone lost on the last section. Although it was possible to recover some, most of it had settled into the interior of the core and could not be reclaimed. This settlement in some cases amounted to as much as 12 or 14 feet, for a length of perhaps 300 or 400 feet, but this was probably the most extensive. Since the breakwater had been completed no further settlement had taken place.

H. B. R. Craig, m.e.i.c.[3]

Mr. Craig considered the paper an excellent one. There were, however, a few points which might possibly, with profit to other engineers, be somewhat amplified.

(1) Regarding the costs of the various types of breakwaters built, could the author give the detail unit costs and quantities of materials that obtained in the different contracts, with the dates of contracts? The unit costs per foot of completed structures were given only, and the value of the paper to harbour engineers and others would be enhanced in this way. It would be better still if the rates of labour paid on the different contracts could be given, but such data might not now be readily obtainable.

(2) As to the design of the breakwaters, it was presumed that the Stevenson formula for wave-blow was used. It was to be noted, however, that at certain other points on the Great Lakes on both sides of the International boundary, where there was a much greater exposure or fetch, breakwaters of somewhat similar design but of smaller cross-sections had been built and had apparently withstood for years the effects of storm-waves. The first rubble mound breakwater built at Port Arthur was 8 feet high above low water level and 48 feet wide at the water level. Twelve years later the design was changed so as to call for a top width of 14 feet, with width at water level 30 feet, and a height above mean water level of 7 feet. The maximum exposure was about 40 miles, from Isle Royale. An example of a rubble mound breakwater with several times that exposure, was that of the structure completed a year ago at Port Burwell on Lake Erie. This was built of rock of somewhat similar sizes, both armour and core, to those used at Port Arthur, the armour stone being obtained at Milton and Queenston, while the core stone came from the former quarry in part, and also from a softer rock quarry at Beachville, Ont. None of the softer or more friable rock was permitted to be placed above the action of frostline, and then only in the core. The Port Burwell breakwater was built with a top width of 12 feet only and to a height of 9.5 feet above low water level, a settlement of about 1 foot being anticipated. It was built to a slope on the lake side of 1½ to 1, and on the harbour side of 1 to 1. There was at all times, but particularly during storms, a heavy race from the west along the lake face, and it would be interesting to see how this rather smaller section of rubble mound breakwater stood up, as compared with other breakwaters of a similar type of construction, having in mind of course their respective locations with respect to exposure, currents, etc. Possibly, the Port Arthur breakwater sections might have been somewhat reduced from the standpoint of economy, but doubtless the designing engineers took into account the exceptionally soft bottom at Port Arthur together with the fact that

[1] This paper was presented at the Annual General Meeting of The Institute, Montreal, Que., 1931, and appears on page 215 of the April, 1931, issue of The Journal.

[2] Assistant to Managing Director, M. J. O'Brien, Ltd., Ottawa, Ont.

[3] Consulting Engineer, London, Ont.

suitable rock was so conveniently available to the site of the structures. He believed that at no other point on the Great Lakes was suitable rock for harbour works so economically obtainable as in the vicinity of Port Arthur and Fort William.

(3) It would be of interest from an historical standpoint if there were published with Mr. Harcourt's paper a plan showing the harbour as it was before any artificial works were developed.

F. Y. Harcourt, M.E.I.C.

The author, in reply, stated that as regards design, Stevenson's formula had been used. The normal fetch was about 16 miles, causing a wave approximately 6 feet in height. One narrow passage coming from Isle Royale was somewhat over 40 miles in length and when a storm came from this direction, which was very rarely, a 10-foot wave height might be encountered. The formula was of more theoretical than practical interest and really had very little to do with the design.

The rubble mound breakwaters at Port Arthur were built largely with 1½ to 1 slope on both sides, as this was the slope which the rock naturally took when placed in the work. No undue effort was made to keep exactly to this slope. This lowered construction costs. As Mr. Craig surmised, the exceptionally soft nature of the bottom, together with the fact that very suitable rock was conveniently available to the site, covered that phase of the design.

When the paper was written, the question of including details regarding costs was considered, but it was thought that to do so would lengthen it unduly.

The first concrete breakwater built was not a fair example from which to draw conclusions as to costs. The second and third extensions, built in 1913, 1914 and 1915, were of similar construction and the unit costs were very much the same in each case. The second extension was constructed by the Port Arthur Construction Company, during the summer seasons of 1914 and 1915. The piling used in the foundation varied in length from 30 to 60 feet, and the cost from 10 to 14 cents per lineal foot. The contract unit cost for piling, placed, driven and cut, was 35 cents per lineal foot. One hundred and twenty-five thousand lineal feet were driven.

Timber, practically all B.C. fir, 10 × 12 and 12 × 12, and in lengths varying from 12 to 22 feet, cost $26 and $28 per thousand feet, delivered. The iron cost about three cents per pound. Crib-filling, largely coarse gravel, although some small rock was used, came at about 85 cents per cubic yard. Crib-work complete, 60,000 cubic yards, filled and set in place, cost $4 per cubic yard. The unit price for mass concrete was $6 per cubic yard, including cement, which cost $1.70 per barrel. Eleven thousand cubic yards were placed. The cost of concrete aggregate, sand and gravel, approximated $1 per cubic yard. The total cost of this particular section, 2,500 feet long, was $514,000, or an average of $200 per lineal foot.

The figures for the first rubble mound breakwater, commenced in 1911, would not give representative costs, as the first two-fifths was constructed on a hard bottom and settlement did not occur; it was settlement which eventually determined the cost. It was constructed between September, 1911, and October, 1915, at a total cost of $557,000, or $132 per lineal foot for the 3,330 feet. The first extension, built 1919 to 1922, Messrs. Chambers, McQuigge and McCaffrey, contractors, was 1,850 feet long and had one unit price, $1.44 per ton, including cover rock. The final quantity placed was 380,000 tons at a total cost of $531,000 or $287 per lineal foot. The settlement in this case was not so great as had been expected.

The second extension, 1923-26, 2,000 feet in length, was built by the Canadian Dredging Company, at a unit price of $1.20 per ton, including cover rock. The total quantity of rock placed amounted to 620,000 tons and the total cost was $744,000, or $372 per lineal foot. The settlement in this case was very extensive, amounting to 100 per cent. The use of a finer material for the core and the handling of this material by dredge and dump scow, accounted largely for the decreased unit cost.

The last section, also 2,000 feet long, was completed last year by Messrs. Chambers, McQuigge and McCaffrey, contractors, and the unit costs were further reduced by the use of a still finer material for the core, which enabled it to be handled by a steam shovel and dump cars onto the dump scows. Unit prices were $1.12 per cubic yard for core material and $1.75 per ton for the large cover or armour rock. Settlement in this section was very extensive, also over 100 per cent.

H. J. Lamb, M.E.I.C.[4]

Colonel Lamb remarked that the author of the paper was to be congratulated on the clear and concise manner in which he had described the work. It was obvious that the dominating factor in the designing of the breakwater was the extremely soft character of the bottom. Not only was it extremely soft, but the depth of it, sometimes as much as 42 or 43 feet, made it very difficult to estimate with any degree of accuracy what the quantities were likely to be. As the last speaker had said, the settlement was extremely heavy in spots. As a matter of fact, the exact settlement in quantities in the last section of 2,000 feet was between 123 and 124 per cent. In the estimates it was figured that it would be at least double, and as Mr. Bell had said, these were not far out.

In designing the proposed extension southward to the last 2,000 feet, described in the latter part of the paper, it was proposed to construct the core, from a depth of about 6 feet below water level to the cover, of quarry run instead of beach material which was spoken of in the paper, and of which the entire core was built in the last 2,000-foot section. The reason for that was that it was found that should heavy seas arise before the cover stone was placed, the beach material was apt to be washed over. There would be less liability of wash with the use of quarry run. Finally, the best proof that the design had been successful was the manner in which the structure had stood since it was completed.

J. G. G. Kerry, M.E.I.C.[5]

Mr. Kerry asked whether the various designs described by the author had proved satisfactory, and could any useful conclusions be drawn from the experience obtained with them.

A. Gray, M.E.I.C.[6]

Mr. Gray enquired if any damage had been caused by storms. It would appear from the paper that even the portion of the breakwater completed in 1886 was still intact, with the exception of 1,000 feet removed in 1909 and 1911.

The author had placed the longest "fetch" at 16 miles with a maximum wave action of 10 feet. Surely with a storm producing 10-foot waves, considerable damage must, at some time, have been caused to the various structures. The only mention of any serious difficulty was in connection with 600 feet of the portion of the breakwater completed in 1911, which was said to have settled consid-

[4] Supervising District Engineer, Department of Public Works, Canada, Toronto, Ont.

[5] Messrs. Kerry and Chace, Toronto, Ont.

[6] Chief Engineer and General Manager, Saint John Harbour Commission, Saint John, N.B.

erably in the course of, and immediately after, construction. This evidently was caused by founding the breakwater on a soft bottom of sand and clay.

It would appear that the difficulty in obtaining a suitable foundation for a timber breakwater on piles was the governing factor in deciding on the rubble mound type of breakwater. In constructing a breakwater of such length as that under discussion, it was quite reasonable to expect varying foundation conditions.

In Saint John harbour, the Negro point breakwater, of a length of 2,250 feet, was originally built of timber cribwork, protected on the outer slopes by rubble mound. This was built between 1875 and 1877, and had a full exposure to the Bay of Fundy from the Atlantic ocean; the maximum storm waves, so far as they could be reasonably estimated, never exceeded 10 feet from trough to crest. Observations over a period of years with a dynamometer showed a maximum wave pressure of about 4,000 pounds per square foot.

Thirteen hundred feet of this original breakwater had been carried away by a storm in 1879. The breakwater was afterwards repaired by placing the stone on the seaward side to a uniform slope of three to one. On the top of the rubble mound a concrete superstructure 15 feet in width and of a length of about 946 feet was erected. This was gradually disappearing, both by the action of storms and the gradual disintegration of the concrete. At the end of the breakwater a light-house had been erected and protected by concrete blocks, each weighing 60 to 80 tons. The light-house and all these blocks had now disappeared. Storms had gradually pushed forward the crest of the breakwater at the outer end for a distance of 35 to 40 feet off the centre line. The outer slopes had been raked down and were now standing at a slope of about six to one.

There was also a breakwater within the harbour, protecting the entrance to Courtenay bay, but this did not have the exposure of the outer breakwater.

The first portion of this breakwater, a length of 4,570 feet, was completed in 1916. Covering stones weighing 10 to 12 tons were carefully laid. A storm in October of 1917 displaced quite a number of these, some of them being moved over 50 feet from their original positions. The breakwater was afterwards extended an additional length of 2,500 feet, and the slopes on the outer end on both sides were three to one, laid random. The experience with breakwaters in Saint John had been that heavy stones laid random made a much more economical and efficient covering than if carefully laid on their beds.

The construction of the Port Arthur breakwater would appear to have been favoured with many natural advantages. There had not been very much delay through weather conditions, the work having proceeded through both the winter and summer seasons. More severe conditions, on a sea exposure, such as Saint John has, would undoubtedly add considerably to the cost of the work.

It would be interesting to know if there had been much accretion on the coast line, anf if the breakwater had been designed to prevent this.

F. Y. Harcourt, m.e.i.c.

The author, in reply, said that there had been no accretion at Port Arthur. The 10-foot wave was, of course, an extreme possiblity, while a 6-foot wave was the one to be expected in severe storms. All the concrete structures on a pile foundation, and the rubble mound structures, were still intact, and had never suffered any damage from storms. As a matter of fact, the ice field going out in the spring was more likely to cause damage than wave action.

In answer to Mr. Kerry's question, it could only be said that the structures were still there and were performing very satisfactorily the service for which they were built. Taking everything into consideration, they had been constructed very economically. The intention, so far as was known at the present time, was to proceed with the rubble mound construction as long as the physical conditions remained similar to those described.

Power System Stability

F. A. Hamilton, Jr.,
Central Station Engineering Department, General Electric Company, Schenectady, N.Y.

Paper presented before the Montreal Branch of The Engineering Institute of Canada, November 13th, 1930.

SUMMARY—The ability of synchronous machines to stay in step with each other at all times is becoming a matter of increasing importance to designers and operators of electric power systems. It is to this ability—or to a lack of it— that the terms stability and instability refer.

Associated with the term stability is the term power limit. There is a limit to the amount of power which a system can handle with stability and this varies with conditions encountered in operation. The maximum power which can be transferred from prime movers to load when the load is steadily increased by small increments is ordinarily greater than the maximum power which can be delivered without loss of synchronism in event of a short circuit or other transient condition.

Methods of predicting power limits under steady or transient conditions have been outlined in various publications and are available to system designers. This paper presents in more elementary fashion certain concepts upon which these methods are based. Factors which affect power limits are discussed and their inter-relation illustrated. The factors involved are those which affect the fundamental quantities appearing in the basic power flow equation $P = \frac{E_1 E_2}{x} . \sin \delta$, which is proven in the appendix.

Methods of increasing power limits are discussed, the more important criterion—the transient limit—being stressed. Reducing the duration of short circuits is the most effective single means of increasing transient power limits. The effectiveness of this is compared with the effectiveness of other means. These other means, which should not be overlooked, include prime mover input control; increased machine inertia; reduced machine, transformer, and line reactances; the use of balancing regulators and high speed excitation; the limitation of short circuit currents in various ways; the use of damper windings in synchronous machines; the use of braking resistors; etc.

Introduction

When the contending forces in any organism are so related that the organism functions as a unit in accomplishing in a reasonable manner the purpose for which it is intended we consider the organism to be balanced or stable. Conversely, to organisms which do not function in what we consider a reasonable manner we apply the words unbalanced or unstable.

It requires but little stretching of the imagination to conceive of organisms which function in a balanced manner when subjected to certain conditions, but which do not function in a wholly satisfactory manner under other conditions. For instance, human beings faced with the necessity of suddenly changing their mode of life sometimes cease to carry on in perfectly balanced fashion. But fortunately most of them finally come to accept the new conditions and live and think again in a normal way.

So it is with electric power systems. Although they have operated for a long time in a more or less reasonable manner, changes have occurred with the passing years, and in some instances, when faced with new conditions, systems have been known to lose their equilibrium and to refuse to function in an orthodox fashion. They sometimes exhibit symptoms of instability; their synchronous components, for one reason or another, occasionally break out of step with one another.

The relatively recent and widespread interest in means for circumventing such possibilities is a natural circumstance in the life of the electric power industry. The possibility of instability has been recognized for many years, but through infancy the industry suffered so little from it that its threat was obscured. However, now that the industry has grown up and wishes to do bigger things, the very size of its systems not only favours the occurrence of instability but makes its effects more widely felt. The maintenance of stability in the future will logically require more intensive effort than in the past, and its ultimate consideration is apparently to be forced upon us at times whether we like it or not.

An Early Problem Involving Consideration of Stability

Practical cases involving the problem of keeping synchronous machines in synchronism have cropped up from time to time during the last few years.

For instance, some years ago, perhaps seven or eight, someone proposed the development of a considerable amount of power at a site not far from Montreal and its transmission to New York and New England. The proposal was never carried out and (neglecting international complications) at least one of the reasons was the fact that to make the procedure profitable the amount of power which would have had to be transported, over a circuit 500 or more miles long, was quite a bit more than a circuit of that length could carry with stability, even under steady conditions. Any attempt to steadily transport such a large amount of power over such a long line would have ended in failure since the synchronous machines at the two ends of the line would have refused to remain in synchronism.

Such a recital is perhaps a carrying of coals to Newcastle, but the situation is recounted as one of the early cases in which the question of stability arose.

A More Recent Illustration

Subsequently many other problems of a more or less similar nature have arisen and in more than one instance practical illustrations of the need for considering the stability question have come to light.

One such instance occurred in the south[1] where two systems were tied together by two high voltage circuits, each about 125 miles in length. These were separated by some distance, and were not what are commonly thought of as parallel lines. One of the circuits may be called the north and the other the south line. During the time when the two systems were connected only by these two circuits a drought throughout the territory served by one of them made it imperative to carry most of the load of that system from the plants of the other. At such a time a fault occurred on the southern portion of the system supplying the bulk of the power, and both tie lines tripped open. The fault was not on either of the tie lines, but on another circuit radiating from the generating station where the south line originated. That generating station broke out of synchronism with machines at the load end of the south line and excess currents tripped that line. Other generating stations belonging to the system supplying the bulk of the power also broke out of step with the other system and the north line opened. The disturbance resulted in a total interruption of supply throughout the better part of an entire state, and the fault which initiated it was not on the system requiring the supply, nor even on one of the lines supplying it.

Such occurrences serve to emphasize the necessity for investigating the stability of systems, and are naturally to be avoided if service demands of today are to be satisfied.

Stability Defined

The commonly accepted definition of stability refers to the ability of synchronous machines to remain in synchronism with each other during normal periods, and during and following disturbances of unavoidable nature.

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(1) Power Limit Tests on Southeastern Power and Light Company's System—S. Murray Jones and Robert Treat—Transactions of A.I.E.E., 1928.

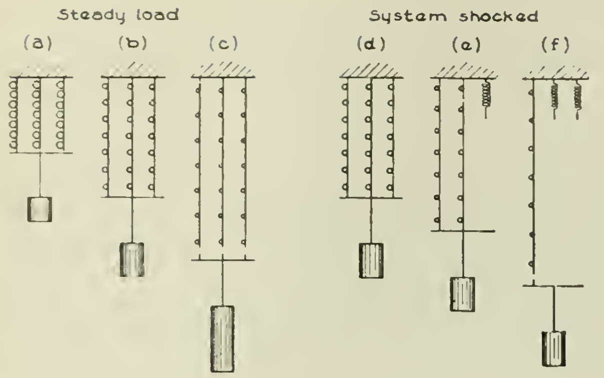

Fig. 1—Analogies of Steady State and Transient Stability.

Power Limit

Associated with the term stability is the term power limit. There is a limit to the amount of power which can be carried with stability, either in normal periods or at times of disturbance.

The power limit is the maximum power which can be transmitted and this differs with the conditions of operation. The maximum power which can be transmitted from generators to load when the load is slowly applied will ordinarily be greater than the maximum power which can be transferred when the load is suddenly applied, and this in turn will be greater than the maximum power which can be delivered without loss of synchronism should a short circuit put in an appearance.

Kinds of Stability

Two kinds of stability are thus distinguishable. They are commonly known as steady state and transient stability. The former refers to the ability to transmit a certain amount of power when the load is steady, or is being applied very slowly. The latter refers to the ability of synchronous machines to remain in synchronism even though some of the conditions of operation are suddenly changed; to the ability of these machines to return to a state of equilibrium after a sudden disturbance has upset, to a certain extent, the state of equilibrium in which they were previously operating.

Stability Calculations

Methods are available for predicting the stability of this or that arrangement of equipment under steady state or transient conditions,(2) and these permit the evaluation of the good and bad points of this equipment, that arrangement of it, etc. In many cases the calculations are long, tedious and involved. At the moment, however, an exact knowledge of the methods of calculation is of less importance than a qualitative understanding of the effect of this thing or that.

A Mental Springboard

As a preliminary step in arriving at an understanding of any complex phenomenon it seems apparent that the vast majority require some sort of mental springboard. Most persons like to conceive of complex things in terms of pictorial analogy. In this case, for instance, an elementary picture of what goes on in an electric power system during steady operation and during transient conditions appears desirable, and a picture of sorts can be drawn.

Consider the various parts of Fig. 1, but remember that the analogy as depicted will necessarily have its limitations.

Examine the spring and weight system shown in (*a*). The position of the springs is governed by the weight. Now if weight is slowly added the springs will take the position shown in (*b*). Naturally if sufficient weight is added the springs will break as in (*c*) even though the weight is applied slowly. This is an incomplete analogy of steady state stability, but if one does not delve too deeply into the whys and the wherefores it will suffice as an illustration—for the moment at least.

Now consider the system shown in (*d*). Then suppose one of the springs is snipped with a pair of shears. The remaining springs will elongate beyond the point shown in (*e*) but will eventually come to rest at that point. Now suppose another of the remaining springs is snipped. In this case the weight (which, if applied slowly, might be successfully supported by one spring alone) may be too much for the one remaining spring with the result that it may break as in (*f*). This is an analogy of transient stability, but again if one should delve too deeply into all of the whys and wherefores it will be found to be an incomplete one. Nevertheless, it also may be defined as a useful picture.

The length of the springs under the various conditions may conceivably represent an angular difference between the machines at one end of a line and those at the other. If the springs are gradually extended,—if the angle is gradually widened as by slowly adding load,—the springs may reach the breaking point,—the machines may break out of synchronism. If the strength of the system is suddenly reduced as by the snipping of a spring,—as with the occurrence of a fault and the consequent opening of a circuit,—the same thing may happen,—the machines may break out of synchronism.

Such an analogy omits many factors, but it provides a starting point,—a useful sort of springboard.

Reactances and Angles

In the analogy just used it has been said that the length of the springs may conceivably represent an angular difference between the machines at one end of a line and those at the other. Now just what is this angle and how does it happen to exist?

When current flows in a circuit containing reactance, such as all power circuits contain, it causes a voltage drop which in effect separates the vector position of the voltage at the load from the vector position of the voltage at the generator end. The more reactance in the circuit, or the more load carried by it, the greater will be the reactance drop and the wider will be the consequent angular separation between the load and generator voltage vectors.

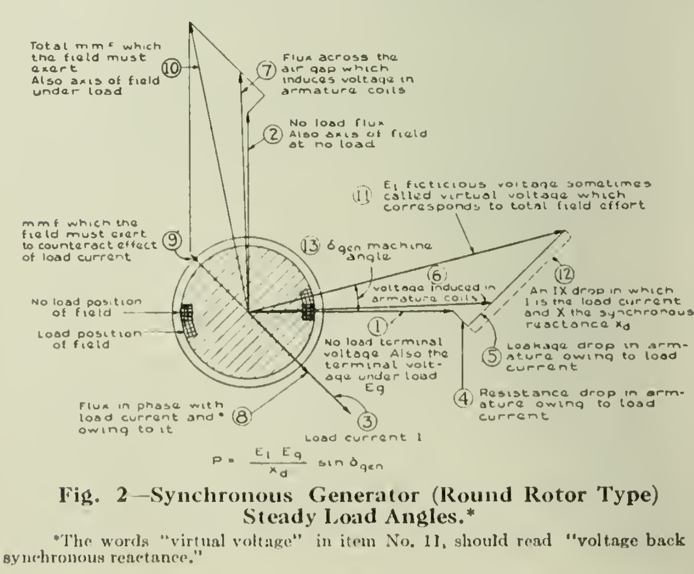

Fig. 2—Synchronous Generator (Round Rotor Type) Steady Load Angles.*

*The words "virtual voltage" in item No. 11, should read "voltage back of synchronous reactance."

(2) Steady State Stability in Transmission Systems—Edith Clarke, Trans. A.I.E.E., 1926; System Stability as a Design Problem—R. H. Park and E. H. Bancker, Trans. A.I.E.E., 1928; Progress in the Study of System Stability—I. H. Summers and J. B. McClure, Trans. A.I.E.E., 1929; The Calculation of Alternator Swing Curves—F. R. Longley, Trans. A.I.E.E., 1930.

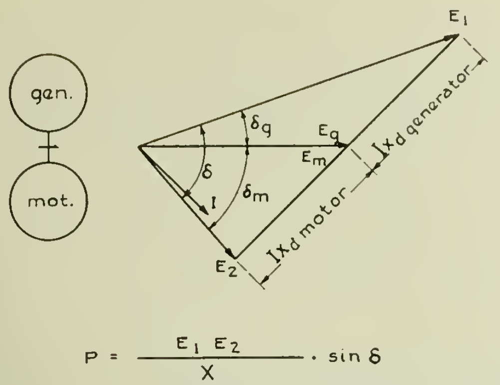

Fig. 3—Synchronous Generator and Motor Steady Load Angles Combined.

If synchronous machines are used at opposite ends of the circuit this angular separation between load and generator voltage vectors cannot be carried beyond a certain point without having the synchronous machines at the two ends of the circuit break out of step with each other.

Thus the power limit of a system is largely a function of certain generator and load voltages, and of the reactance between the points at which these voltages are applied. The question then is, what voltages and reactances are involved, and how are they involved.

Synchronous Machines and Steady State Stability

Obviously some of the reactance involved must be in the rotating machines and, to gain a more complete picture, the simple analogy must be abandoned and the synchronous machine itself must be considered.

Two kinds of synchronous machines are distinguishable: the round or solid rotor type, used largely for high speed turbine generators, and the salient pole type, used for waterwheel generators, synchronous motors, and condensers generally. There are important differences in the characteristics of the two types but for purposes of illustration the simpler theory of the round rotor machine may be selected.

Consider Fig. 2. This is an elementary picture of a simple round rotor machine. Assume that its no load terminal voltage is to be E_g (1) and that the flux producing this is as shown by (2). The axis of the poles at no load is then fixed as shown. Then, keeping E_g at the same value, suppose the machine to be loaded, the current being as shown by (3). There will be a resistance drop in the armature (4), and a reactance drop due to armature leakage (5). Hence the total voltage induced in the armature will be the vector sum of E_g (1), the armature resistance drop (4), and the armature leakage drop (5). This induced armature voltage is shown as (6). This voltage requires a flux crossing the air gap in quadrature ahead of the induced voltage as in (7). The load current tends to produce a flux and this must be counteracted if the machine forces are to remain in equilibrium. An m.m.f. must be produced by the field to counteract the tendency towards production of flux by the load current, as by (9). The total m.m.f. which the field must produce is the vector sum of the m.m.f. required to produce the flux which crosses the air gap (7), and that required to counteract the armature current's flux producing tendency (9). The flux which may be conceived of as corresponding to this is shown as (10). The line in which this acts fixes the position of the field structure under load. Now because it is not convenient to talk in terms of fluxes, some of which do not actually exist, conceive of a voltage in quadrature behind the total field effort as shown in (11). This fictitious voltage which corresponds to excitation, is frequently referred to as the voltage back of synchronous reactance, since the length of the line (12) represents an IX drop, the I being the load current and the X associated with it being defined as synchronous reactance. The usual symbol for synchronous reactance is x_d.

The angle between the voltage back of synchronous reactance and the terminal voltage is the machine angle and the power output (neglecting resistance drop and loss) can be shown to be equal to[3]

$$P = \frac{E_1 E_g}{x_{d_{gen}}} \sin \delta_g.$$

So much for the reactance and angles encountered in a synchronous generator under steady load.

Now refer to Fig. 3 which shows a generator and an equivalent motor closely connected together. In this diagram resistance drops are totally omitted in the interests of simplicity. By symmetry the motor angle appears in the opposite direction and the IX drop in the motor equals that in the generator. The total angle is equal to

$$\delta_g + \delta_m = \delta.$$

The power transferred between generator and motor is

$$P = \frac{E_1 E_2}{x_{d_{gen}} + x_{d_{mot}}} \sin \delta.$$

Synchronous Machines, Transmission, and Steady State Stability

By connecting the generator and motor together by a transmission line through which the load current must pass, an additional angle is encountered as shown in Fig. 4 for two values of load power factor.

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(3) The extremely useful general relation

$$P = \frac{E_1 E_2}{x} \sin \delta$$

involving any two voltages, the reactance between the points where they are applied, and the angle between their vector positions, is proven in the appendix.

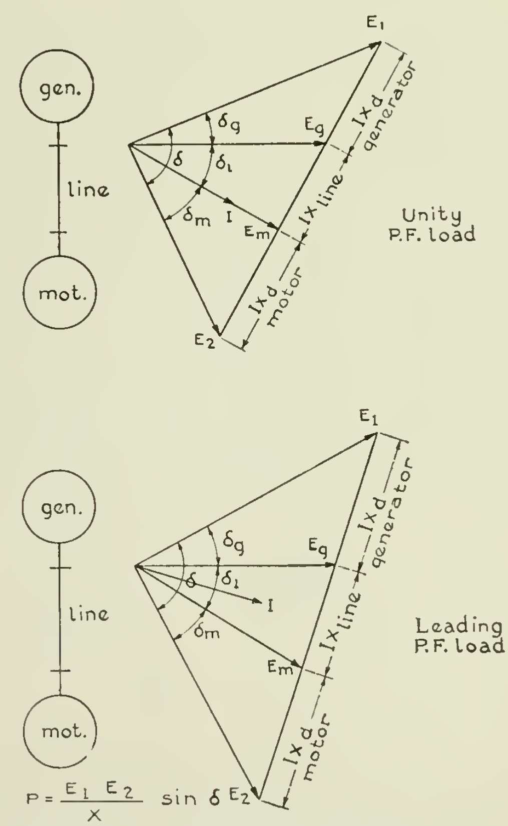


Fig. 4—Synchronous Generator, Transmission Line and Synchronous Motor Steady Load Angles Combined.

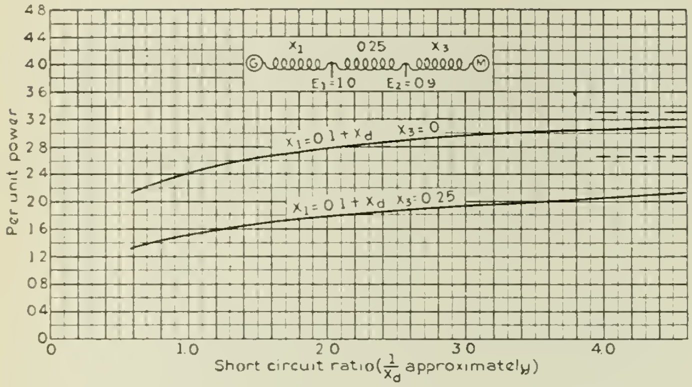


Fig. 5—Short Circuit Ratio, $\frac{1}{x_d}$ approximately.

Again the power can be shown to be a function of the sine of the angle between voltages back of synchronous reactance, and is

$$P = \frac{E_1 E_2}{x_{d_{gen}} + x_{d_{mot}} + x_{line}} \sin \delta.$$

STEADY STATE POWER LIMITS

Since in any of the cases referred to the power transferred from generator to load is equal to

$$P = \frac{E_1 E_2}{x} \sin \delta,$$

it follows that, for given voltages back of synchronous reactances, i.e., for given excitations, the maximum power which can be transferred over a circuit of given reactance is that which is possible when $\delta = 90°$ and $\sin \delta = 1.0$.

In other words the maximum power which can be transferred through a circuit under steady load conditions is given by

$$P = \frac{E_1 E_2}{x},$$

from which it is evident that with given voltages back of synchronous reactances, i.e., with given excitations, the smaller the reactance between the points where these voltages are applied the larger the maximum load which can be steadily carried.

The reactances involved are the synchronous reactances of generators and motors, and the transformer and transmission line reactances, and reducing any one of these will increase the steady state power limit to some degree. The actual increase in power limit will depend upon how much the total reactance is decreased. Thus cutting the synchronous reactance of the generator in half will not double the steady state power limit of a system which includes transformers, lines, and motors as well.

The term used to measure the steady state stability of synchronous machines has come to be called the short circuit ratio and (neglecting saturation and resistance) this is the reciprocal of synchronous reactance. Thus the higher the short circuit ratio the more power can be steadily carried, other things being equal. Possible relations between generator short circuit ratio and steady state power limit are shown by Fig. 5. The top curve applies to a system with characteristics as shown by the small sketch—the load bus being an infinite one.[4] The lower curve applies to a similar system but one in which the load bus is not an infinite one. Interest here is primarily in waterwheel driven generators. The normal short circuit ratio of this type of generator is 1.0 but a ratio of 1.5 can sometimes be obtained (at increased cost) without materially altering overall dimensions. For the particular systems of Fig. 5 the gain in steady state power limit obtainable by using generators with a short circuit ratio of 1.5 instead of 1.0 appears to be only about 10 per cent.

Steady state power limits may be improved to some extent by reducing transformer reactances, but to appreciably reduce these reactances larger than normal transformers are necessary. Roughly speaking normal transformer reactance varies directly with the high voltage rating. For instance a 66 kv. transformer might have a normal reactance of 7 per cent or 8 per cent and a 230 kv. unit a normal reactance of perhaps 12 per cent to 15 per cent as shown by Fig. 6. Transformers of lower reactance are more expensive—they may be looked upon as larger units derated—and their use is not ordinarily warranted. In the systems of Fig. 5 cutting the transformer reactance in half would not increase the steady state power limit more than 1 per cent or 2 per cent.

It goes almost without saying that a reduction in transmission line reactance, as may be accomplished by multiplication of the number of circuits employed in parallel or by the use of higher voltage, is also beneficial in improving steady state power limits.

STEADY STATE POWER LIMITS UNDER HAND CONTROL

Thus far no circumscribing definitions have been used when referring to what has been called the steady state power limit, but actually the power limits under steady load conditions as determined by the relation

$$P = \frac{E_1 E_2}{x} \sin \delta,$$

are those obtainable when the loads are gradually built up in small increments, and excitations changed likewise in small increments by hand adjustment of rheostats while maintaining constant terminal voltage.

The maximum power which can be transferred without voltage regulators is called the steady state power limit under hand control, or frequently just the steady state power limit, since with commercially available regulators and excitation systems the steady state power limit is not likely to be appreciably higher than that obtainable when the excitation is controlled by manual manipulation of rheostats.

The various actions which take place in a system while it is being loaded up to its limit in this fashion are interesting. These will be discussed with the assistance of Fig. 7, which refers to a system comprising a generator and an equivalent motor closely connected together to the same bus.

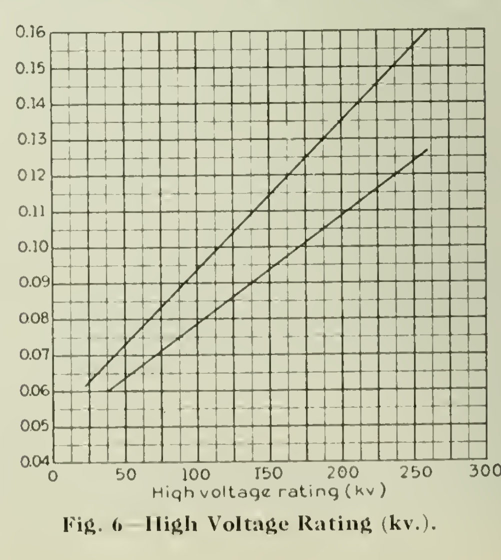


Fig. 6—High Voltage Rating (kv.).

[4] The term, infinite bus, refers to a point where voltage is considered to remain absolutely fixed in magnitude and phase position at all times. It refers to a bus beyond which the system is assumed to have zero reactance. The conception of such a bus is a useful artifice for simplifying calculations. Such an assumption is frequently made when the load system is large with respect to a generating source, the stability of which is under consideration.

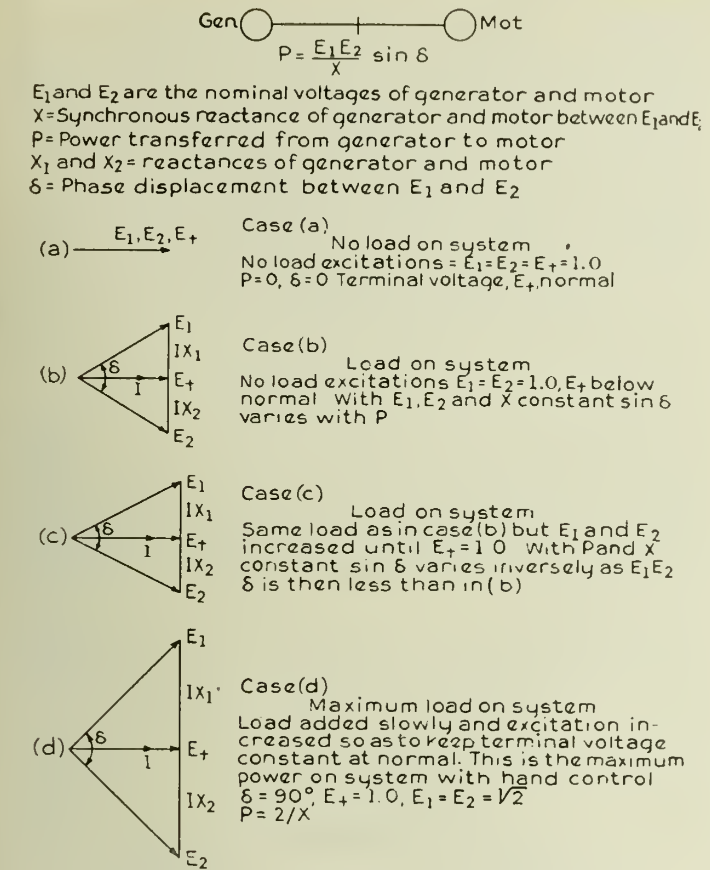


Fig. 7—Successive Steps in Loading a System Comprising an Identical Generator and Motor on the Same Bus.

Note:—In the above figure, the expression $E+$ should read Et

If, in such a system, no load is being transferred from generator to motor (and if no load losses are neglected) the voltages corresponding to excitations can be made to be equal and in phase. And incidentally, the terminal or bus voltage will be equal to and in phase with the voltages which correspond to the excitations. Refer to Fig. 7 (*a*). Now, granting the truth of the statement that

$$P = \frac{E_1 E_2}{x} \sin \delta,$$

it is at once apparent that no load *can* be transferred from generator to motor until E_1 and E_2 cease to be in phase.

Consequently, when a small load is applied to the shaft of the motor, its rotor must temporarily supply the power required by the load by giving up some of its kinetic energy. This causes the motor to commence to decelerate. Thus an angle appears between E_1 and E_2 and power begins to pass from the generator to the motor, which tends to lessen the deceleration.

Prior to this time the generator was operating at no load, and its prime mover was supplying it with but little energy. Now the generator is called upon to deliver more load than is being supplied by its prime mover, so it also begins to give up some of its kinetic energy. It also begins to slow down. Thus it tends to prevent the widening of the angle between E_1 and E_2, i.e., tends to limit the power transferred to the motor. So the motor gives up more of its kinetic energy and continues to slow down.

Now, in response to this slowing down process, the governor which controls the prime mover causes more input to be applied to the task of driving the generator. This causes the generator to accelerate, which tends to widen the angle between E_1 and E_2, and this in turn increases the power delivered to the motor. When the angle becomes wide enough and the power delivered to the motor becomes sufficient for the purpose, it also accelerates and decreases the angle and the power transfer.

Eventually the input to the prime mover equals the generator's output to the motor, and this equals the load demand on the motor. The system will then be in a new state of equilibrium. The generator will be running at its proper speed and so will the motor, but the angle between E_1 and E_2 will remain in a position which satisfies the relation

$$P = \frac{E_1 E_2}{x} \sin \delta,$$

where P is the load demand on the motor, E_1 and E_2 are the excitation voltages, and δ the angle between them.

During all of this time the generator and motor excitations can be assumed to have remained unchanged in magnitude. They have merely moved apart in phase. But the same thing cannot be said of the terminal voltage. It has been reduced in magnitude while remaining unchanged in phase position. See Fig. 7 (*b*). If this terminal voltage is now brought back to normal by adjusting the excitation of generator and motor in like amounts by hand manipulation of rheostats or by voltage regulators, the power transferred from generator to motor will be increased. The motor will use the extra power in trying to accelerate, the generator will begin to decelerate, the displacement angle δ will become smaller, and the extra power will cease to flow until eventually the relation,

$$P = \frac{E_1 E_2}{x} \sin \delta,$$

is again satisfied for the power demanded by the load on the motor and for the new values of E_1 and E_2. The resulting state of equilibrium is pictured in Fig. 7 (*c*).

If this process is repeated, the load being increased by a small amount each time, the two machines can be made to fall out of step. The maximum power will be that which can be transferred when the angle δ is 90 degrees. With E_1 and E_2 separated by an angle of 90 degrees and corresponding to normal terminal voltage, see Fig. 7 (*d*), an increase in load would cause the motor to begin once more to slow down, thus causing E_2 to fall farther back in phase and δ to become greater than 90 degrees. But if the excitation should remain constant at this time, the motor would receive less instead of more power from the generator and would continue to slow down while the generator would tend to speed up.

If the excitations could be increased rapidly enough, the required power might be transferred even though the machines were more than 90 degrees apart. However, with hand control the terminal voltage must drop and this must be observed before the excitations can be increased. It is not practicable, with hand control, to modify the excitations fast enough to keep machines in step when they are more than 90 degrees apart. In fact, as has been said, commercially available regulators are not very effective in taking care of such a situation.

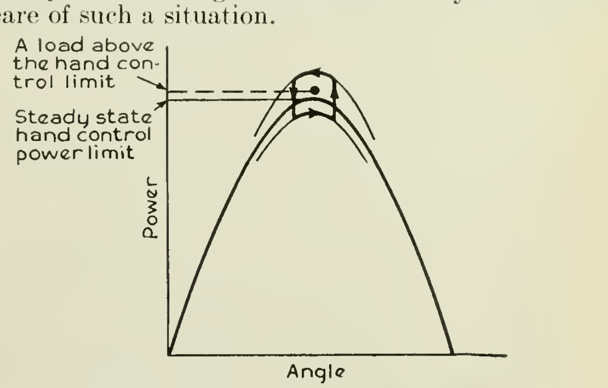


Fig. 8—Power-Angle Curves.

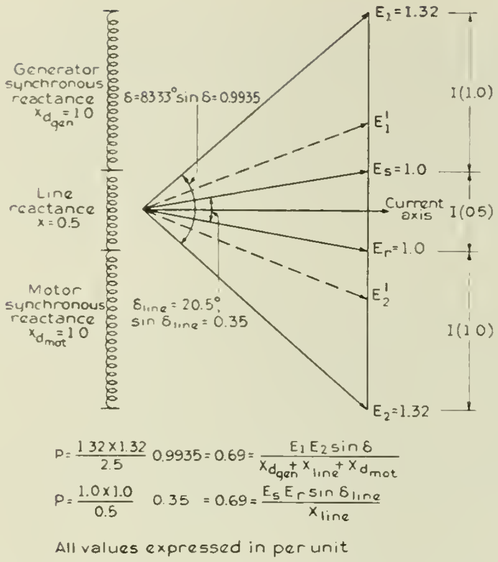


Fig. 9—The Generality of the Expression $P = \frac{E_1E_2}{x}\sin\delta$,

Dynamic Balancing Regulators and Steady State Power Limits

However, by providing suitably responsive regulators and excitation systems the power limits can conceivably be raised above the limit possible with hand control and the system made to operate under a sort of steady state condition which has at times been called the dynamic power limit. The possibility of this has been shown in laboratory tests on miniature systems.

The action of such a regulator may be roughly described by reference to Fig. 8. The heavy curve is one of power versus angle—a sine curve based upon the relation

$$P = \frac{E_1E_2}{x}\sin\delta,$$

where the x includes the synchronous reactance of the generator and motor plus whatever other reactance there is between the two voltages E_1 and E_2 (the voltages back of synchronous reactances).

Assume the system to be operating at the peak of the heavy curve—at the steady state limit with hand control—when a load increase occurs. The increased current widens the angle and since excitations are momentarily fixed (the regulator not functioning for the moment), the system tends to lose equilibrium. The operating point moves to the right and down on the heavy curve. At the same time the terminal voltage decreases, as was discussed in connection with Fig. 7. Assume a suitable regulator and excitation system then come into play to modify the excitation and put the system on the upper light curve. On this curve the system can transfer more than the required amount of power so the angle decreases and the terminal voltage increases. Then the regulator can be assumed to act again to put the system on the lower light curve by decreasing excitation. On this curve the system cannot transfer the required power so the angle starts to widen again and the whole process is repeated time and time again.

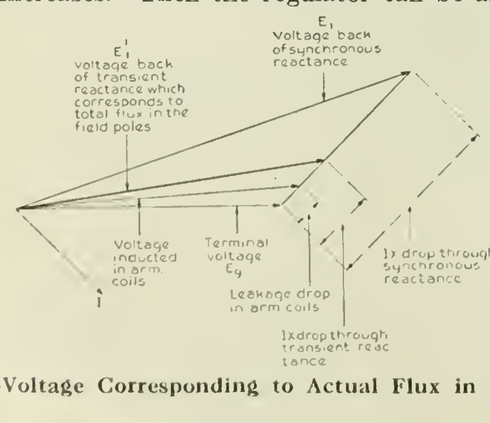


Fig. 10—Voltage Corresponding to Actual Flux in Field Pole.

The average commercially available regulator is believed to possess characteristics of the sort required to provide this dynamic balancing action to but a limited degree on actual systems. However, this is not to be decried at this time. So far operation above the steady state power limit under hand control has not been resorted to on actual systems, and probably it will not be resorted to under ordinary operating conditions, since if a system is to be stable under transient conditions it must ordinarily be operated below the steady state hand control limit.

Transient Stability

The operation of systems under more or less steady conditions has been considered. But it has been said that the maximum power which can be delivered from generators to loads under steady conditions will ordinarily be greater than the maximum power which can be delivered without loss of synchronism should a fault occur somewhere on the system.

Thus it is not ordinarily permissible to load a system to the steady state limit. Ordinarily the amount of power

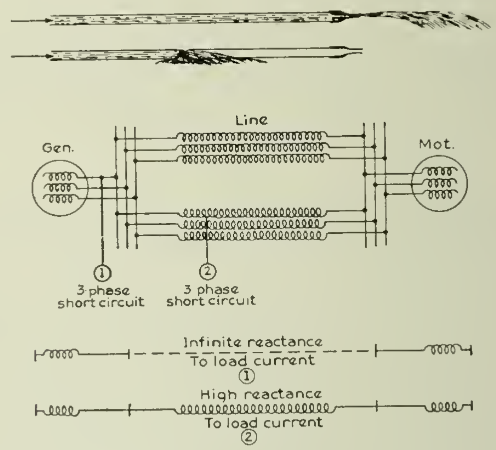


Fig. 11—Transfer Reactance During Three-Phase Faults.

which can be reliably transmitted is fixed by the ability of the synchronous machines to return to a state of equilibrium after a fault has upset the state of equilibrium in which they were previously operating

When a fault occurs the ability of a system to transfer the power which it was handling prior to the fault is momentarily lost. With the occurrence of a fault the power delivered to the motors is suddenly reduced, and as the power delivered is then less than the amount required by their loads, the motors tend to slow down. At the same time the generators at the other end of the system tend to speed up as the amount of power which they can turn out is less than that dictated by the input to their prime movers, this input at the instant after being just what it was at the instant before the fault.

The system is therefore not in a complete state of equilibrium at the instant after the fault occurs,—motors tend to slow down and generators tend to speed up. This means that the motor rotors tend to fall back and that the generator rotors tend to move ahead—the angle between generators and motors tends to widen. The wider the angle gets (up to a certain point) the more power the system can transfer. Hence, as the angle widens, and as the power transferred from generators to motors increases, the slowing down of the motors and the speeding up of the generators is lessened.

If the system is to eventually return to a state of complete equilibrium, the motors must cease to slow down and the generators must cease to speed up; the motors must begin to speed up and the generators must begin to slow down, and this must occur before the angle between them reaches the point beyond which loss of synchronism occurs.

The Cause of the Reduced Power Transferring Ability

It has been said that when a fault occurs the ability of the system to transfer the power which it was handling prior to the fault is lost. It will be of interest to examine the cause of this.

The relation so often referred to previously,

$$P = \frac{E_1 E_2}{x} \sin \delta,$$

is a perfectly general equation. If E_1 and E_2 are any two voltages, x the reactance between the points where they are applied, and δ the angle between the vector position of the voltages, then P is the exact amount of power which is being transferred from one end of the system to the other.

It should therefore be apparent that increasing the reactance between the two voltages E_1 and E_2, without changing either their magnitude or phase position, will reduce the power flow.

This is just what happens when a fault occurs; the same thing happens to a lesser degree whenever a line is switched out, even though no fault exists. When a fault occurs the reactance between certain generator and motor voltages is suddenly increased, and though the reactance is increased, the angle between machines does not instantly change, nor do the voltages themselves change. Thus the power transfer is reduced, and the generators tend to speed up and the motors tend to slow down.

The Machine Voltages Which Do Not Change

Reference must again be made to the relation

$$P = \frac{E_1 E_2}{x} \sin \delta,$$

which has been said to be a perfectly general relation. Its generality may be explained by reference to Fig. 9. This is a vector diagram (drawn to scale) on which the voltages back of synchronous reactances and the voltages at line terminals are shown for a particular load condition on a particular system. The calculations at the bottom of the figure indicate that it makes little difference which voltages are used in calculating the power transfer so long as the proper reactances and angles are used.

Suppose that to calculate the power transfer, voltages designated as E_1' and E_2' had been used in conjunction with the corresponding reactance and angle. The indicated power transfer under the steady conditions for which Fig. 9 was drawn would be the same as shown on the figure.

The voltages designated as E_1' and E_2' are those which might be conceived of as corresponding to the total flux which exists in the field poles of the machines. The total flux in the field poles of a machine is made up of two components—the flux which crosses the air gap to induce voltage in the armature, and the flux which leaks out of the pole faces and back into the field poles without ever reaching the armature. The voltage which corresponds to this total flux is shown again in Fig. 10.

There appears to be a voltage drop between this newly specified voltage and the terminal voltage of the machine. This is an IX drop in which the X is defined as the transient reactance of the machine, (the symbol for which is x'_d). Hence the reason for calling this newly specified voltage the voltage back of transient reactance. This—as in the case of the voltage back of synchronous reactance—is a fictitious voltage, and its significance and usefulness require explanation.

Suppose a fault occurs. When the excess current suddenly starts to flow in the machine armature an induced current automatically flows in the field to prevent demagnetization of the poles. The tendency is for the existing flux to remain constant. Such is the characteristic of all mutually coupled inductive circuits. Now if the total flux in the poles does not change when the generator is short circuited it may be assumed that the fictitious voltage corresponding to this total flux does not change. In other words, the voltage back of transient reactance remains temporarily unchanged in magnitude and the reactance between it and the terminal voltage may be considered as the element which limits the flow of short circuit current.

Actually the flux in the field poles does die away under short circuit conditions but for the first second or so after the short there is some justification (in the interest of simplifying calculations) in assuming that the flux in the poles remains essentially constant and that the corresponding voltage back of transient reactance remains relatively fixed in magnitude.

The die away of flux—the change in voltage back of transient reactance—can be calculated in a given case. The results of such calculations support the principle of assuming this to remain constant during the first second or so of a disturbance. Particularly is this true where a voltage regulator is present. What little decay in flux might take place without it is counteracted by the action of the regulator in increasing excitation. In so far as it does this, the regulator is beneficial from the point of view of system stability, and almost any regulator and excitation system will act to overcome the tendency for the flux to decay, at least during the first second or so after the occurrence of a short circuit.

Consider then that the voltage back of transient reactance remains constant in magnitude for a short time after a fault occurs. The next question is, does it remain fixed in angular position. It does in the first instant after the fault because the inertia of the machine prevents any instantaneous change in angle. Thereafter the angle changes, as will be discussed.

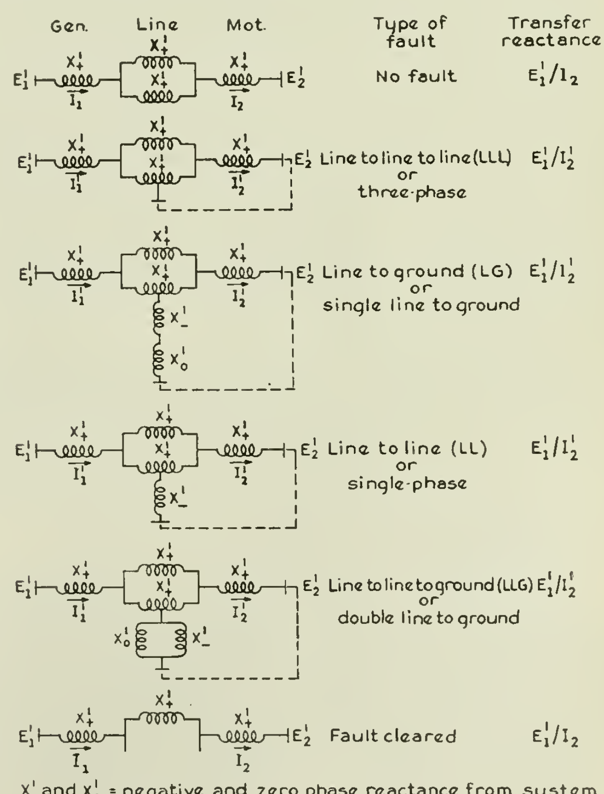


Fig. 12—Transfer Reactance Diagram.

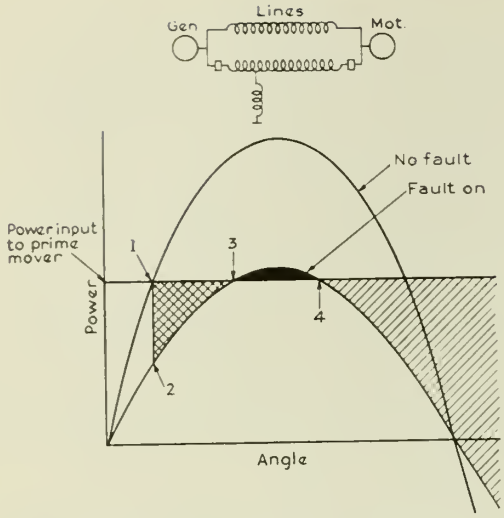


Fig. 13—Instability with Fault Remaining on the System.

The Reactances Which Suddenly Increase When a Fault Occurs

The question now is this: How do short circuits increase the reactances between voltages back of transient reactance? Another simple analogy will help to answer this question.

Suppose water is flowing in a garden hose. The pressure applied at one end causes the flow and water spouts out of the nozzle and performs its appointed task. Now suppose the hose is suddenly chopped apart. The pressure applied at the input end remains and causes a flow out through the place where the hose was chopped apart. But this flow waters the garden in the wrong place. No water goes where the nozzle points. As far as the nozzle is concerned, its applied pressure is zero.

This is what happens in the case of a three phase fault between generator and motor on a simple system as shown at (1) on Fig. 11. As far as the load is concerned, the applied pressure is zero, or the resistance to the efforts of such pressure as is applied is so high that the pressure is of no avail. The condition is thus the same as with infinite reactance inserted.

Should two hoses be used in parallel and should but one of them be chopped open in the middle, the pressure might be able to force some water down the good hose and out the nozzle in spite of the break. The same thing occurs with a three phase fault at the middle of one of the lines as at (2) on Fig. 11. With such a fault the reactance between generator and motor is not infinite and the system retains some of its ability to transfer power, but naturally this is less than the amount which could be transferred with the fault not there.

The amount of power which can be transferred in any case largely depends upon the equivalent reactance between machines and hence the practice of calling these equivalent reactances the transfer reactances. They are obviously values which may be obtained by dividing the pressure (voltage) applied at the generator end by the flow in the circuit at the other end.

Transfer Reactances for Various Kinds of Faults

Faults of other sorts than the three phase variety affect the system similarly but to a lesser degree. These other kinds of faults are not balanced faults, but they may be treated as three phase faults of lessened severity.[5]

Currents which flow in the case of unbalanced faults can be split up into components called the positive, negative, and zero phase sequence components and the reactances encountered by these components can be called the positive, negative, and zero phase reactances. These differ among themselves in different parts of the power circuits, and it is not feasible at this time to consider them in detail. But it is desirable to observe how they are taken into account when reducing an unbalanced fault to its three phase equivalent. This is shown on Fig. 12.

The power being transferred at any instant with or without a fault on the system depends upon the following relation,

$$P = \frac{E'_1 E'_2}{x'_t} \sin \delta',$$

the factors entering the equation being transient quantities; i.e., the voltages back of transient reactances, the angle between these voltages, and the transfer reactance which includes the transient reactances of machines, and is determined in any case by the relation

$$\frac{E'_1}{I'_2}.$$

From an inspection of Fig. 12 and the relations expressed above, it appears that to keep the power carrying ability of the system as high as possible, with or without a fault on the system, x'_+ should be as small as possible and x'_- and x'_0 should be as large as possible, as this is the way to make x'_t as small as possible.

Effect of a Fault Which Suddenly Increases x'_t

When a fault of any sort occurs, the transfer reactance between voltages back of transient reactances, which for the moment may be considered fixed in magnitude, is suddenly increased and owing to the inertia of machines the angle between them remains momentarily unchanged. What happens?

Once more the friendly relation,

$$P = \frac{E'_1 E'_2}{x'_t} \sin \delta',$$

may be called upon for assistance and curves based upon this may be plotted for conditions before the fault and for conditions existing when the fault is on. These are sine curves, as shown in Fig. 13. The peaks of the two curves are inverse functions of x'_t, and hence in the case of the lower curve a function of the type of fault and its location.

At the instant before the fault occurs the system can be assumed to be transferring power of the amount shown at (1); at the instant after, the amount shown at (2).

A Persisting Fault

Assume that the fault remains on the system. Assume also that the input to the prime mover remains unchanged—that in the early stages of the fault the actual speed change is insufficient to affect its governor, this usually being the case. The input is obviously more than the output, so the

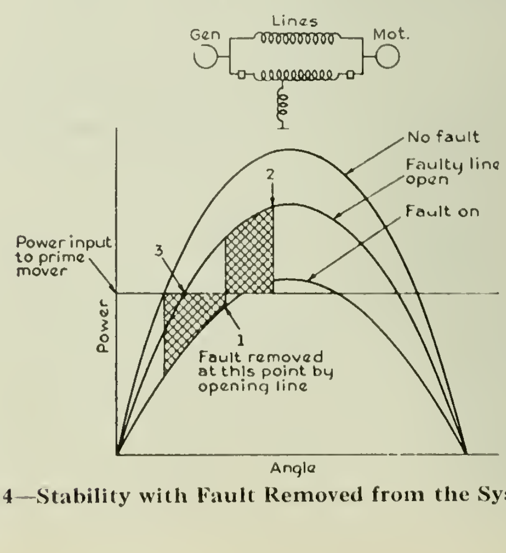


Fig. 14—Stability with Fault Removed from the System.

[5] By applying the symmetrical component method of analysis.

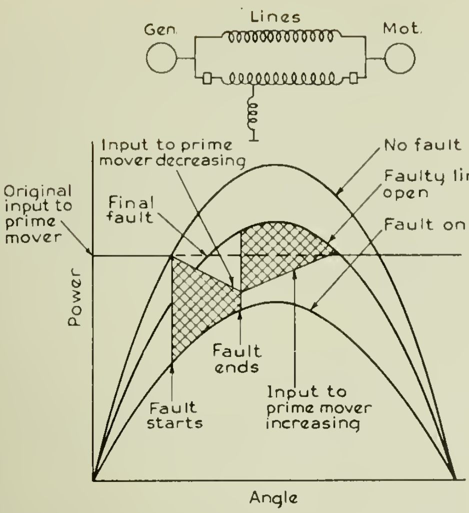


Fig. 15—Effect of Reducing Input to Prime Mover.

generator tends to speed up. The motor tends to slow down. The angle widens—following the lower curve in Fig. 13. The cross hatched area represents the excess of input over output of the prime mover during a period of time. When the angle reaches point (3), the input and output are equal, but during the preceding time the machine has been accelerating and absorbing the excess input in the form of kinetic energy. This must be dissipated, so the angle continues to widen and the output proceeds to grow larger than the input and the excess energy is somewhat dissipated. The amount so dissipated is shown by the solid black area. In Fig. 13 the kinetic energy thus dissipated is not equal to the amount previously stored so the angle continues to widen to the point (4) beyond which the input again exceeds the output. The generator continues to accelerate and finally breaks out of step as the energy represented by the cross lined area is imparted to it. As the energy transferred to the motor continues to decrease, the motor continues to slow down and stalls.

Had the system been carrying less power in the first place, it might have been possible to deliver this even with the fault on the system. But this procedure would not ordinarily be permissible. The power limit would ordinarily be so low as to make operation unprofitable.

Two Things Which Might be Done

Obviously one or both of two things might be done to help the system to deliver the desired amount of power without loss of synchronism incident to short circuits. The fault might be removed from the system and the transfer reactance x'_t thereby decreased, or the input to the prime mover might conceivably be varied in suitable fashion.

The Removal of the Fault

This is illustrated by Fig. 14. When the fault is removed as at point (1), the transfer reactance is decreased but not to its original value, since one of the two lines originally in service is now disconnected. After its removal, the angle continues to widen from (1) to (2) following the middle curve until the previously acquired excess kinetic energy is used up in reaccelerating the motor. This is commonly called the first swing of a disturbance. Then the angle proceeds to decrease and eventually return to the point (3) where the system continues to operate in a stable manner. That is—it will eventually come to rest at the point (3) if there is anything to damp out its swinging. And there usually is. What happens is that the angle decreases along the middle curve to a point below point (3), stops, and increases to a point above point (3), but not as high as point (2), stops, and decreases to a point which is still below point (3), but not so much as before, etc. Eventually it stops at point (3).

Obviously the quicker the fault is removed, the better; the quicker it is removed, the smaller the accelerating energy imparted to the generator rotor and the quicker this is applied to the job of reaccelerating the motor; the quicker it is removed, the smaller the angle to which the machines must swing, and the sooner they will return to a state of equilibrium. The quicker it is removed, the greater the permissible input to the prime mover.

The effect of various switching times on the power limits of systems will appear in various figures to be referred to later.

Varying the Input to the Prime Mover

That this means might be used to increase the power limits of systems has been demonstrated on at least one system where the generators are driven by steam turbines—where it is possible to cut off the steam supply with the required speed without damage.[6] In water wheel installations this has not been practicable since the sudden stoppage of water flow endangers hydraulic structures. However, it is not wholly inconceivable that by-pass mechanisms may be designed in the future for use on water wheel installations. These might be operated by quick acting relays responsive instantaneously to the occurrence of faults. Such a relay was tested on the steam turbine generator system mentioned.

The effect of such devices might be as illustrated in Fig. 15. When the fault occurs, the action of relay and by-pass mechanism might immediately (without waiting for an observable speed change) start to reduce the input to the prime mover, and with the opening of the faulty line, these could start to increase the prime mover input to its initial value. This would limit the widening of angles and permit the raising of power limits to some degree.

However, the advantage to be gained by this procedure is at the moment believed to be quite overshadowed by the efficacy of quick switching and fault limitation.

Transient Power Limit Versus Switching Time

Where a system can be considered to comprise a generator and motor connected together by a transmission system (the simple sort of system which has been used as the basis of discussion thus far), it is possible to prepare curves of the power which can be carried as a function of fault duration. The method used is based upon power-angle curves such as are illustrated by Figs. 13, 14 and 15.

Consider the power angle curves shown in Fig. 16. If the fault is not cleared at all, some power (P_a) can be carried through it without loss of synchronism. If the fault is cleared after the angle has had time to widen as in (b),

(6) Governor Performances During Systems Disturbances—R. C. Buell, R. J. Caughney, E. M. Hunter, V. M. Marquis—Trans. A.I.E.E., 1930.

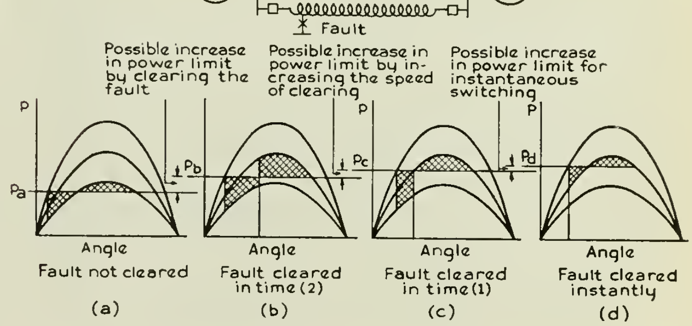


Fig. 16—Variation in Power Limit with Switching Time.

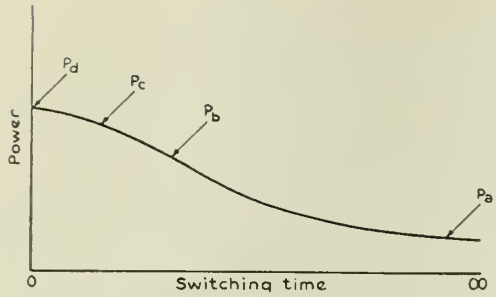


Fig. 17—Power-Switching Time Curve.

the power which might be carried is (P_b); if the fault is cleared faster, as in (c), the power limit is (P_c); and if the fault is cleared instantly (which is the same thing as merely opening a line), the power limit is (P_d).

These various power limits can be plotted against the switching times corresponding to the angular swing which takes place between the starting of the fault and the opening of the breakers. Such a curve would have the shape shown in Fig. 17.

The Effect of WR^2

The rate at which the angle between generators and motors changes during disturbances—the time consumed in changing the angle a given amount—depends upon the inertia of the rotating parts. The heavier these are, the longer the time consumed in widening the angle a given amount, and for a given time of fault duration, the smaller the angle to which machines will swing; in other words, the higher the power limit for the particular fault.

Now, how much can power limits of a given system be increased by increasing the WR^2 of the generators? Fig. 18 shows the gain obtainable for a particular system. The lower curve is based upon normally designed machines. The upper curve is based upon similar machines having approximately 30 per cent more WR^2 than the normal machines. This represents the extra WR^2 which might be added to otherwise normal machines without seriously increasing their dimensions. Adding even this increases costs somewhat. To get more WR^2, machines of greater physical dimensions and considerably higher cost must be used.

The system chosen—the system of Fig. 18—consists of a generator which is relatively small with respect to the system which it feeds. The gain obtainable by increasing the WR^2 is about 7 per cent if the switching time is .3 seconds. The gain obtainable by reducing the switching time from .3 to .2 seconds without changing the WR^2 is of the order of 23 per cent or more than three times the gain obtainable by increasing the WR^2 by 30 per cent.

The gains obtainable by increasing WR^2 are not in all cases so small (for instance, in the system of Fig. 18, much larger machines might be used with further gain). On the other hand, increasing WR^2 will not in all cases result in gains of the order indicated by Fig. 18. The gains depend upon inertias at both ends of the system. In general, the nearer the inertias at the two ends approach each other the smaller the good effect which can be obtained by increasing the smaller inertia. In most large systems the generating end has the smaller inertia. The curves indicate the best gains possible without resort to abnormally large machines, since the system of Fig. 18 consists of a generating station with a finite inertia and a system having infinite inertia.

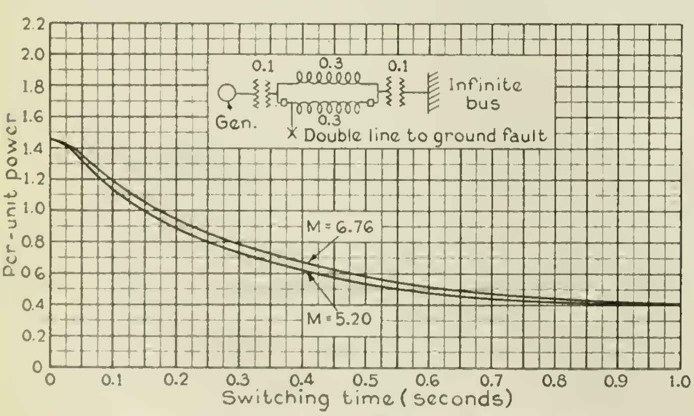


Fig. 18—Effect of Changing Generator WR^2 30 per cent.

Further Comments Concerning Quick Switching

The effect of reduced switching time appears to be of very material advantage as a means for increasing transient power limits. Hence, it is perhaps pertinent to inquire whether such high speed switching can be obtained.

High voltage breakers which will open in as short a time as .133 seconds are now on the market, and breaker and relay combinations which will act in conjunction to remove faulty lines from service in .167 seconds under favourable conditions are available. Fig. 19 is a picture

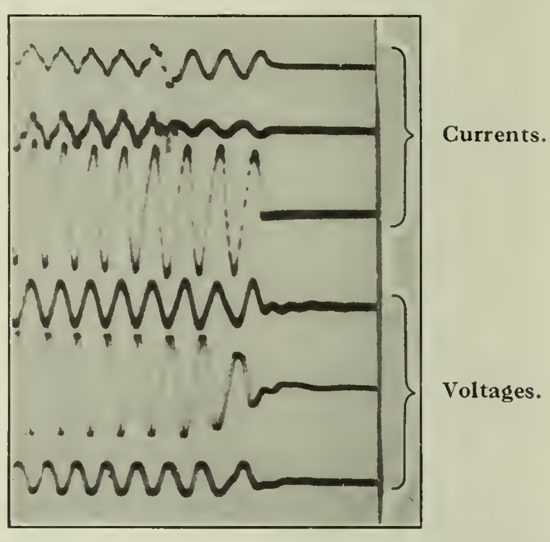


Fig. 19—Opening of a 220 kv. oil circuit breaker as recorded by a new type of automatic oscillograph.

of voltages and currents which indicate the opening of 230 kv. breaker in .133 seconds—8 cycles on a 60-cycle basis—which in this case includes the relay time. However, such fast operation can not yet be relied upon under all conditions and .2 seconds may be considered as a reasonably average lower limit in fault clearing time at the moment.

Should quick switching be relied upon to prevent loss of synchronism, persons reponsible for system operation must assure themselves that the switching equipment remains always capable of clearing faults in the short times relied upon. So, there seems to be some need for a transient recorder to provide data concerning the behaviour of breakers and relays under actual operating conditions. The record on Fig. 19 was obtained with such a recorder. This recorder was started automatically by the fault which it records. It is a relatively inexpensive oscillographic device which starts in less than a half cycle after the beginning of a disturbance and so permits the accurate determination of the number of cycles used by the relays and breakers in clearing a fault from the system.

Incidentally the record shown was obtained during short circuit tests on an actual 230 kv. system. In these tests arcs were initiated across strings of insulators. Observations of these arcs were quite interesting. With quick

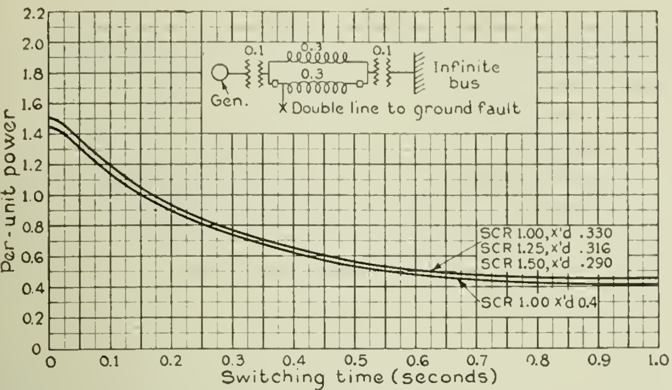


Fig. 20—Switching Time Curve Showing the Effect of x'_d and SCR on Transient Stability.

switching in use the arcs did not blow away from the arcing rings on the insulators. Apparently quick switching is likely to be of benefit by preventing single line to ground faults from becoming more serious—by preventing arcs on one phase from blowing into other phases.

At the moment high speed breakers are somewhat more expensive than slower speed breakers, but recent advances in breaker design justify the hope that this condition may not persist indefinitely.

Other Things Which Increase Transient Power Limits

The effects of quick switching, prime mover input control, and increased WR^2 have been briefly discussed but there are other things which may help to increase the amount of power which systems can carry through short circuits. Some of these will now be taken up, but before doing so it is advisable to recall once more the friendly relation

$$P = \frac{E'_1 E'_2}{x'_t} . \sin \delta',$$

since the efficacy of these other things depends upon their effect upon the various factors included in this equation.

Short Circuit Ratio and Transient Power Limits

The effect of increased short circuit ratio on steady state power limit has been discussed. But it has been said that the transient power limit ordinarily fixes the amount of power which can be dependably transferred. Now the short circuit ratio of a synchronous machine is a measure of its synchronous reactance, not of its transient reactance, and transient reactance is the thing which affects transient power limits. In spite of this, machines with high short circuit ratios are sometimes specified with the expectation that the operation of the system under transient conditions will thereby be measurably improved. The expectation is not always likely to be fulfilled. It should be interesting to examine the effect of short circuit ratio upon transient power limits.

What normal relation exists between short circuit ratio and transient reactance? Interest here is primarily in waterwheel driven generators so the following tabulation pertains to the relations which might be made to exist in a typical waterwheel driven generator of given dimensions.

SCR....................	1.00	1.25	1.50
x'_d....................	.33	.316	.29

The range of transient reactance shown is quite small and it is not always possible to obtain even this range in a machine of given dimensions. Furthermore where the lower reactance can be obtained some increase in cost is likely to be incurred since increases in short circuit ratio are obtained at the expense of higher field currents owing to wider air gaps. To obtain a lower transient reactance than shown in the tabulation it would ordinarily be necessary to increase the size of the machine. This would quite naturally increase the cost, perhaps in an unwarranted fashion. How much then can transient power limits be increased without greatly increasing the size and cost of machines?

This is illustrated by Fig. 20. On the particular system considered the power which might be carried through a fault seems to be just about the same regardless of the generator short circuit ratio assumed. On systems employing shorter lines of the same or higher voltage the advantage of using generators having the higher short circuit ratio might become more noticeable. But in general increasing the short circuit ratio of generators will result in but small improvement in transient power limits.

The improvement is obviously small when compared with the gain which can be obtained by speeding up the opening of faulty lines.

Transformer Reactance and Transient Power Limits

The effect of decreasing transformer reactance was discussed in connection with steady state power limits. There is a limit to which these reactances can be decreased without seriously affecting costs. To take advantage of economically permissible reductions in transformer reactance would help to increase transient power limits, perhaps to a greater degree than in the case of steady state power limits, but the improvement would in any case be quite small.

The Relation Between Steady State and Transient Limits

It might at this time be interesting to compare the amount of power which can be carried by a given system in steady state and in case of short circuits. Fig. 21 will help.

Note the case of the stub feeder fault. The fault is cleared without interrupting a line, both lines remaining in service after the fault has been cleared. The maximum power which can be carried with instantaneous switching can be calculated to be higher than the maximum amount which can be carried in a steady state condition. This is because in applying the general relation

$$P = \frac{E_1 E_2}{x} \sin \delta,$$

synchronous values are used in one case and transient values in the other. Now, it is not possible to start out by carrying more than the steady state limit so even with instantaneous switching the higher limit cannot be taken advantage of.

However, this is nothing to worry about. Fast switching times can be obtained, but truly instantaneous switching is out of the question. For that matter, switching

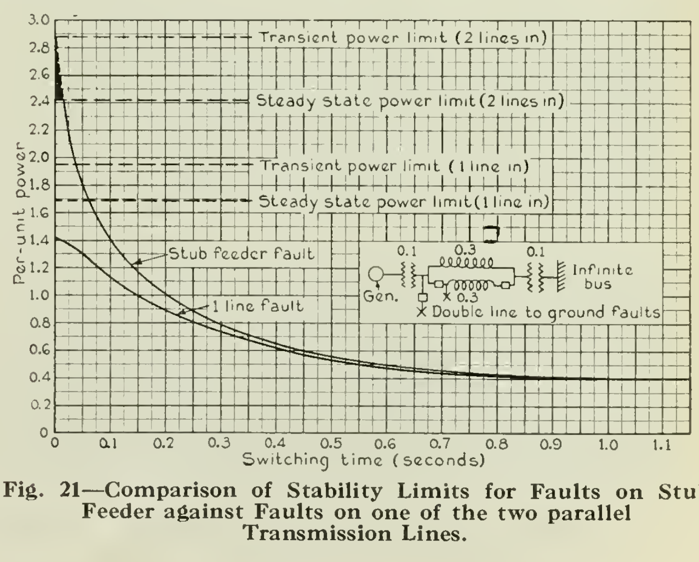


Fig. 21—Comparison of Stability Limits for Faults on Stub Feeder against Faults on one of the two parallel Transmission Lines.

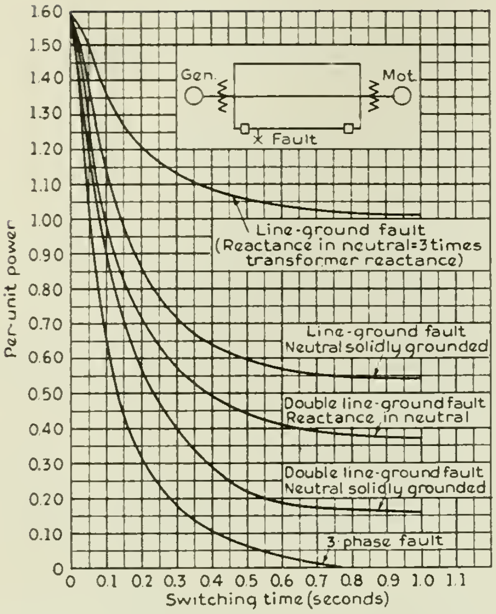


Fig. 22—Power-Switching Time Curves for various Kinds of Faults and the effect of Neutral Reactance.

times which would permit carrying the steady state limit without instability in case of the stub feeder fault shown are unobtainable.

Incidentally, assume for the moment that instantaneous switching could be obtained. Then, if some means for carrying more than the steady state limit to begin with were available, the power which could be carried through a short circuit of the sort shown could be increased. That is where the dynamic balancing regulator would come into the picture. But since such fast switching is impossible, a dynamic balancing act on the part of the regulator would be useless.

Now, forget the stub feeder fault for the moment and consider a fault on one of the lines which means that the line must be opened. The power which can be carried through such a fault with stability is shown by the lower curve. These are the faults which must ordinarily be considered.

Compare the amount of power which can be carried through such a fault which is instantly cleared with the amount which can be carried steady state with both lines in—or, for that matter, with but one line in service. If an attempt should be made to carry the maximum power which could be carried steadily, even with but one line in

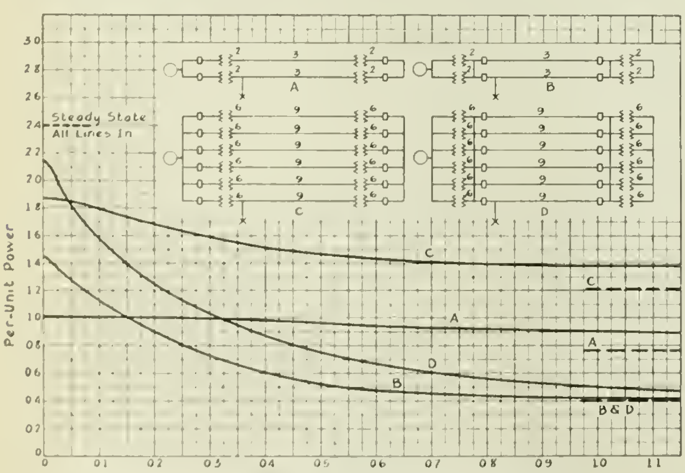


Fig. 23 Comparison of Switching Arrangements for Double Line to Ground Faults.

service, the system would certainly suffer from instability in the event of a line fault. And since switching times as fast as .05 seconds are unattainable, synchronism would be lost even in event of a stub feeder fault.

So once again the present need for a dynamic balancing is not apparent.

These curves, as those previously shown, indicate the gain which may be accomplished by decreasing the switching time from .5 seconds (which was once considered good enough) to .2 seconds which is not at all out of the question now.

Excitation Systems

While the subject of regulators is still in mind, it is desirable to consider the subject of excitation systems generally. It has been said that most of the regulator and excitation systems being applied at this time are capable, to all intents and purposes, of acting with the induced field current at time of short circuits to maintain constant flux in the field poles. Now suppose it were possible to obtain some sort of a system which would act quickly enough to actually increase the flux—and the voltages back of transient reactance—when a fault occurs. Were such a scheme available, it would be possible to raise all of the transient power limit curves bodily and carry more power through short circuits. But just what sort of a scheme would be needed, and what would it do?

Since the flux in the field resists any efforts to change it in the first place—since it refuses to die away when short circuits occur—how then increase it short of treating the field more violently than the short circuit itself treated it? To get any increase in flux—to increase voltages back of transient reactance—exciter voltages would have to be

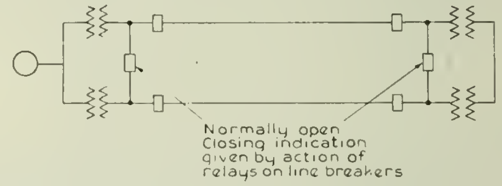


Fig. 24 Combining the Effect of Low Voltage and High Voltage Switching.

increased in tremendously rapid fashion and go to a high value. Some factor such as volt seconds might be used to indicate the tendency of the excitation system to increase flux. There would be little use in having a rate of exciter voltage rise of the order of 1,000 volts per second if the voltage is permitted to increase but a hundred volts. So high voltage exciters or their equivalent would be required.

By such means breaker interrupting duties would be increased and when a fault was cleared from the system, serious overvoltages would result. And unless the flux could be made to die out again in a proper manner, loss of synchronism might occur after a fault is cleared, i.e., on some swing other than the first one.

So extra high speed excitation is viewed with a certain disbelief that it would do much other than increase the costs of installations. The subject will doubtless receive more attention as time goes on, and may show ways to increase power limits. At the moment, however, such installations are not being seriously considered.

At present commercially available rheostatic regulators and exciters, having an average build up rate of perhaps 200 volts per second plus a reasonable maximum voltage are considered suitable from the standpoint of transient stability.

Increasing Transient Power Limits by Fault Current Limitation

The power-switching time curves thus far shown have been based upon double line to ground faults. If three phase faults are excepted this is the most severe type of

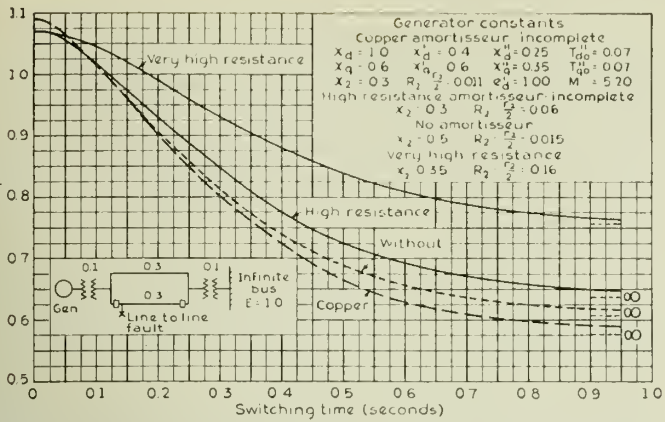


Fig. 25—Power that can be carried through the first Swing with a Line-to-Line Fault by a Water-Wheel Generator with and without Amortisseur Windings.

fault which can occur as might have been surmised from inspection of Fig. 12. Now, referring again to that figure, some conclusions can be drawn concerning the effects of various sorts of faults and means for reducing their severity.

It has been said that it is desirable to keep x'_- and x'_0 as high as possible since in this way x'_t can be kept at the lowest possible value.

The x'_+ and x'_- of such equipment as transformers, series reactors and lines are equal, so if x'_- is increased x'_+ is also increased, which is undesirable. Furthermore, x'_+ and x'_- of generators and motors are so related that it is difficult to increase x'_- without increasing x'_+ in the same proportion. For instance, in the system of Fig. 22 it would be impossible to increase x'_- for a fault at the generating station high voltage bus without also increasing x'_+.

This is not the case with x'_0. This is the reactance encountered by the current which flows in the ground in case of a ground fault. This can be arbitrarily increased by inserting reactance or resistance between transformer neutrals and ground so that the ground current must flow through the added reactance or resistance. This in no way increases x'_+ since it is not in series with the conductors between generator and motor. Thus it is an effective way to limit increases in x'_t during line to ground faults—an effective way to keep the system on a higher power-angle curve during the fault. It is not quite as effective for double line to ground faults since in this case the negative and zero phase reactances act in parallel and increasing one of them does not proportionally increase their parallel value. The degree to which reactance in the neutral increases power limits for line to ground and double line to ground faults is shown for one system on Fig. 22.

If all faults were line to ground, problems of maintaining stability might be largely solved by the use of reactance or resistance in neutral connections together with suitable arrangements for removing the faults in a reasonable time—and this reasonable time might be relatively longer than is now considered desirable in certain cases. It might even be possible to operate with infinite impedance in the neutral—if it were not for arcing grounds.

Unfortunately however, many faults are double line to ground or even three phase and these must be considered if a system which will be stable under any short circuit condition is to be attained. Reactance or resistance in the neutral will help solve the problem where double line to ground faults are concerned, but will not limit increases in x'_t in case of three phase faults. Power limits for three phase faults are lower than for any other sort of fault as shown on Fig. 22.

The Effect of System Arrangement on Transient Power Limits High Voltage Versus Low Voltage Busses

Sometimes a reasonable neutral reactance and reasonably quick switching may fail to provide freedom from instability for double line to ground and three phase faults. In such cases other methods may be of assistance. For instance, low voltage busses may be used instead of high voltage busses. This is advantageous in some cases though not in others, the relative effectiveness varying with the number of lines and their reactance. To make the system's power transferring ability high while the short is on, it is better to bus the transmission lines on the low sides of the transformers at both ends of the line rather than on the high sides, but when the line with the fault is switched out, the transformers connected to that line will be out of service. The transfer impedance will be higher after the fault is cleared than it would have been if the lines had been bussed on the high sides, at the two ends. The length of time the fault remains on the system will determine which of the two arrangements is preferable for a given system. If the short could be switched off instantly, high voltage busses would be better than the low voltage ones, but if it takes a longer time to clear the fault, low voltage busses are often more desirable.

Fig. 23 partially illustrates this. Two systems are shown with high voltage busses, and two are shown with low voltage busses. The steady state power limit is the same in all cases, the difference between systems being that the six line systems have lower voltage lines.

For long lines such as those used in the systems of Fig. 23, the advantage of the low tension switching is apparent. Very fast switching times would be necessary to take advantage of the high voltage switching schemes, and short enough switching times to get above the limits set by low voltage switching schemes for these systems are not now available. If the systems comprised shorter lines, where the terminal equipment reactances might be a greater percentage of the total than in the case of long line systems, the reverse might be true—relatively higher limits with reasonable switching times might be obtained by using high tension busses.

By providing additional high voltage breakers and arranging these as shown by Fig. 24 the advantages of the low voltage and high voltage switching schemes may be combined to some degree. In such an arrangement the transfer reactance during the fault is maintained at the same value as in the low voltage switching arrangement of Fig. 23. Subsequently, when the fault has been cleared and the tie breaker has closed, the transfer reactance

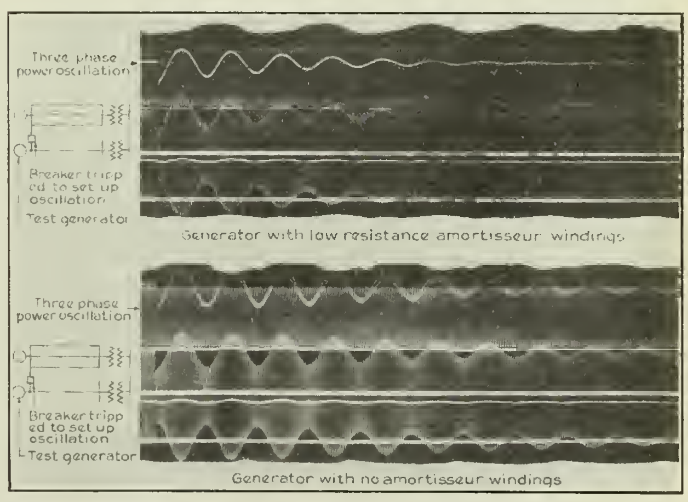


Fig. 26—Effect of Low-Resistance Amortisseur Windings in Damping out Three-Phase Oscillation.

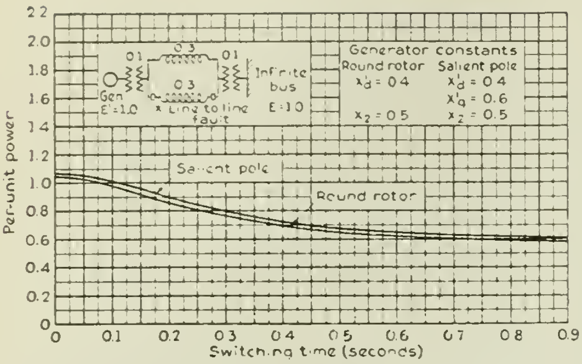


Fig. 27—Switching Time Curve Comparison of Salient Pole and Round Rotor Synchronous Machine Calculations.

becomes the same as in the high voltage switching scheme of Fig. 23 when one line is out of service.

The Effect of Amortisseur Windings on Transient Power Limits

The desirability of damper windings in waterwheel generators has been the subject of some controversy and in recent months a great deal of study has been given to the subject. Although the problem is not completely solved, it is now generally agreed that a damper winding produces three principal effects. These can be discussed most conveniently with the assistance of Fig. 25.

The first effect is called the damping effect. This opposes all speed changes and is always beneficial. The greatest amount of this effect can be obtained by using suitably designed low resistance damper windings.

The introduction of damper windings reduces x'_- of the generator and (remembering the way in which this enters into transfer reactance during faults) it will be seen that this increases the severity of all faults except the relatively infrequent three phase variety. This effect is in the wrong direction.

Since the damping effect of a low resistance damper winding is always beneficial it follows that if the fault were to be instantly removed the power limit with a low resistance amortisseur would be higher than without it. If the fault were removed instantly the evil effect of the lower x'_- of the generator would not be felt. However, as time of clearing faults is increased the tide turns the other way and the power which can be carried, with machines provided with low resistance amortisseur windings, through faults lasting more than about .1 seconds (and they usually do) is less than the amount which might be carried without them. However up to .3 seconds or more the difference is rather insignificant.

Now the third effect of damper windings is also quite important. Under all conditions of unbalanced faults—in case of any but three phase faults—double frequency currents are set up in the damper windings and if these have sufficient resistance the I^2R loss in them produces a braking effect on the machine. It adds a load, the amount of which depends to some extent upon the type and location of the fault, and this partially offsets the difference between power input to the shaft and power output to the load. Thus it limits the tendency of the machine to speed up. So when unbalanced faults are prolonged a gain in power limit can be obtained by using high resistance damper windings.

The curves show the relative advantage of three types of machines. One with no damper, one with low resistance damper, and one with high resistance damper.

On the face of these curves it might be concluded that the high resistance damper is the thing to use. However, the system used as a basis for calculations and the type and location of the fault considered are more favourable to the high resistance winding than otherwise. Furthermore the amount of resistance which can be used and the loss which can be permitted is limited by the ability to design machines so that heat may be dissipated; by the risk which one is willing to take on overheating due to possible unbalanced loads or faults which may accidentally persist too long. Hence the permissible gain might not be more than that shown by the curve marked high resistance (not by the curve marked very high resistance). In this case the gain in power limit for say .2 seconds switching times is not very great—perhaps 3 per cent.

The curves shown are based on line to line faults. Normally it is possible to ride through these with little difficulty anyway and on double line to ground faults the advantage of high resistance damper windings fades some more. For three phase faults high resistance damper windings would not be effective at all. In the cases of three phase faults the x'_- does not enter the picture in any way so all the damping action of low resistance dampers would be effective.

The low resistance winding is effective in damping out oscillations after a fault has been cleared. It is effective in case of balanced three phase oscillations. It is effective in preventing hunting between machines in the same or closely adjacent stations which might be initiated by faults and continue after the faults had been cleared. It is effective in case of large load changes or on systems where the load fluctuates widely. It helps the steadying down process after synchronizing machines. That these things are so can be shown by Fig. 26 which includes the records of two commercially used machines, identical except that one has a low resistance damper and the other none, for identical balanced three phase disturbances. In the case of the machine with the amortisseur winding the disturbance was damped out at least twice as fast as in the case of the machine with no damper winding—and for such disturbances a high resistance damper winding would have behaved just as though there were no damper winding present.

Hence the use of low resistance damper windings is generally desirable on account of their favourable action on all system disturbances, particularly those incident to the worst kind of faults—the three phase sort—though their overall effect on stability limits is small. The use of high resistance damper windings may occasionally be justified but the actual gain in stability obtainable is small if quick

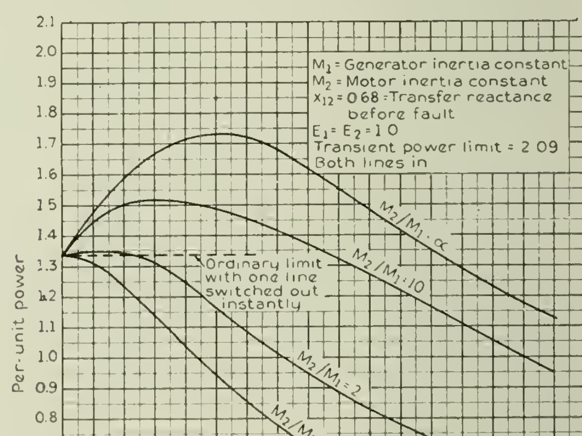


Fig. 28—Per-Unit Power that can be carried through the first Swing with instantaneous Switching using a Series Braking Resistor.

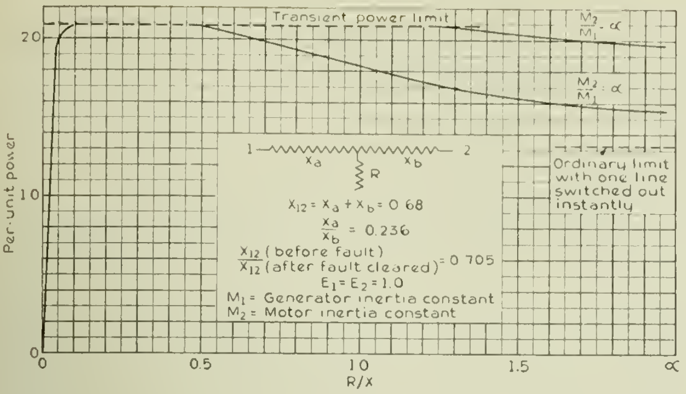


Fig. 29—Power that can be carried through first Swing with instantaneous Switching using a Shunt Braking Resistor.

switching is used while the risk of overheating on persistent unbalanced loads is incurred.

Either low or high resistance damper windings give an important reduction in recovery voltage on clearing faults, and hence a reduction in the duty imposed on oil circuit breakers.

ROUND ROTOR VERSUS SALIENT POLE CALCULATIONS

Earlier in this discussion there appeared a statement to the effect that it is usually justifiable, in the interests of simplifying calculations, to use round rotor theory even though the machines involved should really be salient pole machines. In certain cases however it is not possible to obtain truly comparable results by the use of round rotor theory. The curves shown by Fig. 25 are a case in point. In order to obtain true comparisons of the various kinds of damper windings and their effects it was necessary to use salient pole theory.

However, in the case of the curve showing the action of a machine with no damper winding, approximately the same result might have been obtained by using round rotor theory.

In Fig. 27 is shown the curve previously shown in Fig. 25 for the case of no damper winding and superimposed is a curve based upon identical conditions but calculated according to round rotor theory instead of salient pole theory. The discrepancy between the curves represents the error involved in using round rotor theory instead of the more rigid salient pole method. What error there is, is in the right direction. By using round rotor theory something of the nature of a factor of safety is inserted.

BRAKING RESISTORS AS A MEANS OF INCREASING TRANSIENT POWER LIMITS

Now recall the damper winding question again for a moment. A statement has been made to the effect that high resistance damper windings in reality add a load (in case of unbalanced faults) which partially offsets the difference between the power input to the generator shaft and the power output from the generator to the load. This, it has been said, helps to limit the generator's tendency to speed up.

The same result might be accomplished, perhaps to better advantage, in another way. For instance, a temporary load might be deliberately applied to the generator during times of disturbance. The effect of deliberately applying a resistance load has been recently investigated, and the investigations will doubtless be continued. Two general schemes are under consideration.

The next two figures illustrate graphically the results of calculations made to determine the effect of series and shunt braking resistors on the transient power limit of a particular system. The results, though applying to a particular system, are of such a nature that they may be used as basis for a few general conclusions concerning the effectiveness of such braking resistors.

Fig. 28 shows a series resistor which may be inserted in the circuit by the opening of a shunting breaker.

In preparing the accompanying curves instantaneous switching was assumed. It was assumed that a faulty line might be isolated in zero time and the resistor inserted coincidentally with the opening of the line breakers. The curves indicate the increase or decrease in the amount of power whigh might be carried through the first swing of such a disturbance without loss of synchronism. In other words, the curves illustrate the variation in the starting point of power-switching time curves, such as those previously shown, for various values of inserted resistance and for various ratios of inertia at the two ends of the system. It is apparent that the transient power limit for the first swing could be increased by the insertion of a proper series resistance if instantaneous switching were possible—but only if the ratio of generator inertia to motor inertia is quite large. In general this ratio is not likely to be larger than 4 or 5 and therefore the possible gain owing to the use of series resistors is not likely to be very great in the average case. However, where the inertia ratio is large, say of the order of 10, the maximum gain with instantaneous switching may be of the order of 12 per cent to 15 per cent. As line and resistor switching times become coincidentally greater the percentage gain becomes greater, and if the resistor could be inserted before the fault is cleared the gain might be somewhat further magnified.

Fig. 29 shows the effect of adding a shunt resistance load. As before, instantaneous switching was assumed and the curves illustrate possible increases in transient power limit for the first swing under such conditions. The curves indicate that amount by which the zero switching time transient power limit can be increased by the application of various values of shunt resistance. The curves apply to the system used in the preparation of Fig. 28. Observe that regardless of the inertia ratio some increase in the zero switching time transient power limit can be obtained for the first swing. The maximum gain with instantaneous switching appears to be of the order of 60 per cent. As before, the percentage increase in transient power limit for the first swing may become larger as the switching time is increased.

The effectiveness of methods employing temporary series or shunt resistance loads appear to be beneficial enough to warrant their consideration in special cases where ordinary methods seem likely to fail of accomplishing the desired results,—for instance, where the fastest switching obtainable will not increase transient power limits to the

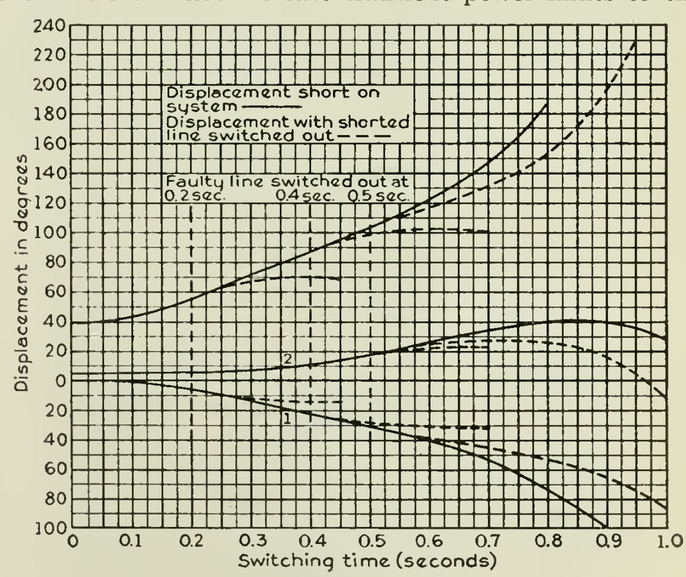


Fig. 30—Swing Curves Double Line to Ground Fault three times Transformer Reactance in Neutral.

desired point. Although at the moment the shunt resistor scheme appears to hold an advantage over the series braking method, both methods seem worthy of further examination.

A word of caution is nevertheless desirable. The use of loading resistors is accompanied by a certain amount of danger. Unless the removal of the resistance load is properly controlled synchronism may be lost on other than the first swing. This phase of the situation will doubtless receive further attention in the future, as will the matter of costs.

The Dynamic Balancing Regulator Again

Now remembering for a moment what has previously been said of the dynamic balancing regulator an interesting conjecture can be drawn.

Were it possible to raise the transient power limit of a system for faults on one of a pair of parallel lines to a point which is above the steady state power limit of the system with one line in service, as by using braking resistors of the shunt type, some benefit might conceivably be obtained from the dynamic balancing regulator.

The system might be operated below the ordinary steady state power limit with two lines in service, but above the steady state power limit of the system with but one line in service. Then with both lines in service stable operation might be provided in case of line faults by using braking resistors, presupposing of course the use of breakers of the proper opening speed. The dynamic balancing regulator might then permit operation under a dynamically stable condition until the faulty line could be replaced in service.

This sort of operation does not at the moment appear to be necessary nor does it at the moment appear to be practical because of breaker speed and regulator limitations. But conceivably the future may indicate the possibility of some gains in this direction. As better regulators and faster switching schemes are developed this sort of operation may occasionally become useful. The vacuum tube regulator, which possesses the dynamic balancing possibilities of the best of vibrating regulators, is showing commercial possibilities and improvements in breaker design indicate that the hope of obtaining even faster switching times may be realized.

Other Things

The discussion of the effect of this or that on the stability of systems might be carried much further. But this discussion has gone far enough to illustrate that every case is unique unto itself and therefore the more interesting. The conclusion may be drawn that there is no complete panacea for instability.

The effect of quick switching has been shown and this seems to be the most practically effective way of increasing system stability. The effect of controlled input to prime movers may come to be of some benefit in the future. A proper excitation system is necessary at least to keep the flux in machines constant and it is rather impractical to try to do much more than that with excitation systems. The effect of limiting faults by neutral impedance and by segregation of the system, which is beneficial at times, has been discussed. Other means, such as changing WR^2 have been mentioned.

But the possibilities are not exhausted. The effect of synchronous condensers has not been touched upon. Sometimes these help to maintain stable operation, although they have a habit of adding to the general confusion amongst machines at times of faults and after. Series capacitors have not been referred to. These counteract the effect of line reactance, but they must be taken out of service during faults or they would break down due to the voltage drop across them with heavy current flow through them. They improve steady state limits, but chief interest is in transient limits. Nothing has been said of the effectiveness of adding lines, but obviously these help to increase power limits up to a certain point. Synchronized at the load schemes have not been discussed and these are sometimes effective.

Complex Problems

In all of this discussion, simple two machine systems involving round rotor machines have been assumed to facilitate the discussion. Obviously such a simple method of analysis cannot always be applied, and where it is applied it is usually necessary to make certain simplifying assumptions.

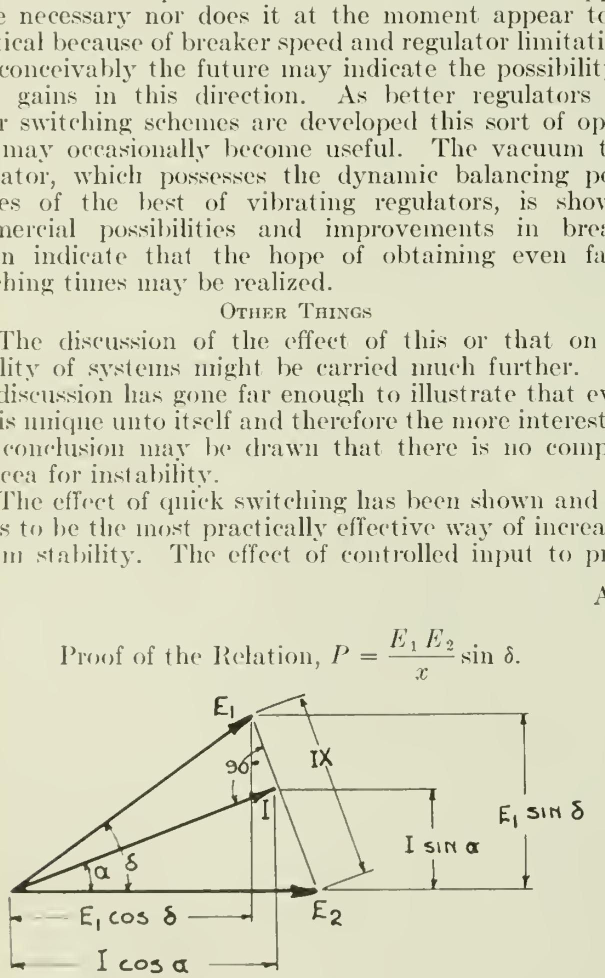
Where system components cannot be lumped together and a two machine problem set up, then the calculations may become truly burdensome. Step by step calculations of the angular position of three, four, or more equivalent machines must be made, the resulting curves being called swing curves. An example is shown by Fig. 30. Moreover, where salient pole machine theory must be employed the calculations become still more complicated. But it is beyond the present scope to discuss these more intricate details. Suffice it to say that methods are available for analyzing most of the problems which arise, and that these methods are being extended as occasion demands.

Conclusion

In conclusion the author wishes to express his appreciation of this opportunity of discussing some of the phases of a problem which is becoming of increasing importance, and also to express the hope that he has usefully explained the fundamental considerations involved. He also wishes to express his appreciation of the assistance furnished by his associates, without which this discussion could not have been so fully prepared.

APPENDIX

Proof of the Relation, $P = \dfrac{E_1 E_2}{x} \sin \delta$.



Vectorially,

$$j(x\dot{I}) = \dot{E}_1 - \dot{E}_2 \quad \ldots\ldots (1)$$

$$\dot{I} = \frac{\dot{E}_1 - \dot{E}_2}{jx} \quad \ldots\ldots (2)$$

Now take the position of E_2 as the vector of reference. Then,

$$I \cos \alpha + jI \sin \alpha = \frac{E_1 \cos \delta + jE_1 \sin \delta - E_2}{jx} \quad \ldots\ldots (3)$$

Simplifying the right hand side of (3),

$$I \cos \alpha + jI \sin \alpha = \frac{E_1 \sin \delta}{x} + \frac{j(E_2 - E_1 \cos \delta)}{x} \quad \ldots (4)$$

Equating the real parts of (4),

$$I \cos \alpha = \frac{E_1 \sin \delta}{x} \quad \ldots\ldots (5)$$

Power being the in phase product of volts and amperes,

$$P = E_2 I \cos \alpha \quad \ldots\ldots (6)$$

Substituting (5) in (6),

$$P = \frac{E_1 E_2}{x} \sin \delta \quad \ldots\ldots (7)$$

Direct Method for Normal Thrust and Moment Influence Lines for Fixed Arches

Alfred Gordon,
Canadian Pacific Railway Company, Montreal.

Paper presented before the Montreal Branch of The Engineering Institute of Canada on February 19th, 1931.

SUMMARY—The determination of influence lines for fixed arches can be performed by the aid of models, or by a standard method of analysis which necessitates a great deal of laborious calculation. The author in this paper sets forth a method of analysis involving no more difficulty than in the case of a two-hinged arch. It is based on the ellipse of elasticity.

It has been shown in recent years that the assumption, in the standard analysis of the reinforced concrete spandrel arch, of knife-edge application of the load by the spandrels to the rib is not warranted; and that the stiffness of the frame formed by the spandrels and deck slab should be taken into account.

A strict mathematical treatment of such a structure, dealing with it as it is, a stiff frame composed of straight and curved members, would need a prohibitive amount of labour. For example, an arch with nine spandrels would have eighteen joints, at each of which there would be an unknown angle of rotation, an unknown vertical displacement, and an unknown horizontal displacement; and these fifty-four unknowns would have to be found for nine positions of a unit load.

In order to meet this situation, the aid of cardboard models has been invoked, and it has been shown that reliable influence-lines may be obtained by observing the distortion of such models. This apparatus is, however, quite costly.

For these reasons, therefore, it seems probable that many arch ribs will yet be designed in accordance with the standard texts.

Now, even the standard method at present necessitates a great deal of work; and the object of this paper is to set forth a method which makes the analysis of the fixed arch, on the usual assumptions, at least no more difficult or laborious than that of the two-hinged arch. It is based on the ellipse of elasticity, and it is presumed for the nonce that the reader is familiar with its theory. This presumption may not be warranted, but seems advisable. The spiders' webs of funicular polygons hitherto associated with the ellipse of elasticity have been sufficient to make it a thing abhorred; but let it be seen, as it were, in its untrammelled beauty, and it may come to be desired, when, if this devoutly-to-be-wished-for consummation be brought to pass, the anatomy of its art may not be so distasteful.

Accordingly, the constructions themselves will first be given, for their simplicity is such, that it is scarcely conceivable anyone would afterwards gainsay the pleading of their *raison d'être*.

Fig. 1 shows the influence-line for the normal-thrust at panel-point 2 of the arch-rib analysed in Hool and Kinne's "Movable and Long-Span Bridges," sections 9-21, and is described and constructed as follows:

(1) The numbers denote the centres of 32 equal "voussoirs," each being 156.4″ long ($ds = 156.4$).

(2) "G" (see Table) is the "elastic weight" (ds/I) of each "voussoir."

(3) "O" is the "elastic centre" of the arch, i.e. the C.G. of the "elastic weights."

(4) X-X and Y-Y are the co-ordinate axes for all subsequent calculations.

(5) The "ellipse of elasticity" is not drawn, but is indicated by its major and minor circles, the radius of the former being given by $a = \sqrt{\Sigma Gx^2/\Sigma G}$, and of the latter by $b = \sqrt{\Sigma Gy^2/\Sigma G}$.

(6) The point $P2'$ is the "antipole of the normal to the arch axis at the point $P2$." If x_p and y_p be the intercepts of this normal upon the X and Y axes, then the co-ordinates of $P2'$ will be given by $x = a^2/x_p$ and $y = b^2/y_p$.

(7) The line M-M is drawn through O and $P2'$, the lengths "m" are scaled, and the products "Gm" are computed, completing the Table.

(8) The "Gm's" are then considered as vertical loads applied at the centres of their respective "voussoirs," and force- and funicular-polygons are drawn for them, using scales as hereafter indicated. The funicular-polygon so obtained is the desired influence-line.

(9) Scales: These may be best represented by the formula:

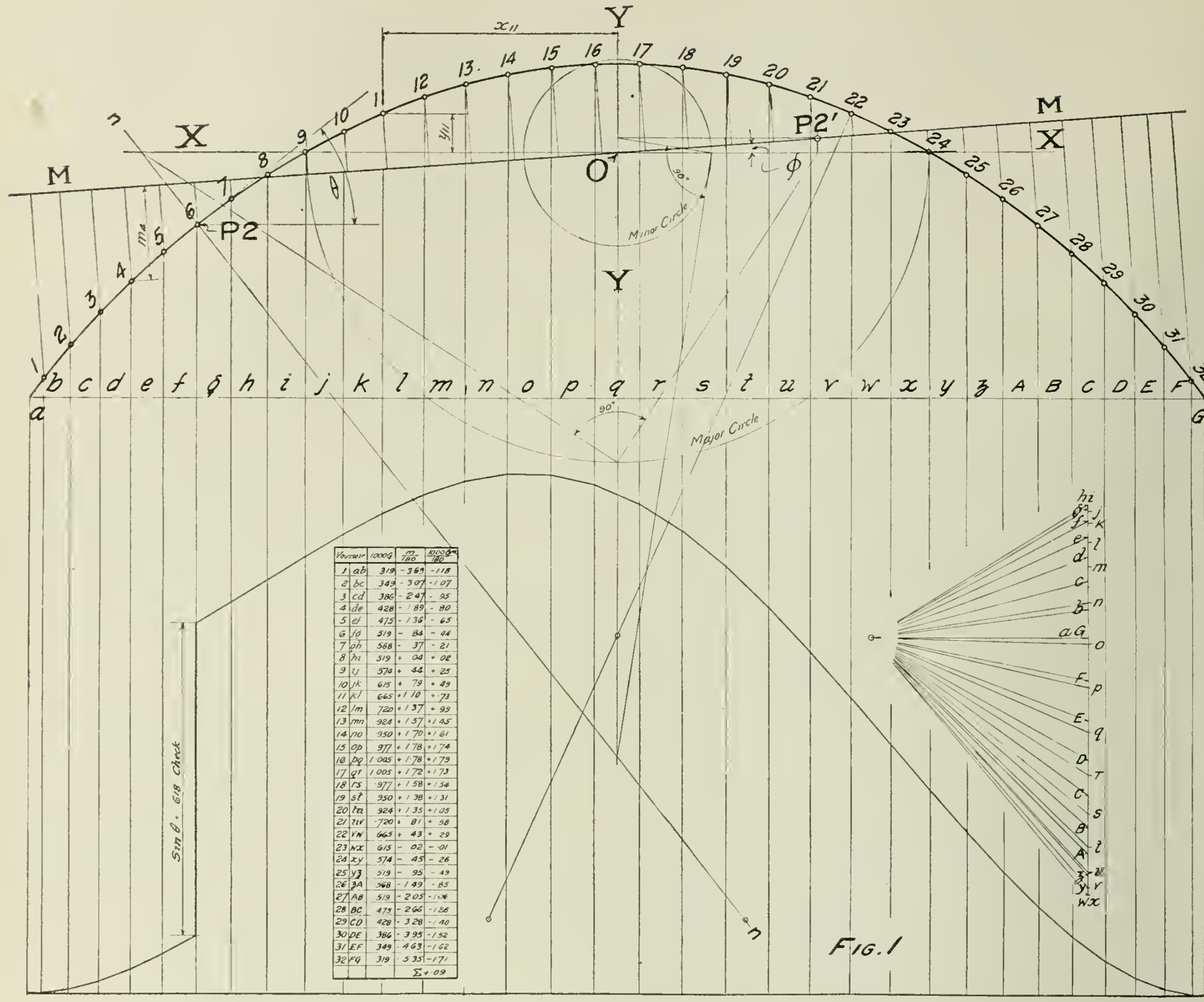
$$\text{Pole Distance} = \frac{\Sigma Gy^2 \cdot \cos\phi}{\cos\theta} \cdot \frac{\text{Scale of Drawing} \times \text{Scale of } Gm\text{'s}}{\text{Desired Scale of Influence Line}}$$

thus, in the present example, ΣGy^2 was 2191, $\cos\phi$ was virtually unity, $\cos\theta$ was .7864, the scale of the Drawing was $1/180'' = 1''$, the scale of the Gm's was $1/.36'' = 1$ (Gm), and it was desired that an ordinate of 10″ on the influence diagram should represent a normal thrust of 1 lb., so that the pole-distance was

$$\frac{2191}{.7864} \times \frac{\frac{1}{180} \times \frac{1}{.36}}{10} = 4.3''$$

It should also be noted that the pole is taken opposite the load-divide-point, Ga.

Fig. 2 shows the influence-line for the moment at panel-point 7 of the same structure. Here the line M-M is the "anti-polar of the point $P7$ with regard to the central ellipse of elasticity." It may be determined by the construction shown (and treated more fully later), or analytically, thus: its intercept, OG, on the Y-axis is given by $OG = b^2/y$ (for $P7$); and its inclination, ϕ, by $\tan\phi = b^2x$ (for $P7$)$/a^2y$ (for $P7$). The remainder of the procedure is the same as for the normal-thrust influence-line except for the pole-distance and the setting off of the force-polygon. Commencing with ab, set off the loads in the usual manner up to the panel-point; then, G being coincident with a, set off the loads GF, FE, etc., up to the panel-point, with sign reversed. Take the pole itself opposite the load-divide point, Ga. These precautions ensure the funicular polygon, which is the desired influence-line, having a horizontal base so that it is immediately available for use. With regard to the scale: if the pole-distance had been made the same length as the load-line, the ordinates on the influence diagram would have been to the same scale as the arch-rib. Thus, in the present example, the scale of the rib was $1'' = 180''$, so that had the unmodified length of the load-line been used, then an ordinate of 1″ would have represented 180 in. lbs.; but the pole-distance was made 100/180 the length of the load-line, so that an ordinate of 1″ represented 100 in. lbs.



Voussoir		1000G	m/180	1000Gm/180
1	ab	319	-369	-118
2	bc	349	-307	-107
3	cd	386	-247	-95
4	de	428	-189	-80
5	ef	475	-136	-65
6	fg	519	-84	-44
7	gh	568	-37	-21
8	hi	519	+04	+02
9	ij	574	+44	+25
10	jk	615	+79	+49
11	kl	665	+110	+73
12	lm	720	+137	+99
13	mn	924	+157	+145
14	no	950	+170	+161
15	op	977	+178	+174
16	pq	1·005	+1·78	+179
17	qr	1·005	+172	+173
18	rs	977	+158	+154
19	st	950	+138	+131
20	tu	924	+135	+105
21	uv	720	+81	+58
22	vw	665	+43	+29
23	wx	615	-02	-01
24	xy	574	-45	-26
25	yz	519	-95	-49
26	zA	568	-149	-85
27	AB	519	-205	-106
28	BC	475	-266	-126
29	CD	428	-328	-140
30	DE	386	-395	-152
31	EF	349	-463	-162
32	FG	319	-535	-171
				Σ + ·09

Fig. 1.

The explanation of these constructions is based on the well-known fact that the influence-line for any reaction, shear, bending moment or stress is identical with the deflection diagram produced by a unit displacement at the point of application and in the direction of the desired reaction, shear, bending moment or stress.

From the principle of consistent elastic distortions, the relation between load, reaction and deflections for an indeterminate structure is governed by the law of the lever, so that (see Fig. 3) we have at once $TD = Wd$, whence, if D and W be made unity, $T = d$, and the curve of vertical displacements due to a tangential displacement of unity at P will be the influence-line for T due to a moving vertical load of unity. Similarly, the curve of vertical displacements due to an angular displacement of unity at P will be the influence-line for the moment at P.

Now, consider (see Fig. 4) the skew-backs connected by a rigid bar, the rib fixed at the panel-point in question and cut immediately to the left of it, the free end being connected to the elastic centre by another rigid bar. (These rigid bars leave the elastic properties of the system unaffected.)* Then, according to the properties of the ellipse of elasticity, a force acting along the line M-M in Fig. 1 will displace the elastic centre in a direction parallel to the tangent to the arch axis at the cut section, that is, will displace the free-end, connected thereto by the rigid bar, tangentially; whilst a force acting along the line M-M in Fig. 2 will produce a pure rotation of the elastic centre, and of the free end connected thereto by the rigid bar, about the panel point.

Let the force acting along M-M, producing this desired displacement or rotation, be unity, then the moment at each voussoir due to it will be "m," and, by the method of moment-areas, the curve of vertical displacements due to it will be given by loading the cantilever (with support and free end coincident) with the several products Gm and obtaining the bending-moment diagrams therefor. The funicular-polygons corresponding to the force-polygons having for their loads these products are these bending-moment diagrams, or curves of vertical displacements, or required influence lines.

The chain of argument will now be completed by proving the statements in the penultimate paragraph, that a force acting along the line M-M in Fig. 1 will produce the desired tangential displacement of the elastic centre; and a force acting along the line M-M in Fig. 2 will produce the desired pure rotation of the elastic centre.

As a preliminary to the proofs of these two statements, there will now be presented such geometrical properties of the ellipse as are germane to them.

(1) If there be a point, P_m (Fig. 5a), and from P_m there be drawn secants, and tangents to the ellipse at the

*See final note.

points of intersection of the secants with it, then each pair of secants intersects on a line M-M, and the point, P_m, and the line, M-M, are said to exist in the relation of pole and polar, while the point, P'_m, (symmetrical with P_m) is said to be the antipole of the line M-M. It may be shown that $(r_m)^2 = m'\overline{m}$.

(2) Any line passing through the centre of the ellipse is called a diameter. The pole and antipole of any diameter, such as AB (Fig. 5b), lie at infinity on a line parallel to the tangents at its extremities. Since two diameters, each parallel to the tangents at the extremities of the other, such as AB and CD, are called conjugate diameters, therefore the pole and antipole of a diameter fall upon its conjugate diameter at infinity. It may be shown that

$$\tan\theta_1 \tan\theta_2 = -a^2/b^2.$$

(3) Consider the line M-M (Fig. 5c). As it moves, parallel to itself, to the position qrs, its pole moves from P_m to the point r, so that the point r is the pole of the tangent qrs parallel to M-M. Now, from the previous paragraph, the pole and antipole of PC, a diameter, lie on the diameter conjugate to PC, that is, on a diameter parallel to the tangent at r, that is, parallel to M-M, that is: the pole and antipole of any line lie on a diameter whose conjugate is parallel to the given line, or: any line joining a pole or antipole to the centre of an ellipse is conjugated with a diameter parallel to the corresponding polar, e.g., rr' is conjugated with PC.

Consider Fig. 6a, the fundamental formula for the deflection of curved beams being $\delta = \int Mm\, ds/EI$, in which M is the moment due to the applied loads, and m the moment due to an auxiliary force applied at the point of which the deflection is desired, and in the direction of the desired deflection: the vertical deflection of B is therefore $\Sigma Fx \,.\, 1 \,.\, x \,.\, ds/EI = F/E \,.\, \Sigma Gx^2$, and the horizontal deflection is $\Sigma Fx \,.\, 1 \,.\, y \,.\, ds/EI = F/E \,.\, \Sigma Gxy$. If the origin of co-ordinates be taken at the elastic centre, or C.G. of the elastic weights, G, then the term ΣGxy becomes zero, so that the vertical deflection is $F/E \,.\, \Sigma Gx^2$. Similarly, if F were horizontal (Fig. 6b), we should have the horizontal deflection due to F given by $F/E \,.\, \Sigma Gy^2$, and the vertical deflection would be zero.

Next consider a force, Q (see Fig. 7), so applied that it causes a displacement of B (connected to O, the elastic centre, by a rigid bar) $= \delta_\theta$.

Resolving Q into its horizontal and vertical components, the horizontal displacement of O will be $x = Q/E \,.\, \cos\phi\, \Sigma Gy^2$, the vertical displacement $y = Q/E \,.\, \sin\phi\, \Sigma Gx^2$; and the tangent of the angle of the resultant displacement will be $y/x = \tan\phi \,.\, \Sigma Gy^2/\Sigma Gx^2$. If an *ellipse* be drawn with half its major axis, $a = \sqrt{\Sigma Gx^2/\Sigma G}$, and half its minor axis, $b, = \sqrt{\Sigma Gy^2/\Sigma G}$, the expression for this tangent becomes $\tan\phi \,.\, a^2/b^2$.

Now, from section (2) of the paragraph dealing with the properties of an ellipse, this indicates that the resultant displacement is at right-angles to the axis conjugate to the direction of Q, i.e., that Q must be applied along the axis conjugate to the diameter parallel to n-n, n-n being at right-angles to δ_θ, to effect the displacement δ_θ.

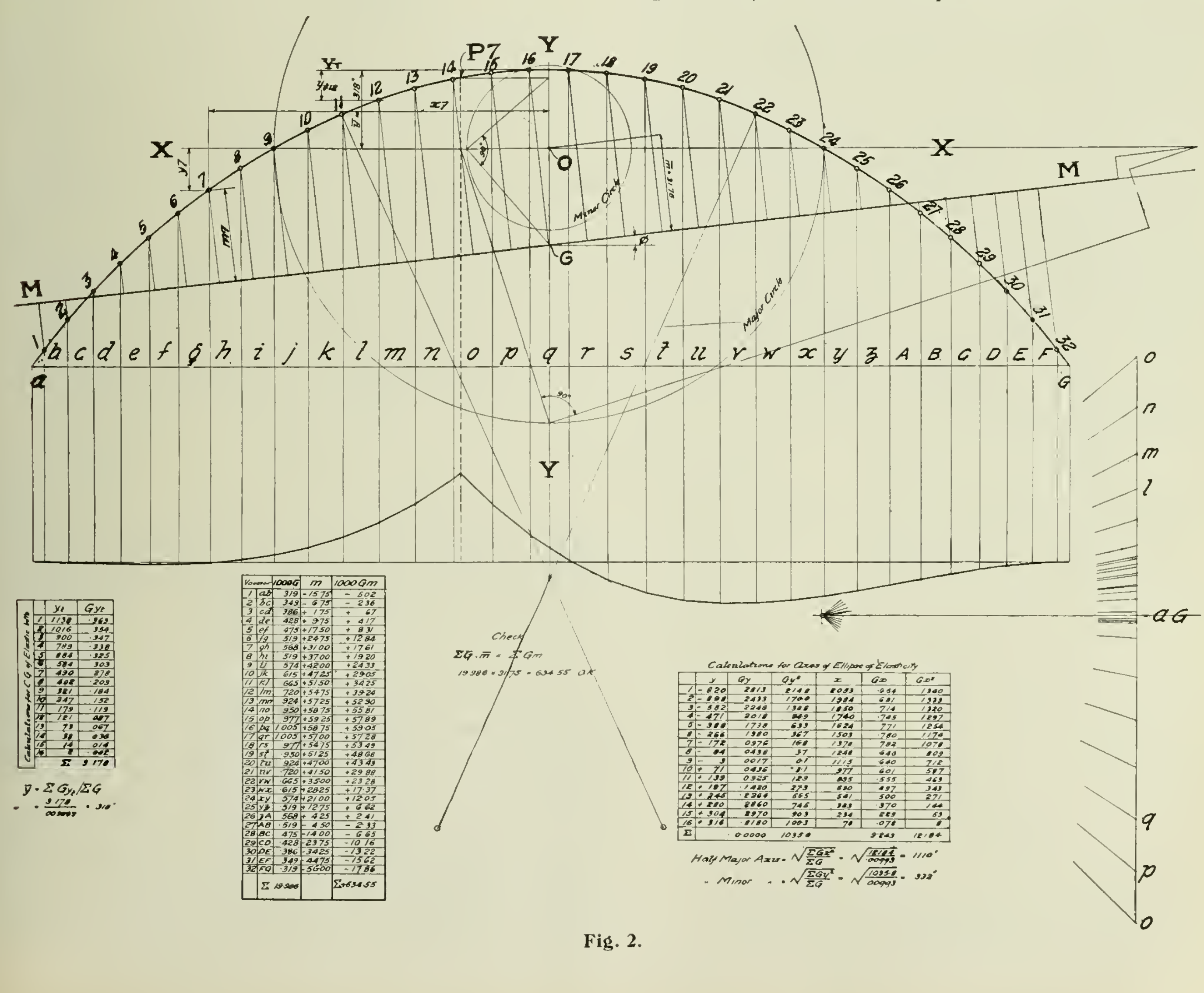


Fig. 2.

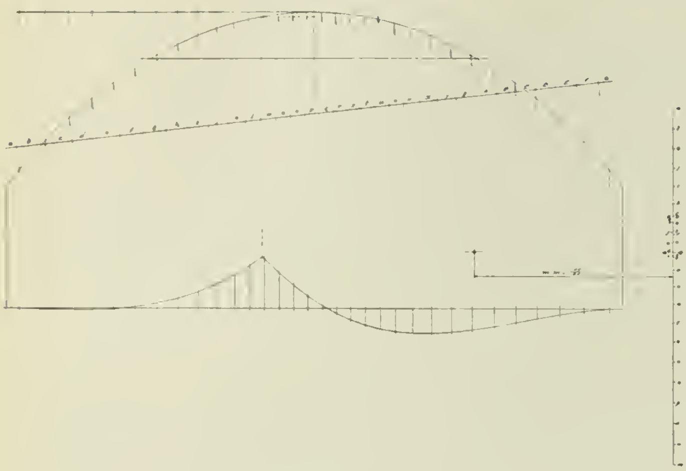


Fig. 2 a.

Again, because the axis M-M (Fig. 1) is a diameter drawn through the antipole of the normal, n-n, to the arch-axis at P, therefore, in accordance with section (3) of the paragraph dealing with the properties of an ellipse, it *is* conjugate to n-n, and any force acting along it *will* produce a displacement of the elastic centre at right-angles to n-n.

Finally, the displacement

$$\delta_\theta = x/\cos\theta = \Sigma Gy^2 \,.\, \cos\phi/\cos\theta = \frac{b^2 \Sigma G.\cos\phi}{\cos\theta}$$

(E and Q being taken as unity), from which follows the pole-distance used in the construction of the thrust influence lines.

Again, consider Fig. 8. The point B will rotate, due to the force F, about some instantaneous centre, C, yet to be determined, through an angle $\alpha = F \,.\, \Sigma Gm$ (from the fundamental formula $\alpha = \int Mm \,.\, ds/EI$, in which M is the moment due to the applied loads, and m is the moment due to an auxiliary couple applied at the point of which the rotation is desired, thus $\alpha = \int Fm \,.\, 1 \,.\, ds/EI = F \,.\, \Sigma Gm$—hence the pole-distance used in the construction of the moment-influence-lines).

Drawing through B the rectangular axes X-X and Y-Y, we have

$$\Delta_x = \rho_x\alpha = \rho_x F \Sigma Gm; \quad \Delta_y = \rho_y F \Sigma Gm \qquad \text{(1a and 1b)}$$

and, applying a unit force first along X-X, and then along Y-Y,

$$\Delta_x = F \Sigma Gmy; \quad \Delta_y = F \Sigma Gmx \qquad \text{(2a and 2b)}$$

Equating, there result

$$\rho_x = \frac{\Sigma Gmy}{\Sigma Gm}; \quad \rho_y = \frac{\Sigma Gmx}{\Sigma Gm} \qquad \text{(3a and 3b)}$$

If the elastic moments, Gm, be regarded as weights, the coordinates of their C.G. will be

$$x_m = \frac{\Sigma Gmx}{\Sigma Gm}; \quad y_m = \frac{\Sigma Gmy}{\Sigma Gm} \qquad \text{(4a and 4b)}$$

giving

$$x_m = \rho y; \quad y_m = \rho x \qquad \text{(5a and 5b)}$$

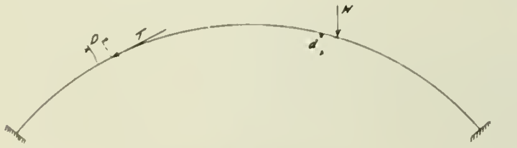


Fig. 3.

Fig. 4.

whence: The instantaneous centre for any terminal point of an elastic system under the action of a force acting along any line M-M is coincident with the C.G. of the elastic moments, Gm.

Continuing, the displacement of B along M-M is $\Delta_m = F \Sigma Gm^2 = F \Sigma G\ (m' - \overline{m})^2 = F \Sigma Gm^2 + F \Sigma Gm'^2$ since $2 \Sigma Gmm'$ is zero due to O being the C.G. of the elastic weights, or

$$\Delta_m = F\overline{m}^2 \Sigma G + F \Sigma Gm'^2 \qquad (6)$$

since $\overline{m}$ is constant.

Also, just as, above,

$$x_m = \Sigma Gmx / \Sigma Gm,$$

so $\qquad m_m = \Sigma Gmm/\Sigma Gm = \Sigma Gm^2/\Sigma Gm,$

or $\qquad \Sigma Gm^2\ (= \Delta_m/F) = m_m \Sigma Gm = m_m\overline{m}\, \Sigma G$

(since O is the C.G. of the elastic weights), that is

$$\Delta_m = Fm_m\overline{m}\, \Sigma G = Fm'_m\overline{m}\, \Sigma G + F\overline{m}^2 \Sigma G \qquad (7)$$

Equating (6) and (7), we obtain

$$m'_m\overline{m} = \Sigma Gm'^2/\Sigma G.$$

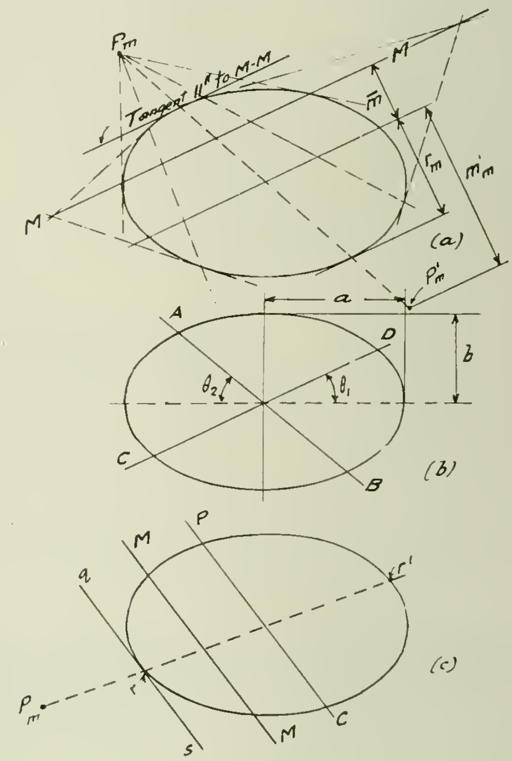


Fig. 5.

Let the ellipse be drawn as before. It is clearly nothing more than the ellipse of inertia of the elastic weights, from the familiar properties of which it follows that their radius of gyration about M-M will be

$$r_m = \sqrt{\Sigma Gm'^2/\Sigma G,}$$

giving $\qquad r_m{}^2 = \Sigma Gm'^2/\Sigma G = m'_m\overline{m}.$

We have seen, however, in section (1) of the paragraph dealing with the properties of an ellipse, that this is the relation between a polar (M-M) and its antipole (P'_m). Accordingly, the instantaneous centre of a force acting along M-M; the C.G. of the elastic moments (Gm); and the antipole of M-M—are all identical.

It should be remarked that the pole, as well as the antipole, is related to the line M-M by the same formula, since the pole and antipole are symmetrical; but the pole cannot be the instantaneous centre of a force acting along M-M. If this were so, then, in Fig. 5c, if the force were acting along the line qrs, of which the pole is r, then its

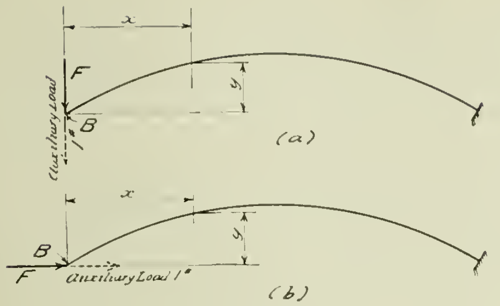


Fig. 6.

instantaneous centre would fall on its line of action, which is impossible. The instantaneous centre is coincident with the antipole, r'.

A simple graphical construction enables us, given the ellipse and the line M-M, to find the antipole—even without drawing the ellipse. It is shown in Fig. 9.

Join the intersection, P, of M-M with the major axis, to the intersection, Q, of the major circle and minor axis. Draw QR at right angles to PQ, cutting the major axis at R. Join the intersection, S, of M-M with the minor axis, to the intersection, T, of the minor circle with the major axis. Draw TU at right angles to ST, cutting the minor axis at U. Then OR and OU are the co-ordinates of the antipole P'_m. The inverse process enables us to find M-M, given P'_m.

Thus the antipole $P2'$ of the normal n-n was found in Fig. 1, and thus the polar M-M corresponding to the antipole $P7$ in Fig. 2; and since the antipole $P7$ is the instantaneous centre for the terminal point of the system, i.e. the elastic centre, under the action of a force acting along M-M, therefore this force will cause the elastic centre to rotate about $P7$ as was stated at the outset.

Thus the critical statements, that a force acting along the line M-M in Fig. 1 will produce a tangential displacement of the elastic centre, and a force acting along the line M-M in Fig. 2 will produce a rotation, have both been proved, and the chain of argument is complete.

Before drawing to a conclusion, since the explanation of these influence-lines has unavoidably necessitated, in turn, an explanation of the ellipse of elasticity, the treatment of the latter may here be completed by one or two notes which, if they had been inserted earlier, would have broken the march of the main argument.

It should be observed that in equations (1a) and (1b), since $\Sigma Gm = \overline{m}\Sigma G$, the displacements along the axes X-X and Y-Y are

$$\Delta_x = F\rho_x\overline{m}\Sigma G \quad \text{and} \quad \Delta_y = F\rho_y\overline{m}\Sigma G$$

respectively.

These expressions for the displacements along X-X and Y-Y, together with the expression for the displacement along M-M, $\Delta_m = Fm_m\overline{m}\Sigma G$, in equation (7), may all be expressed in words, as follows: the displacement of the terminal point of an elastic system under the action of a force in any direction is given by the equation: Displacement = Force × Perpendicular Distance of Antipole of Line of Action of Force to Line along which Displacement takes place × Perpendicular Distance of Line of Action of Force to Centre of Ellipse (of elasticity) × Sum of Elastic Weights.

This equation, of course, as we have seen, does not, however, apply when the line of action of the force passes through the elastic centre. The displacement then, it has been shown, is along the diameter conjugate to the line of action of the force, and is given by the equation

$$\vec{d} = Fb^2\Sigma G \,.\, \cos\phi/\cos\theta.$$

The proved statements in the last two paragraphs, and the demonstration that a force applied along a polar will cause a rotation of the elastic centre about the corresponding antipole, in amount equal to $F\Sigma Gm = F\overline{m}\Sigma G$, summarize completely the fundamental theory of the ellipse of elasticity.

These influence-lines have the advantage that it is very easy to check their construction. For example, in the normal thrust influence-line there is a step at the vertical under the panel-point in question, and this step must be, to scale, sine θ, since this is the vertical component of the assumed unit tangential displacement at the panel-point; whilst the moment-influence-line consists, as may be seen, of two curves starting tangentially from the two ends of the rib, and the cusp formed by their intersection must fall on the vertical through the panel-point in question, and, furthermore, the sum of the Gm's must be equal to the product of the antipolar force, unity, acting along M-M, and its perpendicular distance from the elastic centre.

The moment-influence-lines, it should be said, are of greater importance than those for the thrust, as in practice it will be found best to draw two sets of them, the one for the upper "core-points," the other for the lower, thus giving the extreme fibre stresses directly, and rendering the thrust-influence-lines superfluous.

It may also be remarked that, strictly speaking, the Gm's should be applied as vertical loads *not* at the centres of their respective "voussoirs," but at the antipoles of the ellipse of elasticity of each voussoir with regard to the line M-M, thus taking account of rib-shortening. This is, however, a super-refinement; and, further, it seems desirable, with the tendency to compensate for rib-shortening by the use of hinges, to compute this separately.

A still greater simplification of the work may be effected by dividing the arch-axis into sections such that ds/I is a constant. Fig. 2a shows the same construction

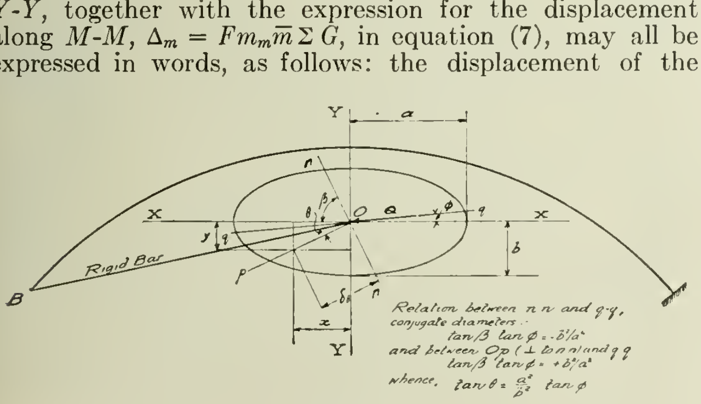


Fig. 7.

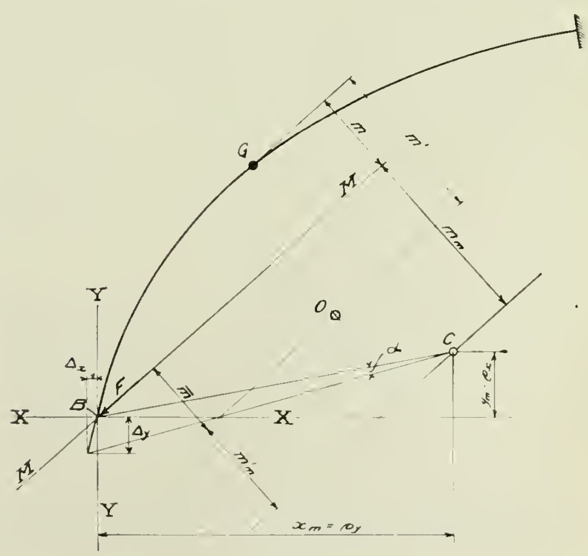


Fig. 8.

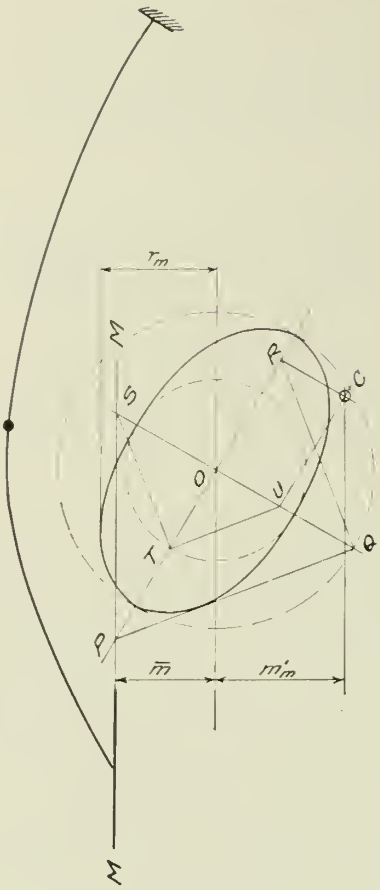


Fig. 9.

as for Fig. 1, with this modification. The arch-rib was divided into 32 such sections, the work of computing the C.G. of the elastic weights and semi-major and minor axes of the ellipse being thereby greatly reduced, and the tabulation of the products Gm being rendered unnecessary, it being only required to lift the lengths, m, off the main figure with proportional dividers, and thus obtain the load-line at once. The location of the elastic centre is given by the mean of the ordinates, k; the radius a is $\sqrt{\frac{\Sigma x^2}{32}}$, and the radius b is $\sqrt{\frac{\Sigma y^2}{32}}$.

With a table of squares these calculations are a bagatelle and after they have been made the work is as easy as the drawing of a bending-moment diagram, with which, in fact, it is identical. In this figure, by intention, only essential lines have been shown, and it is itself more eloquent than anything that can be said on its behalf.

It is true that there would have been more complications had an unsymmetrical arch been selected for an example; we should had to "conjugate" its axes; and there would have been still more complications had arches on elastic piers been selected; we should have had to combine the ellipses of the arches and piers

Had an unsymmetrical arch been selected, we should have had to assume temporary axes H-H (horizontal) and V-V (vertical). The principal axes X-X and Y-Y of the ellipse would then be at an angle with the temporary ones such that its tangent would be given by the expression

$$\tan 2\phi = \frac{2\,\Sigma\,Ghv}{\Sigma\,Gh^2 - \Sigma\,Gv^2}.$$

Had arches on elastic piers been chosen, it would have been necessary to supplement the present treatment of the ellipse of elasticity by practically a repetition of Mr. Janni's treatment of the same problem in section 48 of Professor Hool's "Reinforced Concrete." As that section does not involve any of the "spiders' webs" by which it is there preceded, and as it may readily be understood with the introduction here afforded, it seemed better to indicate it than to resort to bare quotation.

In brief, the simplifications effected by considering the most elementary example, a symmetrical arch, are not responsible for the elegance of the diagrams. The complications mentioned pertain only to the determination of the ellipse of elasticity, the slope and length of its axes. These having been determined, the procedure would be as straightforward as here shown for the symmetrical arch.

This directness arises from the physical concepts which lie behind it. Whereas in the standard method we consider the horizontal, vertical and angular displacements of the elastic centre, from which we are able to evaluate influence lines for the horizontal thrust, vertical reaction, and moment, from which in turn we can obtain expressions for the normal thrust and moment at any section; in the method presented we are able, through the properties of the ellipse of elasticity, to apply a *single* force in such manner that it will produce *any* desired displacement or rotation of the elastic centre. This fact, coupled with the law of consistent elastic distortions and the principle of moment areas, virtually reduces the analysis of the fixed arch to the same order as that of a structure which is indeterminate in but a *single* degree.

Because of the directness of the method in application, it has seemed imperative to re-present the ellipse of elasticity, shorn of its usual festoon of spiders' webs of funicular polygons, in its essence, as simply a geometrical means of locating a force that will produce a desired displacement or rotation. There is, it must be admitted, no originality in the proofs offered; but it may be claimed that there is some originality in the shearing of these festoons. It is surely no more than the truth to say that the existing examples of arch-analysis by means of the ellipse of elasticity are enough to make any average engineer, with the normal moment of inertia in respect to new methods, wish the whole subject to Hanover.

Finally, certain acknowledgments must be made. The method just completed was in part indicated by D. B.

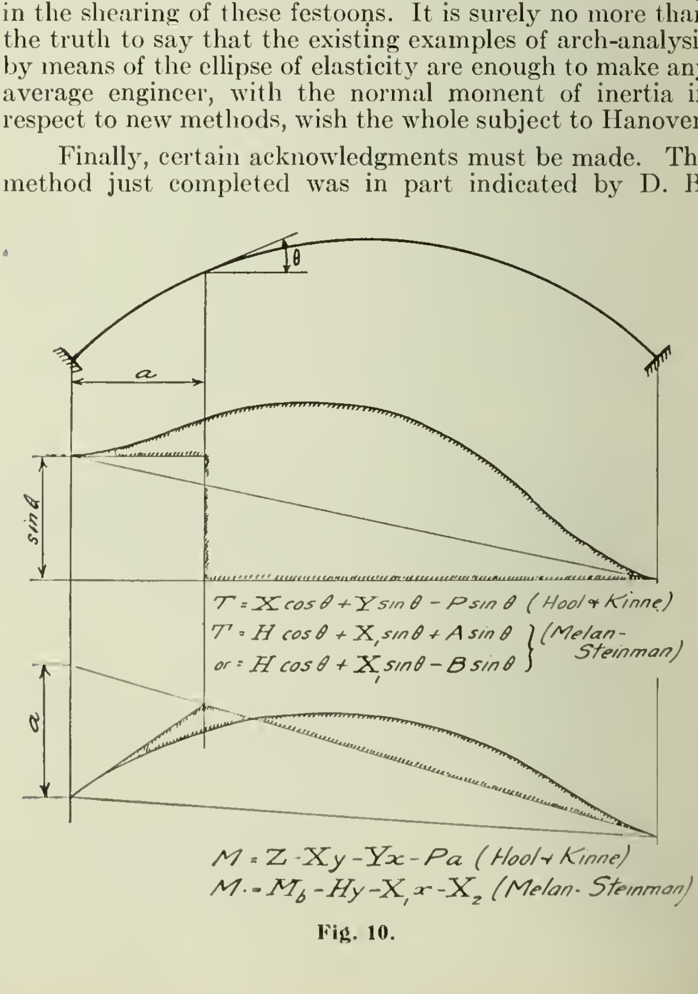


Fig. 10.

Steinman, M.Am.Soc.C.E., in the discussion of the paper by A. C. Janni, M.Am.Soc.C.E., "The Design of a Multiple-Arch System and its Permissible Simplifications" (Trans. American Society of Civil Engineers, vol. 88), where he barely stated the method for the moment-influence-line. The remark seems to have passed unnoticed for five years.

It was a corollary that the same idea should apply to the normal-thrust-influence line, but it was not so clear just how the application should be made. Eventually the problem was solved as shown; and when the solution was found, it appeared to have been anticipated in Johnson, Bryan and Turneaure's "Modern Framed Structures," Part III, Appendix C, section 8, on the "Deflection of Beams Under Unsymmetrical Bending." This seems to have passed unnoticed for fourteen years.

A good text, therefore, for this sermon, would be "The stone which the builders rejected, the same is become the head of the corner."

Of course, the whole method is implicit in the ellipse of inertia; but, as Professor Swain remarked, when it was contended that his formula for computing rotation in elastic distortion was "implicit" in Castiliagno's work-equations, the whole of modern dynamics is "implicit" in Newton's laws of motion, but this does not detract from those who have made those implications explicit

It is hoped that it will be considered of some service to the profession to have made explicit, in these constructions, what has hitherto either been merely implicit or else brushed on one side into possible oblivion through its practical utility having been under-estimated.

Note: The introduction of the rigid bar connecting the skew-backs, and cutting the ring thus formed so that it becomes a cantilever with free end and support coincident, are not mere tricks. Otherwise, we should run into all the complications of "residual" cantilevers or beams. That is, dealing with the thrust, we might load the arch as a straight cantilever beam, supported at the left-hand end, with the same elastic weights, Gm, and from the moment-diagram thus obtained deduct $\sin\theta$ between the left-hand end up to the panel-point considered. Or we might load the arch as a simply supported beam with the same elastic weights, Gm, and combine the moment-diagram thus obtained with the influence-line for shear at the panel-point considered due to a moving load of $\sin\theta$. The first alternative would correspond to the equation $T = X\cos\theta + Y\sin\theta - P\sin\theta$ used in Hool and Kinne, Q (see Fig. 7), multiplied by a constant, replacing $X\cos\theta + Y\sin\theta$. The second alternative would correspond to the equations $T = (H\cos\theta + X_1\sin\theta) + A\sin\theta$ (loads to right of P) and $T = (H\cos\theta + X_1\sin\theta) - B\sin\theta$ (loads to left of P), in which $X_1 = (M_L - M_R) \div$ span, and A and B are the reactions of a simple beam, as in "Plain and Reinforced Concrete Arches," Melan-Steinman. The same reflections apply to the moment-influence-lines. The method adopted avoids all these complicated equations, and is consistent with Fig. 3 and the simple $TD = Wd$, enabling us to deal with the influence-line for T or M directly, as well as giving it to a straight-line base ready for use without re-plotting. The only use of the "ellipse of elasticity" is to locate the line M-M, along which a force will produce the tangential displacement, D, or a simple rotation. Fig. 10 is added to show the complications, both in theory and practice, avoided.

Discussion on "Direct Method for Normal Thrust and Moment Influence Lines for Fixed Arches"

Paper by Alfred Gordon[1]

J. F. Brett, A.M.E.I.C.[2]

Mr. Brett remarked that the author's method of stress calculation, applied to arches, although not new, had as yet received only limited attention in text books, its treatment consisting usually of the bare statement of the underlying formulae. He considered that the author's amplification of the subject was original and of real practical value to the profession.

At the outset it should be noted that the fundamental problem in arch design, after the selection of the proper type of arch, consisted of the design of the axis, the determination of the rib thickness and the reduction of the elastic stresses due to deformation.

The checking of the stresses by the Elastic Theory in one form or another was only the last step, and was quite distinct from the design, because it had not been found possible, so far, to obtain an exact solution of the fundamental problem directly through the Elastic Theory.

Arches might be classified according to their various characteristics, such as span length, span to rise ratio, arrangement of ribs and spandrels, manner of putting the rib under load, etc. The characteristics of the several classes were so different that it was not possible to analyze them all by any single method.

The method of analysis discussed by the author assumed that the ring or ribs would not be seriously affected by the deformations of the spandrel supports and the deck framing. This was only true when the rigidity of the latter was quite small compared to that of the arched member, or when the spandrels were provided with some form of hinged connection.

A rigidly connected stiff deck framing might displace the neutral axis of an arch as much as several feet from the position it would occupy if this influence were non-existent, and at certain points along the rib the stresses might be increased.

Again, if it were desired to make use of the spandrel superstructure to assist the arch, as is done quite often in the case of bridges with a rise to span ratio in the neighbourhood of 1 in 10, the structure would become in reality a Vierendeel truss and could be analyzed by the original method of Professor Vierendeel, or more simply, if it were assumed that the points of inflexion are located at mid-panel for the chords and at mid-height for the vertical web members.

If it were further assumed that the moment of inertia of all the members is the same, the problem became one of simple statics. It was claimed that the values obtained by the approximate method did not differ by more than ten per cent from those of the exact analysis.

This short discussion of the effect of the spandrel superstructure upon all arches would show the necessity of considering the problem of arch design in the light of the true structural conditions existing, rather than as a problem of pure mathematics. In the process of solving the structural problem, method of stress analysis must not restrict the designer's ingenuity and understanding, but

(1) This paper is published on page 243 of the April, 1931, issue of The Journal.

(2) Designing Engineer, Montreal Water Board, Montreal.

should merely indicate to him the factor of security of his structure.

This statement did not detract from the mathematical accuracy of the form of analysis under discussion, but visualized it only as a tool usable in certain specific cases.

The mechanical analysis of indeterminate structures of the use of small models, referred to by Mr. Gordon, was most certainly a decided advance in structural engineering, and even if used only to establish an outline of the elastic line, it furnished a most valuable guide through the maze of computations.

Mr. Brett believed that the cost of the necessary apparatus and models would be fully justified even for modest undertakings. In extreme cases of interaction between rib and spandrel framing the use of models was indispensable.

A case in point was the 311 foot arch over the Rhone river near Chambery. In this intricate case, the results obtained from the mechanical analysis showed the necessity of modifying the analytical computations and the final design was based on the co-ordination of both methods.

His understanding of the author's direct method of influence line determination was, that the usual computations for moment and thrust at points along the rib and the construction of the load polygon would not be required. The influence lines would be used for the dead as well as for the live loading and seemingly the claim of time saving advantage of the method could only be based on these premises.

In so far as monolithic arches without flexural connections were concerned, the usual case in the United States, it was overhelmingly against established practice to discard the load polygon properly located by means of the elastic analysis. Apart from the approximate direct method of Strassner, the load polygon was the only means whereby the shape of the arch axis corresponding to the most effective elastic equilibrium could be determined. This determination must proceed through successive trials and adjustments, and it might be based on the dead load alone or include a part or all of the live load, depending on the rise-to-span ratio, the length of the arch and individual judgment.

If flexural connections were used, then in so far as the dead load and a substantial portion of the rib deformations were concerned, the structure would be a three-hinged arch whose axis coincided with the mechanical load curve in contradistinction to the elastic load curve of the monolithic arch. In this case the direct determination of the influence lines would be an advantage, although it must be noted that the elastic calculations for that part of the deformations stresses occurring after the closing of the flexural connections must still be made.

To sum up, Mr. Brett agreed with the opinion most generally held to-day, that the introduction of the ellipse of elasticity in arch analysis is only necessary in case of multi-span continuous arches on elastic piers when the arches and the piers have a varying moment of inertia between the points of support. The only other practical way to obtain an exact solution for this type of structure would be through the original method of Ritter, as extended by Professor Suter and others. Of the two methods, possibly that based on the ellipse of elasticity was the shorter, though both these methods were a combination of analytical and graphical processes, and were to be preferred in practice as a rule to a purely analytical or graphical process.

He regretted that he could not agree with the claims as to the simplicity of the mathematical processes involved in either of these methods of solution, contending that the exact analysis of this type of structure was one of the most delicate problems of structural engineering.

P. L. Pratley, M.E.I.C.[3]

Mr. Pratley referred to the paper as being a very interesting description of a mathematical "stunt" and admitted that he had not had occasion to apply this method in his practice up to the present. He was rather of the opinion that the author had begun in the middle of his subject from the point of view of the listeners and that a little more elementary explanation of what the method sought to accomplish by means of the particular mathematical "stunt" involved would be of assistance in a general appreciation of the work. It would be interesting to know whether any member present had had an opportunity of comparing the proposed method with the more usual and better established methods in respect of time and labour involved. He remarked that on general principles he was inclined to avoid the use of terms and quantities which had no corresponding physical interpretation. For instance, the "Elastic Weights" ds/I did not represent any physical or tangible feature and the peculiar cantilever arm was of course not an actual fact. He preferred, as a rule, methods of analysis wherein the engineer could be constantly reminded of the basic principles upon which his analysis was based. For instance the method of least work always appealed to him as being one where every step in the mathematical procession was related to the fundamental fact that nature would comply with the principle of the conservation of energy and would perform the necessary work of support or resistance with the least expenditure of this energy. Consequently by expressing the work function in terms of the unknown elements such as moments, or thrusts, or shears or reactions, and differentiating in turn to each of these unknowns, one was actually conscious at all times of the principle that all of these unknowns would so arrange themselves that the differential of the work function to any one of them would become zero in order to keep the work down to a minimum. It was perfectly true that the author suggested that Castigliano's equations and Maxwell's reciprocal theory were actually the basis of all these enquiries, but the chairman felt that normally there was more advantage in adopting methods that kept this fact before the student or practising engineer. He thought that if the author would, in reply to the discussion, make a short explanation as to what the immediate object was of the mathematical treatment presented and the purpose of introducing the ellipse of stress, the theory of poles, polars and anti-poles, it would be a welcome addition to the paper. The mathematics in itself was of course quite simple, but he felt that the object of this mathematics needed to be made clearer, particularly to those who had not previously dealt with this type of analysis.

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[3] Monsarrat and Pratley, consulting engineers, Montreal.

Conservation of Natural Gas

Robert M. Gourlay,
Canadian Western Natural Gas, Light Heat and Power Company, Calgary, Alta.

Paper presented before the Lethbridge Branch of The Engineering Institute of Canada, on November 1st, 1930.

SUMMARY—Conditions in the Alberta oil fields where the product is largely wet gas and an estimate of the value of the gas at present going to waste. A description of the repressuring of the Bow Island field is included.

The storage of natural gas in underground reservoirs has become very important because of the peculiar conditions existing now in Turner valley. We are aware of the various negotiations on foot to save the tremendous waste of gas by sale to cities in Saskatchewan. While it is known in a general way that the storing of natural gas in depleted fields has been carried on in the United States we have heard little about it, and the work done this year at Bow island may prove of some interest. Turner valley is still something of a puzzle to geologists and operators, though a number of problems incidental to drilling and production have been defined and overcome. The major problems confronting the operators at present are those of finding a commercial outlet for the surplus gas and on the other hand solving the problem created by the freezing in of deep lime producers. A small outlet for the gas is provided by the Gas Company's storage project at Bow island and the problem may be solved in the long run by the proposed pipe line to Regina. The freezing problem still baffles the operators. It is due to the sudden release of gas under a pressure that has probably never been equalled in any other field. The large volume of wet gas encountered under exceptionally heavy pressure in the lime, have however revived the original theory of an underlying reservoir. So far no tests in the large producing area of Turner valley have been carried through the lime. Although in the extreme south Sterling Pacific No. 1 met a shale strata after drilling through a great thickness of lime, McLeod No. 4 drilled about 1,400 feet in the lime and got a second producing horizon but did not go through the formation. Whether an underlying reservoir exists and whether it is within reach of an exceptionally deep test are questions that only the drill can answer.

Recent developments in Turner valley were featured by the bringing in of three new producers in the deep lime horizon. The most important of these are apparently East Crest and Mayland No. 2, the latter with about 13,000,000 feet of gas and 150 to 175 barrels of naphtha per day. It is quite evident that the daily open flow is increasing monthly and regardless of the waste it is allowed to blow open in order that the gasoline content may be extracted. This brought the Gas Company's attention to the matter of seeking some means of conserving a portion of the gas, which cannot be distributed.

The origin of gas and oil has been made the subject of much debate by geologists and chemists. The most generally accepted belief, is, that they have been formed by chemical action induced by heat and compression acting upon animal matter buried in the sands at the time when they were deposited along a sea shore in ages past. These sands subsequently settled very slowly, being overlaid by other deposits, sometimes hundreds of feet in depth. As the overburden increased, compression and heat consolidated the sands and the overlying materials as rock formations. Ages afterwards other deposits were formed including strata which contained sufficient remains of various organisms to form another gas or oil sand. These upheavals and settlements were repeated many times over a period of millions of years. The sand or gas-bearing stratum must be covered by an upper layer of hard non-porous rock, commonly called the "shell" which holds the gas down, something in the same way that warm air collects and is held under a gable roof. Without this, the gas would sooner or later seep upward even to the outer air. Although these theories leave some problems without satisfactory explanations they partly explain why some small portions of the earth contain gas.

Enough natural gas went to waste in Turner valley during the past year to supply the needs of all present Alberta users for fifteen years. Assuming that Saskatchewan was to use 8,000,000,000 cubic feet of gas a year as compared with Alberta's 7,000,000,000 cubic feet of gas per year, enough went to waste in the year to supply Saskatchewan for twelve years. Figures are staggering when we reduce them to something within the scope of the mind. On a B.t.u. basis compared with coal, enough natural gas goes to waste every day in Turner valley to equal nine trainloads of high grade coal, each train being of 50 cars and each car containing 40 tons; in other words, the equivalent of 18,000 tons goes to waste daily; multiply that by 365 for the total wasted each year, this means that the equivalent of 3,285 trainloads or 6,570,000 tons of coal burned as waste in Turner valley each year. Therefore with coal at $6 a ton nearly $40,000,000 worth of heat is being wasted every year. Naphtha and crude oil output in the valley at present approximates $4,000,000 in value annually. Utilization of the gas lost in the process of this reclamation of oil would remove a cardinal waste and would place the natural gas industry on a firmer footing. It is generally known that storing of natural gas in depleted fields has been done in the United States and the experiment of repressuring the Bow island field this year may prove of value. There are several requirements that are essential in selecting underground reservoirs and one of them is, that the Gas Company must have control of the entire field. The depleted field must also be accessible to the main gas line and the old wells must be reconditioned so as to permit the pumping of gas under high pressure without it again escaping to other sands which are not suitable to gas storage. The field at Bow island covers an area of about 22 square miles and was discovered in 1909, and over a period of ten years, 27 wells were drilled to the gas horizon at an average depth of 1,800 to 2,000 feet. The boundaries of the field were defined by the drilling of either dry holes or water wells. The wells as drilled proved, that the gas sand body is entirely surrounded by water and one of our problems will be to control the encroachment of this edge water so that the flooding of the gas sands will be prevented. Early in 1927 the Gas Company realizing that the Bow island field which originally contained approximately 45,000,000,000 cubic feet of gas and over a period of twelve years produced approximately 38,000,000,000 cubic feet of gas reached the stage whereby the withdrawal of more gas would accelerate the encroachment of water and the drowning out of the whole field, decided to carry out experiments of repressuring the field by the introduction of gas from the Foremost field 30 miles away; 37,000,000 cubic feet of gas from this field was introduced to Bow island sands over a period of five days.

Bow Island Repressuring Plant.
Canadian Western Natural Gas, Light, Heat and Power Company.

This small amount of gas had the effect of raising the rock pressure from 256 pounds per square inch to 286 pounds or a trifle less than 1 pound per 1,000,000 cubic feet stored.

The removal of water from gas wells is one of the most serious problems in the production of natural gas. Usually the problem of water removal increases in importance as the production of gas declines. Frequently the condition of wells is such that water occurring in the formation penetrated by wells and in the producing gas sand cannot be satisfactorily shut off and operators are compelled to remove water by pumping, bailing or swabbing or by employing a syphon after it is entered. The cheapest way of removing water is by means of a syphon where applicable. The term syphon as used in a natural gas industry is applied to a pipe or tubing installed in a gas well to remove water. Its operation depends upon the expansion of gas within the eductor pipe and the fact that the rising gas bubbles decrease the density of the column of water in the syphon line. Usually the pressure of gas in the well suffices to start the syphon.

The first experiment of repressuring from the Foremost field being successful it was decided to carry out further work of introducing gas for a longer period of time and using some of the waste gas from Turner valley. In April of this year work was started in the Bow island field of cleaning out and overhauling such wells as could be used for storage. Of the 27 wells in the field possibly not more than 12 will be suitable for repressuring purposes. When these wells were drilled twenty years ago upon completion to the gas horizon, some of the strings of casing were pulled for use in drilling additional wells. The cementing process was little used or practically unknown at the time and the casing left on the top of the gas horizon was therefore uncemented. It is estimated that it will take two years

Intake Scrubber.

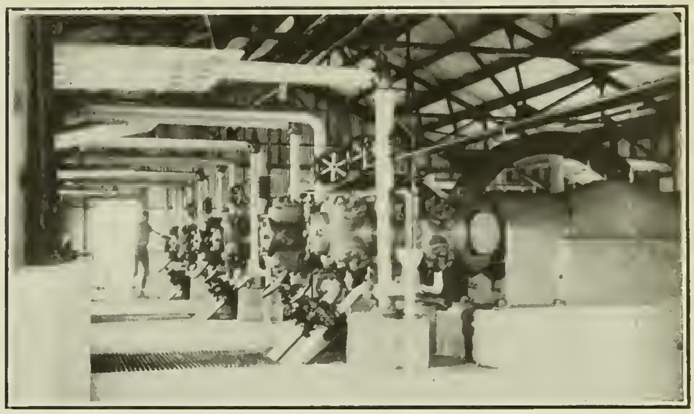
work of reconditioning the wells, and 15 or more of these wells will be abandoned and the water shut off completely by the use of cement or mud fluids. At present we are repressuring through three wells Nos. 4, 7 and 8. No. 3 well had to be cemented off on account of perforated casing and No. 6 well abandoned in the same way on account of tools lost in the well many years ago. Additional wells will be reconditioned from time to time and connected to the main repressuring line. To overcome rock pressure in the existing wells and ultimately to force back encroaching water having an estimated hydrostatic pressure of 730 pounds per square inch, it was necessary to install compressors capable of handling high pressures. This summer three, two-stage 200 h.p. direct driven gas engine compressors manufactured by Clark Brothers were installed, having a combined capacity of 3,000,000 feet per day at 800 pounds discharge pressure, or, 5,000,000 feet delivery at 400 pounds discharge pressure. The intake gas from Turner valley reaches the plant at a pressure of 75 pounds per square inch and is regulated to 40 pounds for the compressor intake, and 15 pounds pressure for the fuel gas in the power end. The intake gas in the low pressure cylinder is compressed to 150 pounds and piped through cooling coils called the inter cooler. It then enters the high pressure cylinder where it is increased to 400 pounds pressure and piped through another set of cooling coils called the after

Cooling Coils.

cooler before it enters the field lines to the wells. The arrangement of the piping is such that the gas can be reversed and sent out of the field when required. Before starting the compressors wells 4, 7 and 8 were turned into the main repressuring line and registered a pressure of 264 pounds. After 24 hours repressuring the compressors registered on the discharge side 270 pounds indicating that the wells were offering but slight resistance. The original rock pressure of the field was 730 pounds. The compressors have been running almost continually since August 4th and the quantity of gas pumped into the sand through the three wells has varied from 3,000,000 to 5,000,000 cubic feet of gas every day.

The auxiliary equipment installed in conjunction with the compressors consists of a 90 h.p. direct driven gas engine and generator which supplies electric light and also power to three motor driven centrifugal pumps. Two 10-inch water intake lines were laid from the bed of the Saskatchewan river to a settling well. The pumps have a capacity of 200 gallons per minute each. The engine end of the compressors require 12 gallons of cooling water per horse power hour and about the same amount is required for the compressor cylinders or a total of 240 gallons per minute for the three machines. The cooling coils in warm weather will require about 100 gallons per minute. A total of 340

Compressor Building, showing Intake Lines.



Interior of Compressor Building.

gallons per minute for the plant. One pump can therefore be held in reserve in case of emergency. The engines are of the two cycle type and very economical. The gas consumption is only 10 cubic feet per horse power hour. The success of the storage of gas in Bow island field will not be determined until the plant has been operating about six months, when sufficient data can be gathered to warrant a definite decision being made on additional expenditure and enlargement of the present plant. In the meantime the repair and inspection of the gas wells will continue until it is felt that the main gas bearing sands within the boundaries of the encroaching water are fully protected. After all it might well be asked why the gas is blowing open in one field and a costly plant installed to pump it back into the ground in another field 150 miles away. The answer may be this, that in this province anyone can buy petroleum and natural gas leases from the Dominion government and drill for gas and oil. As long as the company can make a commercial success by the extraction of gasoline it will carry on, and the well will not be shut in pending a satisfactory market for the gas which is most decidedly not a by-product. There would however be no difficulty in capping the wells until such a time as the supply was needed. Once they purchase their lease and continue under the present government requirements there is no law at the present time to cause the well to be shut in. This has been carried on for many years and should the provincial government desire now to conserve the gas an enormous sum would be required to indemnify the owners for work already done, let alone the value of their acquired leases. Such a sum would be prohibitive. The situation is also complicated by the divided ownership of the mineral rights. That the natural gas supply is unlimited or that new gas is being formed by nature is an opinion that is not accepted so generally as it was a few years ago. The most exhaustive study of gas fields has shown that whatever gas is being generated underground is negligible. When any gas is removed from a sand there is no new gas takes its place as proved by the silent evidence by abandoned wells and fields. When some of the gas is removed from a sand the pressure is lowered in much the same way that the pressure in an automobile tire is reduced when air is removed, for the space occupied by the gas is generally a definite or fixed container. There can be no natural gas supplied to consumers except as it comes from the wells which have tapped nature's limited store house and it is this fact that differentiates the natural gas business from that of supplying manufactured gas or electric service where the sources of supply are so unlimited that the undertaking may sell fuel service guaranteed to be unlimited in time and volume. Each sale of a cubic foot of natural gas is a sale of the nonreplaceable part of the gas operators capital. Our great coal areas may lie in reserve for years to come and wheat may be grown from year to year but natural gas can never be reproduced.

Note: Since the above paper was written, it has been decided not to construct the pipeline to Regina as proposed, and other means for the conserving of gas are being considered.

Discussion on "The Water Supply Problem in Southern Saskatchewan" Paper by W. A. Johnston[1]

Dr. J. A. Dresser[2]

Dr. Dresser remarked that he would like the author to enlighten him on one point.

For a few years while working on a certain oil and gas problem in the Peace river district, it was often necessary to cross a wide syncline between the Rocky mountains and the lower country on the east, by boat on the Peace river. The country to the south was suffering from a lack of water. The rocks along the Peace river appeared to have a slight inclination towards the south. Would there be any possibility of obtaining water within the strata to the south of the Peace river by borings to a reasonable depth? That is, was there a possibility of water entering the strata which were inclined only very gently to the south but which might be reached at a depth of one thousand or fifteen hundred feet for some miles south of the Peace river in a country which was otherwise desirable, but which definitely lacked a water supply?

W. A. Johnston[3]

Mr. Chairman and gentlemen: Regarding the question Dr. Dresser has raised, I must say I do not know anything about the area, but if Dr. Dresser thinks there is a very good chance, I fancy he is right, because he is a pretty good geologist.

Dr. F. D. Adams, Hon.M.E.I.C.[4]

Dr. Adams considered that the paper was one of much interest and value. What the northwest needed more than anything else was water, and any area which could be freshened with a supply of good water, becomes more fruitful and therefore much more valuable not only to the province in which it existed, but to the Dominion as a whole.

Some seventeen years ago when the Research Council of Canada was started by Sir George Foster, the question came up as to whether there were any ways in which research could be applied with advantage to big problems in connection with mining, agriculture, and so on, in the Dominion, and the problem of securing additional supplies of water by artesian wells in the western provinces presented itself at once. A gathering at Ottawa of persons who were especially competent to deal with this question at the time discussed the matter, the consensus of opinion including that of the Geological Survey was that one could scarcely hope to find any considerable supply of fresh water under the great plains. Water had indeed been obtained by boring in many places but it was too saline for common use, so nothing further was done with reference to the matter.

The author must therefore be congratulated and also the Geological Survey for assigning him to make a more careful investigation of the water conditions in the provinces. It was very satisfactory indeed to know that his work had already been rewarded by the discovery of areas underlain by strata carrying fresh water and perhaps there are other areas, still more extended, in which such water could be obtained by boring.

J. W. D. Farrell, A.M.E.I.C.[5]

Mr. Farrell stated that the paper was a very useful contribution to the available information on underground water supplies in the prairie provinces. Economically the subject was one of prime importance to a large portion of the population of those provinces and it was to be hoped that the investigations such as the author had been engaged upon would be continued by the Geological Survey and the results made available from time to time through papers and reports. In prospecting for ground water supplies geological assistance was of the utmost value for the correct interpretation of drillers' logs, surface indications, and topography.

Southern Saskatchewan was not without its lakes and surface streams but these were principally located in deep valleys in cases like the Qu'Appelle lakes or up a hill in cases like the Carlyle lakes on Moose mountain. The centres of population, on the other hand, had been established at locations suitable for distribution along the main railway lines, which had been kept to the general prairie level. The result had been that cities like Regina and Moose Jaw had been compelled to develop underground sources for their water supplies.

In southern Saskatchewan natural conditions did not favour surface streams. The annual precipitation was small and the rate of evaporation was high. Those conditions made underground storage appear to be a wise provision of nature. Underground waters as they occurred in southern Saskatchewan had some advantages over surface supplies. They were usually of excellent potability, clear and free from contamination, requiring neither filtration nor sterilization. The temperature had a very small variation throughout the year. Regina tap water, for instance, had a temperature range of from 39 degrees to 45 degrees F. On the other hand, there was the disadvantage of comparatively high mineral content, usually hardening salts of calcium and magnesium, with a fair amount of sodium sulphate, which was not hardening, but was corrosive. The hardness and mineral content usually increased with the depth from which the supply was obtained. At Boggy creek, water obtained from a shallow deposit contained 280 p.p.m., while deeper waters ran as high as 1,160 parts per million in mineral content. A similar occurrence had been noticed about the water from test wells at Mound springs but location seemed to influence the amount of mineral content more than depth. The water in the wells along the south boundary of the field were considerably softer than the water from wells one-quarter to one-half a mile north. Another disadvantage of an underground source was the difficulty of knowing its capacity. Here again the opinion of a geologist based on field work was of great value.

Where underground waters were found in regular formations such as the sandstone of North and South Dakota, the prospecting for and locating of a supply did not appear to offer serious difficulties. When the underground source was that very heterogeneous formation known as glacial drift, the problems connected with prospecting and locating a source and estimating the capacity were extremely difficult and often baffling to waterworks engineers and well drillers.

Mr. Farrell observed that it had been his good fortune to be in touch with the author who had been sent by the Geological Survey to assist in the solution of water supply problems as they affected Regina, and he was able to observe portions of the investigations. From this association much disconnected data had been gradually combined into a useful working knowledge and familiar topographical features took on a new significance. It had turned out that

[1] This paper was presented at the Annual General Meeting of The Institute, Montreal, Que., February, 1931, and published in the January, 1931, Journal.
[2] 437 St. James Street West, Montreal.
[3] Geological Survey, Department of Mines, Ottawa, Ont.
[4] Montreal.
[5] Superintendent of waterworks, City of Regina, Sask.

the inconsistent glacial drift did have some regularity and its formations had been laid down to some extent at least in accordance with laws that could be deduced by trained observers. The author attributes the geological work at Regina to Dr. Simpson, but as Dr. Simpson had pointed out, his report was based on the co-operative work of the entire party and he made special reference to the survey and mapping of the Pleistocene deposits by the author.

The Regina supply was developed at two locations, known as Boggy creek and Mallory springs. The Boggy creek source was in the valley of Boggy creek, 5 miles northeast, and the Mallory springs source 4 miles east, of the centre of the city.

Both the Boggy creek and Mallory springs sources were initially developed as artesian fields with the exception of one well at Boggy creek which was pumped intermittently. Under this development, the combined yield averaged a little over 3 m.g.d. At both sources it had been found that increasing the number of wells did not permanently increase the yield, that is, after an optimum number of openings had been made to the water bearing layers, additional openings did not produce an additional flow.

In 1928, Regina experienced a considerable increase of population and indications pointed to this growth being continued in 1929. In January, 1929, the demand had overtaken the maximum artesian production at the sources. The city was thus faced with the necessity of immediately increasing its water supply and also of making plans for a supply that would be in excess of consumption for some years to come. It had been recognized that the solution of the problem of immediate supply lay in forcing the yield of the existing sources beyond their artesian flow. This was an engineering problem and while simple in statement, its achievement was accomplished with sufficient speed only by the united effort of almost all the city's engineering resources both human and material.

The second phase of the problem, that of providing a permanently increased supply, involved a study of local underground sources both developed and to be developed, and of more distant surface supplies.

To advise on this problem, Mr. Nicholas S. Hill, Jr., of New York, and R. O. Wynne-Roberts, M.E.I.C., of Toronto, were chosen as consultants, and to assist in the geological studies, the Geological Survey was appealed to for aid. This aid was very effectively given by Mr. Johnston and his party, and resulted in a clearer understanding of the geology of the recent deposits in the district and their relation to underground water supplies.

The information provided from the geological studies indicated that it was reasonably safe to provide permanent equipment for developing Boggy creek and Mallory springs to yield considerably more than their artesian flows. An independent study by Mr. Wynne-Roberts indicated the same conclusion. Mallory springs was now entirely a pumped supply, yielding on the average 1 m.g.d., as compared with its former artesian flow of 0.3 to 0.4 m.g.d. At Boggy creek, the artesian flow was still the main contribution to the supply but equipment had been installed for increasing the yield to 5 m.g.d., as compared with a former yield of 2¾ m.g.d. The effect of prolonged pumping on the artesian flow at Boggy creek had yet to be ascertained, but present indications were that the artesian flow would be reduced. The developed supply at present was 6 m.g.d. and capable of expansion for short periods to 7 m.g.d., which compared favourably with an average consumption of 3.8 m.g.d., and peak demands on a few days in summer of 5 m.g.d. Steps were being taken to connect the Mound springs field to the city in the near future and develop a supply estimated at not less than 2 m.g.d.

The new type of well put down was quite a departure from the old meta cased wells of 5-inch and 6-inch diameters, without screens. The two wells at Mallory springs and one of the wells at Boggy creek were put down by the Kelly Well Company of Grand Island, Nebraska. These wells were cased with a column made up of 3-foot sections of precast concrete casing, and screened with the required number of 14 inch sections of precast concrete screen. Both casing and screen were 18 inches inside diameter. While under construction the well was temporarily cased with steel casings larger than the outside diameter of the concrete casing. When the well was dug to its final depth the sections of concrete screen and casing were lowered to their proper locations. As the temporary steel casing was being withdrawn, gravel of suitable size was packed around the outside of the screen sections thereby increasing the effective diameter of the screen. The other pumping wells at Boggy creek were lined with 10-inch cast iron pipe and provided either with brass Cook screens or with concrete Kelly Junior screens. All the pumped wells were equipped with Pomona deep well turbine pumps driven by electric motors.

The artesian field in the neighbourhood of Mawer should prove of interest in the future to both Moose Jaw and Regina. The size of the field and its source as described by the author indicated a very considerable capacity. As this was close to the proposed route of a pipe line from the Saskatchewan river, the development might form part of the early stages of a plan for bringing water from the river. The mineral content of the water suggested the need for investigation as to the effect when used for human consumption, the effect on plumbing and the result obtained when mixed with the water now available at Moose Jaw and Regina.

R. O. Wynne-Roberts, M.E.I.C.[6]

Mr. Wynne-Roberts thanked the author for the information on hydro-geology in the paper, as a supply of water in the territory referred to was of vital importance for the general welfare of the people. Mr. Wynne-Roberts had been instructed by Regina in 1911 to advise on the question of a more adequate supply of water for the city, and on that occasion the first task was to study the geology as there was no information available.

There had been a number of invasions of ice sheets of tremendous thickness and width which had passed over this territory carrying with them hard rocks which had acted as huge abrasures, to grind and level the earth surface. When the ice had receded towards Hudson Bay, enormous volumes of water which came from the melting ice discharged mud which formed the plains: boulders which formed tesselated moraines and sand, gravel and other material which filled the depressions and built up hills in different places. Hence, it was often difficult to diagnose the underground formations. When recognized geologists undertook to reveal the secrets the problem became more clarified and the public should be grateful to the author and those associated with him for presenting information of such great value.

It was found in Boggy creek area (72 square miles) that a substance known to well drillers as hardpan overlay the main water bearing strata. This substance in general had a fairly uniform grade and thickness for some miles to the southwest, and when it was tapped on the city's quarter section of land about 8 miles northeast of the city, over forty gushing wells were struck by 1914. These continued to overflow for many months but eventually as the number of wells were increased (now 73) the underground pressure diminished and the water subsurface flows yielded about 3 to 3.5 million gallons per day. His estimate

[6] Wynne-Roberts, Son and McLean, Toronto, Ont.

of 1911 for the ultimate yield of the Boggy creek area was about three million gallons daily, which had been more than realized. The water rose in 1912 to a height of 35 feet above the ground and it now flowed into the collecting lines.

Mallory springs were located about 5 miles east of the city and about 2½ miles south of the quarter section above referred to. These wells were drilled about two years ago and there were now two Kelly wells with deep well pumps.

The maximum daily safe yield from Boggy creek and Mallory springs had been estimated at about six million gallons.

The geological formation of the Flying creek area, which was about 14 miles north of Regina and included Mound and other springs, appeared to resemble that of Mallory springs area more than Boggy creek, inasmuch as the underground water-bearing strata were irregular in depth. He had reported on Mound springs, etc., in 1911. The author was correct in stating that there were now nine 6-inch cased wells sunk to a depth of 90 to 200 feet, tapping water at 50 to 155 feet below the ground surface, with static heads of 10 to 24 feet. These wells had been tested individually to ascertain the flows. The effect of the flow of one well on another had been observed in three instances but the aggregate yield had not yet been ascertained. It should be borne in mind that the water-bearing strata were now under the same condition as the Boggy creek wells were in 1912, that is, it was practically under virgin pressure, and it would be instructive to know what the author anticipated the ultimate aggregated flows from the nine Mound wells would be.

He acknowledged that there were other potential small sources in the area, which might be eventually developed. The question which engineers would have to consider and advise the clients was to what extent the other sources could be relied upon in time to supplement the supply for a growing city.

The total annual precipitation ranged from 9.53 inches to 24.53 inches. The average of 39 years was 12.62 inches of rain and 4.41 inches snow, or rain, making a total of 17.03 inches. Precipitation and evapo-transpiration in southern Saskatchewan might be divided into three divisions:

1. Snow, the most of which fell upon frozen ground. There were exceptions but these might be set aside in most years. The melted snow drained away to streams or into sloughs before the ice was out of the ground.
2. Rain which fell during the growing season between April and August inclusive was usually consumed by plant growth, together with loss by evaporation.
3. Rain which fell in the fall after the harvest and before May in the spring and more or less percolated into the ground. Some of it was lost by evaporation.

Government investigations in western Canada and elsewhere showed that very little underground water was derived from snow. Others contended that some snow when melted drains into earth shrinkage cracks. This depended upon the character of the early winter and whether water from snow got in them and became frozen thus preventing further flows. Most of the sloughs had water-tight floors. When farmers desired to drain any of them they drilled holes to permit the water to pass out to the underground beds.

The crux of the problem was how long the water bearing strata would continue to yield water and in what quantity without depleting the wells sunk into the higher reaches. When the rain averaged only 7.93 inches during three years and much of this was consumed by plants and lost by evaporation it would be observed that the problem was one of very great importance.

The subject of evapo-transpiration had become an important one in the discussion on matters of water supply in relatively dry territories. The yield of crops was dependent on the quantity of rain and the roots absorbed with avidity any moisture available in dry growing seasons. In years of relative abundant rainfall crops in the west were plentiful. In more humid eastern Canada the conditions were somewhat different. The striking feature of certain western crops was the depth to which roots actually extended in the search for water.

The water which replenished the underground sources in southern Saskatchewan was therefore mostly derived from rains falling in the spring and fall, less the evaporation which occurred. The withdrawal of water in large quantities must ultimately affect the storage capacity of the underground sources necessary to sustain such heavy droughts, especially if the dry season was a prolonged one, and unfortunately such events were not unknown.

The work done by the author and his collaborators was most acceptable, as it would be of value to all concerned in the problems of water supply in the west. If underground water could be found south of Regina and Moose Jaw down south to the neighbourhood of Weyburn it would enable the district to prosper beyond imagination. There were also other areas in southern Saskatchewan where the services of the Geological Survey would be of great advantage.

It was gratifying to learn that a large artesian area of about 40 square miles lay between Darmody and Central Butte and northwards to within 3 miles of Bridgeford. It would be of interest if the author could give some idea what the probable aggregate yield from this area would be. The author stated that the source of the water to this area appeared to be far up the South Saskatchewan river. This was somewhat difficult to understand as the elevation of the river north of Swift Current was about 1,744 as compared with 1,987 where the well water rose near Mawer.

It might be stated that R. O. Wynne-Roberts was instructed in 1928 to extend his investigations and in this connection he had the collaboration of Mr. W. A. Johnston, Professor Howard E. Simpson and Mr. Nicholas S. Hill, Jr. As would be expected in a district like southern Saskatchewan certain areas which gave promise of water supply, proved on testing to be inadequate in quantity or unsuitable in quality.

W. H. Powell, M.E.I.C.[7]

Mr. Powell stated that he had read the paper with a great deal of interest.

In Vancouver, with over 400 million gallons a day available within from 6 to 10 miles from the centre of density of population, the difficulty of the Saskatchewan problem was amazing.

The study of the conditions by geological engineers foretold with a considerable degree of accuracy the probability of a ground water supply. But the quantity and quality always seemed to be a matter of more or less conjecture.

It would be interesting to know the cost of the wells in the Regina field and the quantity of water supplied. It was probable that the statistics of cost and quantity over a large number of wells would show only the vaguest relation existing between them.

A very excellent report by Dr. Adams some years ago on the ground water supply of Montreal discussed both characteristics.

The South Saskatchewan seemed to be the natural source of any large quantity of water for the Moose Jaw-Regina district. The problems was too large for any one

[7] Engineer, Greater Vancouver Water District, Vancouver, B.C.

city. The author referred to the water requirements of mixed farming. Could not the South Saskatchewan scheme be made to serve a very large agricultural development? It would appear that a water district such as Winnipeg or Vancouver should be created to attend to the requirements of the area. Now that pipe could be fabricated and installed so economically by the welding process and its hydraulic qualities were so much superior to the older fashioned riveted pipe even 100 miles of pipe line was not the financial matter that it was only a few years ago.

Professor J. A. Allan [8]

Professor Allan observed that the author, who was regarded as an authority on the subject, had described a problem of most vital importance to many parts of western Canada. The area discussed in the paper was not unique in western Canada; in fact, there were other areas, at least in Alberta, where the water problem was more acute and difficult of solution than it was in southern Saskatchewan.

He stated that too little attention has been given in the past to water supply problems in Canada, for there were districts in western Canada where settlers were compelled to haul water 10 or 15 miles or even a greater distance, and where many have been compelled to abandon their farms. There are towns where all the water required is brought in by tank cars on the railway. There are other districts where there is abundant water, but on account of dissolved salts the water is unusable.

During the past ten years he had had to give considerable attention to water supply for domestic and industrial purposes in central and parts of northern Alberta. Due to the attention given to the water problem by the Geological Survey of Canada, under the field direction of the late Dr. D. B. Dowling, an artesian area was defined in southeastern Alberta where water of local origin was lacking. In this case the observations of the field geologist were confirmed and the presence of artesian water from artesian sands determined by the drilling of a number of test wells, by the Federal government under the direction of Dr. Dowling. The policy of determining the water horizons by drilling can be highly commended, and similar methods should be followed in other parts of western Canada, where the source of underground water was in doubt, and where the depth entails too great a cost to be undertaken by the individual farmer or by the small town.

When investigating possible water supplies, it had been necessary to convince many individuals that the recommendations given them by operators of the divining rod were unsound and not based on geological facts. In deprecating such methods of finding water, many kinds of instruments in use to-day were not included, as some of these were based on scientific principles, and have been referred to as geophysical methods of locating underground fluids. There are geophysical methods, based on the conductivity and density of the rock, used to-day for locating rock structures or porous horizons suitable for water or other fluid horizons, or for indicating the depths to the contact between unconsolidated material and bedrock, that should be considered worthy of consideration in water supply surveys.

In the third paragraph he believed the author had not made it clear why in many places if the bedrock was reached there was no use drilling any deeper. Also why does the bedrock not contain water in the vicinity of Moose Jaw, where there was a large artesian water basin in the bedrock in the area midway between Moose Jaw and the South Saskatchewan river. To the geologist the explanation might be quite evident, but this was not true in the case of the engineer who did not know the stratigraphic succession in southern Saskatchewan? Even in the Regina district might not the lower formations in the Cretaceous contain water sands as is the case west of Cypress hills?

In the fifth paragraph the association of ground water with morainal deposits was considered. There were marked limitations to a supply of water from this class of unconsolidated material and the origin of such deposits naturally gave irregular distribution of porous and impervious material, unless the glacial deposits had been resorted by water and bedding had resulted. The contact between glacial deposits and the bedrock was a common source of water in many parts. Again, if the glacial deposits contained soluble salts, such as sodium or magnesium or aluminum sulphates or chlorides, these might contaminate water supplies in the glacial deposits over large areas.

Professor Allan observed that he must express difference of interpretation of the meaning of the term "artesian water" as used by the author. The commonly accepted usage of the term artesian water was that the water was not of local origin, but had entered the water-bearing strata some considerable distance, possibly upwards of a hundred miles from the point where the water was obtained by drilling. Artesian water in southeastern Alberta had entered the strata in the foothills over 100 miles to the west, while in the central United States, artesian water had entered the outcrop of porous strata several hundreds of miles to the west. It did not seem appropriate to designate as "artesian" water of meteoric origin in glacial gravels and of comparative local origin and dependent upon local precipitation. Underground water associated with irregularly sorted morainal deposits was not artesian water.

In districts where rock outcrops were scarce, the geologist must seek evidence in underground water from all wells drilled, bored or dug in the district. It was the rule rather than the exception that records were not kept of wells for future use. The Geological Survey of Canada was rendering a real service in collecting drilling records in many parts of western Canada, but there was urgent need of governmental regulations, both Federal and provincial, whereby complete and accurate records would be made of all wells at the time when the operations are under way. There were districts in Alberta where water was scarce but where complete records of wells already drilled would enable the geologist to determine water horizon, whereas now it was necessary to drill a series of test wells before a solution to the water problem could be anticipated.

It was to be hoped that the paper would stimulate interest among the engineers in the water supply problem. In the past the engineer in locating transportation lines and even towns, considered, primarily, the surface features, accessibility and lowest grades between various points, forgetting, it would seem, that a water supply was also of vital economic importance. It was not necessary to go far afield to see that there are towns where a slightly different location would have obviated the water supply problem.

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Engineering Standardization—Its International Aspect

During the years which have elapsed since the War there have arisen a great number of international problems, all difficult of solution. Many of these have been of vital moment to the peace and prosperity of the world; others, fortunately less pressing and of a non-political character, have afforded opportunities for the friendly interchange of views between national bodies of delegates. Such international discussions, involving personal contact between the representatives of national organizations, even if they do not succeed fully in their objects, are nevertheless of great benefit in bringing about a better mutual understanding of the various national points of view, characteristics, and mentalities and the difficulties which have to be faced before agreement is possible.

As an example of such discussions we may take those on engineering standardization, considered from the international point of view. The growing recognition of standardization as an important factor in economics and industry has led to the establishment of national standardizing bodies in all of the more highly industrialized countries. The movement commenced in Great Britain before the War by the formation of the British Engineering Standards Association in 1901, and this example has now been followed by more than twenty other countries. The Canadian Engineering Standards Association was established in 1919. The need for some co-ordination of the methods of working of all these associations soon made itself felt, and, largely as a result of conferences of their secretaries which were held in London in 1921 and in Zürich in 1923, a new organization, known as the International Standards Association, was established in 1929; the following eighteen countries now belong to it:

Austria	Italy
Belgium	Japan
Czechoslovakia	Norway
Denmark	Poland
Finland	Roumania
France	Russia
Germany	Sweden
Holland	Switzerland
Hungary	United States

Its executive offices are in Switzerland, and its objects are, to interchange information on the standardization work accomplished in the various member countries, to assist and co-ordinate the work of the national standardizing bodies, and to avoid conflict between the standards they adopt.

The work of The International Standards Association is supplemented as regards certain subjects by that of one or two other organizations. For example some of the work of the International Electrotechnical Commission has to do with engineering standards as applied to electrical problems. Co-operation between these bodies, however, seems to be adequately provided for. It may be noted that the list of adherents to the International Standards Association does not at present include either Canada or Great Britain, their abstention being due to reasons which it is hoped will not be of permanent effect.

The subject of international standardization has not received the attention it deserves from engineers in general, and as a result there has been considerable misapprehension as to the extent and scope of the movement and as to its possible effect on the industrial relations of the various countries.

Some who regard engineering standardization as a great benefit for the industry of their own country hold a different view as to international agreement on engineering standards. They are inclined to fear that such agreement may actually re-act injuriously on their own industrial progress by furnishing to outsiders confidential or detailed information otherwise not available, and by intensifying international competition. Such an outlook would seem to indicate that its holder cannot rely entirely upon his own efficiency and the excellence of his product to maintain his place in the world markets, and loses sight of the many opportunities for sales abroad which compliance with international standards of quality, dimensions or workmanship would afford. This view, however, is not generally held, and it is difficult to see, for example, why, if international agreement on sizes of nuts enabled British spanners to fit American as well as British nuts, this would cause the British purchaser to buy more American and fewer British machines than is now the case. Actually the relative merit and price of the two machines would still be the deciding factor, while there would be greater opportunity for the sale of British wrenches.

The report for 1930 on the progress of the International Standards Association has just been issued, and indicates considerable and growing activity and a gratifying measure of practical success. The work of the association is carried on by twenty-nine technical committees, each dealing with some specific subject of international interest and sponsored by one of the national standardizing bodies. Their proceedings are circulated in the three official languages of the association, English, French and German, and a working agreement has already been reached in connection with a number of important subjects. Several standards have already acquired definite international status, thus, for example, the British Whitworth screw-thread is now a national standard in eleven countries; the nominal dimensions of the most important series of radial ball bearings have practically become a world standard, and agreement on their tolerances is expected to be reached very shortly.

Another subject of primary importance now being dealt with by a number of continental countries with a view to international agreement is the problem of limit gauging, both as regards a standard reference temperature and the question whether tolerances should be applied primarily to the plug or to the hole. It is encouraging to note that the leading German engineering firms are now willing to abandon their own national system of limits and fits, at considerable sacrifice, in order to work in agreement with the other countries represented in the International Standards Association. Negotiations on this extremely contentious subject began in 1923 and were continued at meetings held in Zürich in 1925, New York in 1926, Prague in 1928, in Paris and Cologne in 1929 and in 1930 in Stockholm and Prague, a list which will give some idea of the lengthy discussions which are needed before effective international agreement on an important subject can be reached.

A considerable measure of agreement has been attained in connection with the standardization of paper sizes, the object being to facilitate trade by the use of the same series of sizes for cut papers in various countries. Ten countries have now agreed on the same size for business letter paper and proposals are being considered for standard sheet sizes for other kinds of paper for printing and other purposes, the general adoption of which would lead to marked economy both for the paper manufacturer and for the user.

From the long list of subjects which are being handled by the International Standards Association, a few further examples may be selected at random. Obviously convenience and economy would result if it were possible to obtain international agreement on the leading dimensions of certain fittings of ships, so that, for example, a British vessel entering a German port could obtain without delay and at reasonable cost replacements for such accessories as bollards, port-lights and the like, without sending to a long distance for such replacements. Again it would be of advantage if the authorities of all industrial countries were agreed on the same pressure tests for the acceptance of steam boilers; if shafting, keys and couplings could be made in a series of sizes or shapes which would permit of practical interchangeability, and there is, of course, an enormous field for international standardization in connection with automobile parts. The supply of replacement parts for agricultural machinery affords another wide opportunity for international standardization, particularly as regards ploughs, mowers and harvesting machines, and if there were international agreement on highway signals they would be far more readily understood by automobile drivers of all nations. The list of such topics might be extended indefinitely.

The undoubted economies resulting from the work of the International Standards Association, and its beneficial effect on international trade, would alone justify the time and effort expended upon it, but, in addition, it leads to an exchange of engineering information and experience which tends to place the construction and manufacture of engineering equipment upon a sound and uniform international basis. This is of continually increasing value in eliminating unfair competition and misunderstanding, in simplifying specifications, insuring adequate quality and in affording increased opportunities to all countries for commercial activity in engineering products.

Address by Beaudry Leman, A.M.E.I.C., at the Annual Dinner of The Engineering Institute of Canada, February 4th, 1931.

Mr. Chairman and Gentlemen,

I had prepared a very elaborate and almost eloquent introduction to this talk, wherein was expressed my pleasure in meeting my fellow engineers of bygone days, but it suddenly dawned upon me that I was not here with you for that purpose, that your President and Secretary had in view a much more important object lesson, so far as you were concerned, and that their motives and designs when inviting me to this dinner were darker and more sinister than you and I had thought. They were not content with modern forms of torture, which have become more humane as civilization has progressed; even the middle ages did not offer any form of punishment that would satisfy their refined cruelty; they sought their inspiration in ancient history and renewed a practice resorted to only in extreme cases, by the most rigid and stern inhabitants of Greece: the Spartans. When a Helot, the underdog of those days, had been derelict in his duty, the leaders of Sparta would feed him well, oversaturate him with wine, and then bring him before the populace to stand, as best he could, as an example that would impress the younger generations and keep them in the path of righteousness. I have been brought before you tonight under similar conditions, for I have wandered away from the avenues of pure and disinterested science, and, unpardonable crime, I have worshipped the golden idol. As president of the Canadian Bankers' Association I can offer no alibi before this jury. I stand before you, in shame and in confusion. Now let whomsoever has never sinned throw the first stone. I must confess I feel a certain sense of security as I turn towards your President, and we all know how forbearant is Mr. Durley. I do believe, gentlemen, that these cruel ordeals should cease and that in future you should be satisfied with the incentive provided by the rewards given to merit and abstain from asking an engineer who became a banker to talk when he should be delving into simple arithmetic to figure out the value of his collateral security.

I understand that it is not good form to talk "shop" after dinner. This eliminates matters that would be of interest to you and questions that I might happen to know something about.

And yet, it should be possible to find a common denominator for engineering and business. May I suggest that investigations be made in the direction of ascertaining if the formulae used in the determination of the "factor of safety" in engineering could not be made to extend to business problems. There is a marked tendency nowadays to unify all fundamental laws and I read lately that Professor Einstein had developed an algebraic expression that would apply to gravity, light and electro-magnetism. The old belief in the possibility of transmuting metals one into another, which was discarded for many centuries, is now not only an accepted theory, but an accomplished fact. Why, even the old time nursery rhymes are applicable to present economic conditions, for we all know too well that "Jack Commodity and Jill Security went up the hill lured by a silver quarter; Jack fell down and broke his crown and Jill came tumbling after."

Let us make a superficial inquiry in the realm of "safety factors" and investigate if there is any likelihood of bringing more closely together engineering and business, as their present divorce has been a cource of great mental agony to one who is deeply interested in the welfare of both. The engineer approaches the problem as follows: in order that the safety of a structure shall be assured, there must be no danger of rupture in any of its members. To secure this assurance of safety the stress induced in any member by any load which the member will be called upon to carry must never approach the ultimate strength of the material. The working stress for any material is the unit stress which by experiment has been found safe to allow in that material and still give a proper degree of security against rupture and is the unit strength to be used in determining the sizes of structural members of that material. The factor of safety is the number by which the ultimate stress must be divided to give the working stress. The purpose of the factor of safety and the working stress is twofold: first, to guard against undiscoverable defects in the structural material employed, which defects reduce the ultimate strength of the material; and second, to provide against the possibility of an increase in the load to be carried due to unforeseen circumstances. Let us see how this last sentence would read if applied to business: "The purpose of the factor of safety and the working stress is twofold: first, to guard against undiscoverable defects in the organization, which defects reduce the ultimate strength of the undertaking; and second, to provide against the possibility of an increase in the load to be carried due to unforeseen circumstances." I submit that so far the formulae seem to fit in very satisfactorily. But you know that engineers would not be satisfied with a general factor of safety, even if it should run from one hundred per cent to four thousand per cent; they have torn it apart, analysed it and weighed its component parts. They have found that the apparent factor of safety is the product of four other factors: the first is the ratio of ultimate strength of the material to its true elastic limit; the second depends on the character of the stress produced within the material; the third depends upon the manner in which the load is applied to the piece (for a load suddenly applied the factor is greater); the fourth is the "factor of ignorance." The first three of these factors provide for known contingencies; the fourth provides against the unknown, such as excessive or accidental overload, unexpectedly severe service, unreliable or imperfect materials and all unforeseen contingencies of manufacture or operation. This "factor of ignorance" may become as great as one thousand per cent. Again we are compelled to acknowledge that the various elements to be considered when determining the factor of safety applicable to engineering materials must also be taken into account in business, for the same reasons and almost in the same proportions.

Let us bear in mind that these factors of safety are used by engineers not in connection with unknown untested or untried materials, but with bronze, nickel, steel, cast iron, granite and the like whose resistance to compression, tension, flexure, torsion and shear, have been measured most carefully, under practically all conditions, with the best instruments that can be built and under the supervision of the most experienced and capable men. And yet, after human intelligence and ingenuity have forced back the borders of the unknown, liberal allowance is made for the "factor of ignorance." What a lesson and what an inspiration for those who, engaging in business, whether it be commerce, finance or industry, have to build with far less stable materials and to contend with none the less powerful forces. No engineer has encountered more unreliable quicksand or gumbo to build upon than the shifting sands of popular whims, fancies or fashions upon which many a business rests. The pressure of competition, the breaking strain of taxation, the abrasions made on profits by multidinous fixed charges, the lack of elasticity in our budgets, the plasticity of politics and the resiliency of our incomes should be figured out in business and large factors of safety applied.

Whilst engineers were actively engaged in improving the quality of the materials used in their structures by seeking proper alloys that would strengthen the fibre of these materials, have we witnessed any great improvement in the moral fibre which makes up the elements entering in our social fabric? The most conspicuous new alloy developed during the recent years in business appears to have been "ease," in place of the old-fashioned "effort" which was renowned for its toughness. "Ease" has found its application in a great many ways and we all know how widespread has become its use: easy work—easy money—easy payments—easy credit—easy living—easy profits—finally, easy come easy go. I am afraid "ease" is not as good an alloy as many were led to believe and that our economic structure has not been strengthened thereby. Great hopes were founded on the use of this "easy metal" and it was suggested that it would do away not only with the cumbersome "safety factors" but even with the time-honoured safeguards which a few still remembered and called prudence and thrift. Why! if this policy of ease had kept its promises, you engineers would have had to invent some new material endowed with supernatural qualities, at the risk of being hopelessly outdistanced on the road to progress. I may be out of touch with modern engineering development but I am not aware that you have as yet been successful in devising motors without brakes, or steam engines without fly-wheels, or hydro-electric generators without governors. This "easy fabric" would do away in economics with all the regulators, which would become useless impediments. Why adhere to the gold standard, when paper is so much easier to procure in abundance? Why practise self-restraint to accumulate capital when credit may easily be made available to all? Why work and toil when it is so much easier to speculate? Why save for the future when it is so much easier for the State to provide for your needs? Why row upstream when it is so much easier to drift? Why have ambition, initiative, forcefulness, when it is so much easier to wait for something to turn up? Why have public spirit and ideals when it is so very much easier to be unconcerned and sceptical?

Please do not believe I am suggesting a doctrine of pessimism, reaction and retrogression. Engineers have experimented in many fields and on many materials; these tests have not all been successful and many a promising discovery has proved impracticable. When stumped in one direction they have sought a solution in another, always benefiting by the investigations they have made. The "easy alloy" could not give business all that an unbalanced optimism had dreamt of, but it does not mean that all the elements entering in the alloy should be discarded and abandoned. Because too much credit has been used in the alloy does not imply that credit is not capable, when used in proper proportions, of rendering very extensive and efficient service. Because gold is no longer a fetish and we have learned to carry on financially with a smaller ratio of the precious metal should not mean that we may with impunity disregard its function as a lever, a brake and a regulator. The stock exchanges have been instrumental in gathering small and scattered amounts of capital and in welding them into strong, progressive organizations, and they are not solely to blame if their activities have occasionally been turned into mere gambling operations. We are all desirous that our laws should reflect a more advanced civilization, provide more social welfare and extend a more generous hand to those who are handicapped or afflicted, but in so doing we should guard against sapping the very foundation of human progress, which has been private initiative and personal interest.

We hear a great deal nowadays about the Russian five-year plan and we are prone to believe that something new has appeared under the sun. The "people's commissars," Messrs. Lenine and Trotsky, strove, conformably to their own words: "when they had reached a more advanced stage of socialistic development, to direct all enterprises from a central point, having in view a rational plan of distribution of the available energies and resources co-ordinated along the lines of pre-established national progress." These words and this programme merely carry us back four or five centuries when the common law of the middle ages, or the edicts and decrees of kings, or the corporate regulations of manufacturers and traders, or the by-laws of the chartered boroughs or towns tried to regulate production and to force a rigid discipline upon industry, commerce and agriculture. This method has been tried, has been found wanting and, to the honour of humanity, has not stifled personal liberty. Personal liberty is a condition which has been achieved and secured through age-long struggles and is one of the proudest adornments of our civilization; its life-long enemies have been license and easy-going habits. From time to time it becomes necessary to fight to preserve personal liberty and these battles have to be waged against the foes that are within as often if not oftener than against the foes that are without. May I conclude by quoting Doctor Nicholas Murray Butler in a lecture on Nation-Building and Beyond:—"The path of civilization through the ages is littered with splendid but wasted ideas. The largest visions, the deepest insights, the most compelling arguments, have been spread before the minds of men by prophets and by seers, by statesmen and by nation-builders and then let fall into the darkness of forgetfulness. Nearly everything that man has ever said well was best and most finely said by those ancient Greeks and Romans who, after 2,500 years, still rule the mind of the western world. Material waste is as nothing compared with the intellectual and moral waste which follows upon our not heeding the counsels that have been offered us from generation to generation and from century to century."

OBITUARIES

Pamphile P. V. DuTremblay, A.M.E.I.C.

The death is reported, at Ste. Anne de la Perade, on February 24th, 1931, of Pamphile P. V. DuTremblay, A.M.E.I.C.

Mr. DuTremblay was born at St. Paul's Bay, Que., on November 17th, 1844.

He commenced to practice as a provincial and Dominion land surveyor and civil engineer at Ste. Anne de la Perade in 1874, and has since remained there. He took an active interest in municipal affairs and was the first mayor of Ste. Anne.

Mr. DuTremblay joined The Institute as an Associate Member on May 10th, 1898.

Gustavus Adolphus Bernasconi, M.E.I.C.

Deep regret is expressed in recording the death of Gustavus Adolphus Bernasconi, M.E.I.C., which occurred at Granville Ferry, N.S., on January 12th, 1931.

Mr. Bernasconi was born at Chiasso, Switzerland, on September 18th, 1844. Graduating from the Ecole Polytechnique at Zurich in 1865, he came to Canada in 1871, In 1872 he entered the service of the Department of Public Works, Canada, at Saint John, N.B., and remained with the department until he retired in 1923, his last appointment being that of resident engineer in charge of the public works in Cape Breton, with headquarters at North Sidney.

Mr. Bernasconi joined The Institute as a Member on December 9th, 1897, and was placed on the Life Membership list in September, 1923.

NORMAN M. McLEOD, M.E.I.C.

Norman M. McLeod, M.E.I.C.

Members will learn with much regret of the death of Norman M. McLeod, M.E.I.C., which occurred at Montreal on February 23rd, 1931. Mr. McLeod, who was the son of the late Professor C. H. McLeod, was born at Montreal on September 13th, 1877, and graduated from McGill University in 1899 with the degree of B.Sc.

After graduation Mr. McLeod spent a year with the Dominion Bridge Company at Lachine as structural draughtsman. In 1900 he joined the staff of the Canada Foundry Company, where for the first two years he was engaged in structural design with supervision of shop and field work. From 1902 to 1910 he was in charge of the Bridge Department of this company

In 1910 Mr. McLeod left the Canada Foundry Company to engage in engineering contracting, and was associated with the late Mr. F. H. McGuigan, the first contract of any size being the Queen street viaduct in Toronto.

In 1913 he formed a company in Toronto which operated under his own name, and amongst some of the works completed were some sixteen theatres for Jules and J. J. Allen, and the Famous Players; the Bank of Commerce book vaults; the Oriental Textile plant at Ottawa; the Cadillac building for General Motors at Oshawa; the Durant Motor factory, and several large bridges for the Ontario Department of Highways. During the last two years he was general manager for the Frontenac Dredging Company, doing dredging and general contract work.

John William Astley, M.E.I.C.

It is with much regret that the death of John William Astley, M.E.I.C., which occurred at Victoria on February 28th, 1931, is recorded.

Mr. Astley was born at Barrie, Ont., on June 26th, 1845. He received his early education at the Barrie Grammar school, and from 1865 to 1869 was articled to the Northern Railway Company, Toronto. He was soon promoted to the direction of important survey work in northern Ontario for the Canadian Pacific Railway. In 1900 he became chief engineer of the Klondike Mines Railway, and since that time has directed much railway construction in central and western Canada. Mr. Astley was appointed engineer of construction for the city of Winnipeg in the year 1908, which position he occupied since that date. He was an acknowledged authority on railway engineering subjects, and constantly contributed to Canadian newspapers, mining and railway journals and other periodicals. In the Northwest Rebellion of 1885, Mr. Astley joined the special constabulary attached to the Northwest Mounted Police.

Mr. Astley joined The Institute as an Associate Member on April 8th, 1892, and was transferred to full Membership on June 10th, 1911. He was made a Life Member in 1923.

PERSONALS

J. B. P. Dunbar, A.M.E.I.C., since 1925 district engineer, Military district No. 12, at Calgary, Alta., has been transferred to military district No. 5, at Quebec, where he will again fill the office of district engineer.

C. C. Parker, S.E.I.C., is now with James, Proctor and Redfern, Toronto, Ont. Mr. Parker, who graduated from the University of Toronto in 1929 with the degree of B.A.Sc., was formerly with the engineering department of the Manitoba Bridge and Iron Works, Ltd., Winnipeg, Man.

H. A. Gregory, S.E.I.C., who was formerly attached to the control department of the Anglo-Canadian Paper Mills, Ltd., at Limoilou, Quebec, is now on the staff of the Aluminum Company of Canada, and is located at Shawinigan Falls, Que. Mr. Gregory graduated from McGill University in 1927, with the degree of B.Sc.

W. G. Worcester, M.E.I.C., professor of ceramic engineering at the University of Saskatchewan, Saskatoon, Sask., has been made a fellow of the American Ceramics Society. Professor Worcester, who is on the staff of the Department of Labour and Industries, has been very active in the development of the clay industries of Saskatchewan. In 1930 he was given an honorary degree by the University of Ohio, Columbus, Ohio, from which college he graduated.

J. R. Holmes, S.E.I.C., has been appointed branch manager at Montreal for the Robbins and Myers Company of Canada. Mr. Holmes graduated from McGill University in 1929 with the degree of B.Sc., and was for a time in the eastern division plant engineer's office of the Bell Telephone Company of Canada, Montreal. Prior to accepting his present position, Mr. Holmes was on the staff of the Canadian Ingersoll-Rand Company, Ltd., Montreal.

John Grieve, M.E.I.C., Receives New Appointment

John Grieve, M.E.I.C., who has since 1928 been general industrial sales manager of Brandram-Henderson, Ltd., has been appointed sales promotion manager of the Imperial Varnish and Color Company, Ltd., Toronto. In addition to successful paint sales operation on many of the largest engineering works in Canada and the United States, Mr. Grieve has had long experience in research work. He is an Associate Member of the American Society of Civil Engineers, a member of the Architectural League of New York, of the Arts Club of Montreal and of the Engineers' Club, of both Toronto and Montreal.

J. A. L. Waddell, M.E.I.C., consulting engineer, New York, has been awarded the first Clausen Gold Medal by the American Association of Engineers. The Clausen gold medal is to be awarded annually to the citizen of the United States (engineer or otherwise) who has during the preceding year performed the most distinguished service for the social or economic welfare of engineers. The medal is not awarded for engineering or scientific achievements unless they have served very definitely and directly to promote the social and economic welfare of engineers. Dr. Waddell enjoys an international reputation as an expert in bridge design and economics, having to his credit in Canada and the United States hundreds of bridges of all kinds. He has also designed and constructed many important and difficult bridge structures in Mexico, Japan, New Zealand, Russia and Cuba.

Joseph H. Wallace, M.E.I.C., has become connected with the Black-Clawson Company, Hamilton, Ohio. Mr. Wallace graduated from the Worcester Polytechnique Institute, department of civil engineering, in 1892 with the degree of B.S., and received the degree of C.E. from the same institution in 1899. From 1892 to 1894 he was connected with the United States Lighthouse Establishment, being assigned in 1893 to conduct experiments for the improvement of fog signals under the direction of Major W. R. Livermore, U.S.A. From 1894 to 1897 Mr. Wallace was constructing engineer with A. B. Tower and Company, Holyoke, Mass., and from 1897 to 1901 was a partner in the firm of Tower and Wallace, mill and hydraulic engineers, New York, N.Y. Mr. Wallace has for a number of years been a member of the firm of Joseph H. Wallace and Company, industrial engineers, New York.

R. W. Mitchell, A.M.E.I.C., who has for some years been engaged in private practice as a consulting engineer in Montreal, specializing in reinforced concrete work, water and filtration works, sewerage works, bridges and dams, and the investigation of centrifugally cast concrete pipe and coal handling problems, has been elected president of Consolidated Pipe Company, Ltd., Montreal. Mr. Mitchell received his early training in the office of Messrs. Crouch and Hogg, Glasgow, Scotland, where he served an apprenticeship of five years. On coming to Canada in 1911, he joined the staff of the resident engineer on maintenance of the Grand Trunk Railway, in Montreal. In August of the same year he was on the staff of the resident engineer of the Montreal filtration works, and later in the capacity of chief assistant supervising the work. In 1913, when the Montreal main water supply conduit burst, he designed and supervised the construction of the emergency works from the Lachine canal. From 1920 to 1922 Mr. Mitchell was designing engineer with the Montreal Water Board. His overseas service dated from September, 1914, when he enlisted with the Royal Engineers as a sapper. He was commissioned in the field and retired with the rank of major.

BOOK REVIEWS

The Principles of Coal Property Valuation

By A. W. Hesse. Wiley & Sons, New York, 1930, leatherette, 5 x 7½ in., 183 pp., figs., tables, $3.00.

This book covers in a very comprehensive way the whole field of coal property valuation from the undeveloped coal rights holding to properties equipped with the most modern devices for coal winning and preparation.

It is divided into three major sections: virgin coal lands, operating properties and appraisals and valuations.

Under the first head are included geological examinations, topographical surveys, preliminary investigations as to the character of the coal seams, estimation of probable recoverable coal of commercial grade, accessibility of property to markets, including transportation facilities. Methods of investigation to be followed are outlined and the writer draws special attention to the necessity of giving close study to the local characteristics of the field under investigation. This is particularly applicable to practically all of the coalfields of western Canada, where the assumption of conditions found in older and more regular fields resulted in the loss of much capital in the earlier days of development.

Under operating properties valuation of equipment and consideration of its adaptability to the working conditions in the mine are set forth. Costs of production and the effectiveness of mining systems followed are considered, as well as methods of preparation necessary in order to obtain markets and best prices.

Under appraisals and valuations consideration of financial factors entering into successful operation is given. A number of very useful formulae and tables are included, which may be used in arriving at present values of equipment and property.

This book is a valuable work of reference in engineering economics for all those called upon to value or advise in connection with the operation of coal properties.

B. L. Thorne, M.E.I.C.,
Mining Engineer, Dept. of Natural Resources, Canadian Pacific Railway, Calgary, Alta.

Mercury Arc Power Rectifiers: Theory and Practice

By Othmar K. Marti and Harold Winograd. McGraw-Hill, New York, 1930, cloth, 6 x 9 in., 473 pp., figs., tables, $6.00.

Existing literature on the subject of mercury arc power rectifiers has not been readily available to Canadian power and traction engineers; much of it has been written in German and a large proportion of the remainder has been put out in the form of articles in electrical journals; technical matter in this form is scattered and inconvenient to refer to. This book covers all phases of the subject with clarity and completeness. The authors of this treatise have been associated with the development of the mercury arc power rectifier from its earliest beginnings and the information is based on a very extensive background of experience.

The book opens with a story of the various steps which marked the evolution of the mercury arc power rectifier.

The fundamental theory of arc rectifiers is explained in a very complete and lucid manner. The mathematical development of the expressions describing the wave shape, power factor and other features of the rectifier is given in full, and numerical results are obtained using the basic physical constants appertaining to mercury vapour.

The book proceeds to show how these scientific deductions are applied in the practical development of a power rectifying device. Back-fires and the methods of overcoming these troubles are discussed. The effects of different types of load and the behaviour of the rectifier under short circuit conditions are covered very completely, and a number of oscillograms are given to illustrate these points. Special types of transformers and certain auxiliary power equipment are required to supply A. C. power to these rectifiers. The theory and design of these transformers is set forth at considerable length. Another chapter covers the mechanical design of the rectifier itself and describes the auxiliary apparatus, vacuum pumps, automatic equipment for the maintaining of the vacuum, water cooling systems, etc. Special attention is given to operating matters, such as voltage control, regulation, and all the details which require to be taken care of in a substation which is supplying D.C. power continuously. Power panel arrangements and protective apparatus are described and their functions explained very fully.

Inductive interference with communication circuits and the methods which can be adopted for the prevention of any difficulties of this kind, form the subject matter of another chapter.

The testing of rectifiers and performance rating of rectifier substations is adequately covered.

The volume is well supplied with illustrations and a very complete bibliography is included in an appendix.

As a work of reference and a text book of engineering data on rectifiers, this work is probably the most comprehensive that has appeared; but it might have been made more complete if some reference had been made to expected service life on this type of plant.

J. L. Clarke, A.M.E.I.C.,
Transmission Engineer, The Bell Telephone Company of Canada, Montreal, Que.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Presented by the Societies:
- The Royal Society of Canada: Transactions, 3rd Series, vol. 24, section 2, May, 1930: English Literature, History, Archaeology, Sociology, Political Economy and Allied Subjects.
- American Society for Testing Materials: Proceedings, vol. 30, 1930, Part 1: Committee Reports; Tentative Standards. Part 2: Technical Papers.
- American Society of Mechanical Engineers: Membership List, 1931.
- The Institution of Mechanical Engineers: General Index to Proceedings, 1911-1920.

Reports, etc.

Dominion Bureau of Statistics, Transportation and Public Utilities Branch, Canada:
- Statistics of Steam Railways of Canada for the year ended December 31, 1929.

Dept. of the Interior, Topographical Survey, Canada:
- [Map of] Kempt Lake, Quebec, [1931].

Dept. of the Interior, Forest Products Laboratories:
- Blue Stain: A Cause of Serious Loss to Manufacturers of White Pine Lumber.

Dept. of the Interior, Forest Service, Canada:
- The Forest Products Laboratories of Canada, Ottawa, Montreal, Vancouver.
- Circular 26: Creosote Treatment of Douglas Fir.
- 27: Stain and Decay in Lumber-Seasoning Yards.
- 28: Strength Tests of Creosoted Douglas Fir Beams.

Dept. of National Defence, Geographical Section, Canada:
- Topographic Map: Quebec, Disraeli Sheet, 1931.

Dept. of Mines, Ontario:
- Bulletin No. 76: Preliminary Report on the Mineral Production of Ontario in 1930.

New Brunswick Electric Power Commission:
- Eleventh Annual Report for the year ending October 31, 1930.

Workmen's Compensation Commission, Province of Quebec:
- Third Report, 1930.

Bureau of Standards, United States:
- Circular No. 389: The Making of Mirrors by the Deposition of Metal on Glass.
- Building and Housing No. 14: Recommended Minimum Requirements for Fire Resistance in Buildings (Report of the Dept. of Commerce, Building Code Committee, 1931.)

Bureau of Mines, United States:
- Barite and Barium Products in 1929.
- Talc and Soapstone in 1929.
- Stone in 1929.
- Lime in 1929.
- Natural Gas in 1929.
- Technical Paper 481: Re-treatment of Mother Lode (California), Carbonaceous Slime Tailings.
- 484: Analyses of Wyoming Coals.
- 486: Chemistry of Leaching Bornite.
- 495: Coke-Oven Accidents in the United States during the Calendar Year, 1929.

Public Health Service, United States:
- Public Health Bulletin No. 198: A Study of the Pollution and Natural Purification of the Illinois River. Part 2: The Plankton and Related Organisms.

Geological Survey, United States:
- Bulletin No. 823: Bibliography of North American Geology, 1919-1928.
- 826: Names and Definitions of the Geologic Units of California.

The Port of New York Authority:
- Tenth Annual Report, December 31, 1930.

Public Works Dept., City of Boston [Mass.]:
- Annual Report, for the year 1929.

Dept. of Registration and Education, Division of the State Water Survey, State of Illinois:
- Bulletin No. 29: Studies on Two-Stage Sludge Digestion, 1928-29.

The Metropolitan Water District of Southern California:
- Summary of Preliminary Surveys, Designs and Estimates and Final Report, Engineering Board of Review.

University of California, Dept. of Geological Sciences:
- A Vertebrate Fauna from a New Pliocene Formation in Northern California.

Ohio State University:
- Engineering Experiment Station Bulletin No. 56: Researches in Dry-Press Refractories, Part 1: Relation of Forming Pressure to Physical Properties.
- Engineering Experiment Station Bulletin No. 57: Strength of Brick and Tile Plasters Under Varied Eccentric Loading.

United Engineering Trustees, Inc.:
- Reports for years 1929-30.

Technical, Books, etc.

Presented by E. & F. N. Spon, Limited:
- Spon's Electrical Pocket-Book.

Presented by Norman W. Henley Publishing Company:
- Modern Aviation Engines, Vols. 1 and 2, 1929, by V. W. Pagé.

Presented by John Wiley & Sons, Inc.:
- Airplane Structures, 1929, by A. S. Niles and J. S. Newell.
- Applied Aerial Photography, 1929, by A. C. McKinley.
- The Rigid Frame Bridge, 1931, by A. G. Hayden.
- High Speed Steel, 1931, by M. A. Grossman and E. C. Bain.
- Automobile Steels, 1930, by A. Muller-Hauff and Karl Stein.

Presented by V.D.I.-Verlag, GmbH, Berlin:
Maschinengetriebe, 1931.
Inhalt Verzeichnis der Zeitschrift Maschinenbau, 1918-28.
Ludwig Loewe & Co., A.-G., Berlin, 1869-1929.
Presented by Northern Electric Company:
Bell Telephone Laboratories: A Description of the Laboratory Research Organization of the Bell System.
Bell Telephone System: Monographs B506-B521, B523, B525-528.
Presented by Yale University Press, New Haven:
Union-Management Co-operation on the Railroads.
Presented by American Institute of Steel Construction, Inc.:
True Economy in Highway Bridge Design.

ELECTIONS AND TRANSFERS

At the meeting of Council held on March 24th, 1931, the following elections and transfers were effected:

Member

HARRISON, Albert Dex, (Sheffield Univ.), mech'l. engr., Harland Engineering Co. Ltd., Montreal, Que.

Associate Members

COONEY, Richard Thompson, Jr., asst. supt., United Engineers and Constructors (Canada) Limited, for the New Brunswick Electric Power Commission, Newcastle Creek, N.B.

GARNETT, Charles Ernest, (Manchester Coll. of Technology), engr. in charge of all engrg. sales and installations, and vice-president Gorman's Ltd., Edmonton, Alta.

GREENING, Edward Owen, location engr. for P.G.E. Rly. Lands, survey of resources, Quesnel, B.C.

McWILLIAM, Archibald, (Royal Technical College, Glasgow), struct'l. designer, Canadian Bridge Company, Ltd., Walkerville, Ont.

TYRER, Thomas George, Sask. land surveyor and asst. field inspr., Surveys Branch, Land Titles Offices, Regina, Sask.

WIGMORE, Roy Douglas Hazen, B.Sc., (Acadia Univ.), asst. dist. highway engr., Prov. Dept. of Public Works, Saint John, N.B.

Juniors

HOLGATE, William Thomas, B.Sc., (Univ. of Alta.), students' test course, Canadian General Electric Co. Ltd., Peterborough, Ont.

PALMER, Frederick Ernest, (West Kensington Tech. Coll.), engrg. dftsman., Riverbend mills, Price Bros. & Co. Ltd.

THOMSON, William John, B.Sc., (Queen's Univ.), chemist, Abrasive Company of Canada, Hamilton, Ont.

Transferred from the class of Associate Member to that of Member

MORRISEY, Thomas Sydney, Lt.-Col, D.S.O., (Grad. R.M.C.), vice-president, United Engineers and Constructors (Canada) Limited, Toronto, Ont.

WANG, Sigmund, Chem. Engr., (Coll. of Christiana), manager of laboratories, Canadian International Paper Company, Hawkesbury, Ont.

WOODYATT, James Blain, B.Sc., (McGill Univ.), president and general manager, Southern Canada Power Company, Ltd., and vice-president and general manager, Power Corporation of Canada Limited, Montreal, Que.

Transferred from the class of Junior to that of Associate Member

COMEAU, Jules, B.A.Sc., C.E., (Ecole Polytechnique), asst. to engr. in charge, Technical Service, City of Montreal, Que.

JICKLING, Robert William, B.Sc. (E.E.), (Univ. of Man.), transmission and distribution engr., Saskatchewan Power Commission, Regina, Sask.

MILNE, Oswald, (Barrow Technical College), chief engr., Peabody Limited, 161 Victoria St., London, S.W.1, England.

OLIVER, Cuthbert Jack, B.Sc., (McGill Univ.), overhead distribution engr., Rio de Janeiro Tramway Light and Power Co. Ltd., Rio de Janeiro, Brazil.

Transferred from the class of Student to that of Associate Member

BRIGGS, Herbert Lee, B.Sc. (E.E.), (Univ. of Man.), relay engr. and asst. to chief operator for system, City of Winnipeg Hydro-Electric System, Winnipeg, Man.

Transferred from the class of Student to that of Junior

WRIGHT, Harold Sinclair, B.Sc. (Mech.), (N.S. Tech. Coll.), chief engr., steam power plant, Demerara Electric Company, Ltd., Georgetown, British Guiana.

Transferred from the class of Student to that of Affiliate

MacINNES, Donald Alexander, (Grad. R.M.C.), B.Sc., (McGill Univ.), advertising manager, Lake of the Woods Manufacturing Co. Ltd., Montreal, Que.

Students admitted

CAMERON, Hoyes Alexander, (Mount Allison Univ.), Sackville, N.B.

CARTER, John Russell, (Univ. of Toronto), designing dftsman., struct'l. dept., H.E.P.C. of Ontario, Toronto, Ont.

EVANS, George Egerton, (Univ. of B.C.), Wellington, B.C.

GREEN, John Scott, (Univ. of Toronto), 59 St. George St., Toronto, Ont.

HULL, Roland Street, (N.S. Tech. Coll.), Woodstock, N.B.

JARVIS, Gerald Walter, B.Sc., (Queen's Univ.), demonstrator in mech'l. engrg., Queen's University, Kingston, Ont.

MacDONALD, John Winston, (N.S. Tech. Coll.), 72 South St., Halifax, N.S.

MARTIN, Reginald Lee, (McGill Univ.), field engr., Lucerne-in-Quebec, Monte Bello, Que.

McLACHLIN, Hugh Frederick, (Grad. R.M.C.), ap'tice, Canadian Westinghouse Company, Hamilton, Ont.

RALSTON, William Pasmore, (R.M.C.), Hill and Dale, Port Hope, Ont.

ROY, Leo, B.A.Sc., C.E., (Ecole Polytechnique), ap'tice course, Shawinigan Water & Power Company, Montreal, Que.

SMITH, Ralph Rolland, (Mount Allison Univ.), Sackville, N.B.

SMITH, William Stanley, (Univ. of Toronto), Toronto, Ont.

WATSON, Dalton H., (Univ. of B.C.), 1826-13th Ave. West, Vancouver, B.C.

Undergraduates at the University of Saskatchewan, Saskatoon, Sask.

ANDERSON, Gordon Stuart, Theodore, Sask.
CLARK, Ralph William, 818-14th St. East, Saskatoon, Sask.
DOUGLAS, Arnold Howard, Saskatoon, Sask.
FOWLER, Joseph Sims, 1005 Melrose Ave., Saskatoon, Sask.
MOLLARD, John Ellis, Watrous, Sask.
McGOWAN, Edwin Archibald, Officers' Mess, R.C.A.F., Camp Borden, Ont.
OLSON, Arthur Bishop, 1036 College Drive, Saskatoon, Sask.
SCHNEDAR, Clarence Christopher, 715-12th St., Saskatoon, Sask.
WOOD, Donald Waldron, 1036 College Drive, Saskatoon, Sask.

Undergraduates at Queen's University, Kingston, Ont.

CONN, Hugh Gordon, Kingston, Ont.
LaFONTAINE, Daniel Joseph, Tweed, Ont.
RICHARDS, Victor Lloyd, 29 Clergy St. West, Kingston, Ont.
THOMAS, Charles Edwin, 47 Delaware Ave., Hamilton, Ont.
TURNER, Alex. John, 119 Maple Ave., Hamilton, Ont.
WAITE, Matthew J., 21 L. Albert St., Kingston, Ont.

Undergraduates at the University of New Brunswick, Fredericton, N.B.

HURLEY, Joseph Louis, 456 George St., Fredericton, N.B.
MACREDIE, John Robert Calderwood, 752 King St., Fredericton, N.B.
PARLEE, Rutherford J., Lower Millstream, N.B.
WILLIS, Ralph Richard, Youghall, N.B.

Undergraduates at McGill University, Montreal, Que.

CHARLEWOOD, Charles Benjamin, 2664 Orchard Ave., Oak Bay, Victoria, B.C.
DOBBIN, David Crawford, 2095 Grey Ave., Montreal, Que.
HENNIGER, Charles Freeman, P.O. Box 886, Smiths Falls, Ont.
MARKEY, Henry Toller, 2133 Dorchester St. West, Montreal, Que.
PARISH, Charles Ernest, 3434 McTavish St., Montreal, Que.
PRICE, Harold Buchan, 3566 Lorne Ave., Montreal, Que.
ROGERS, Howard W., 1174 St. Mark St., Montreal, Que.
WARNOCK, Robert Nicholson, 344 Metcalfe Avenue, Westmount, Que.

Wm. Kennedy and Sons, Ltd., of Owen Sound, Ont., announce a new standardized line of right angle speed reducers having a remarkable power transmission efficiency. The new reducers, which were developed by the Falk Corporation, are built up with spiral bevel gears, combined with single helical gears for the final reduction when more than a single speed reduction is necessary. Wm. Kennedy and Sons are distributing bulletin No. 210, a 48-page booklet, which describes and illustrates these speed reducers. This booklet may be obtained upon request from Wm. Kennedy and Sons.

BRANCH NEWS

Border Cities Branch

Harold J. A. Chambers, A.M.E.I.C., Secretary-Treasurer.

MANAFACTURE OF REFRACTORY MATERIALS

The February meeting of the Border Cities Branch was held on February 20th, 1931.

Messrs. Ted. F. Stockslager and W. G. Sinn, of the Harbison Walker Company, the speakers on this occasion, were introduced by H. J. Coulter, Jr.E.I.C., and by means of motion pictures they proceeded to illustrate the processes of manufacture of the various refractory materials used in commerce today.

First among these processes to be illustrated were the methods of manufacture of firebrick. Fireclay, from which firebrick is made, is mined in numerous widely distributed places in the United States. It is quite hard and flinty as found in nature and it is necessary to crush and grind it, after which it is graded and then ground again to a certain fineness and a measured quantity of water added until the required consistency for moulding is obtained.

Firebrick was up until quite recent times, and for some special types and shapes still is, hand made, but for the most part is machine made. The clay is fed into the moulds of the brick making machines from overhead hoppers, and then pressed into shape and placed on drying racks after which it is burned in either periodic or continuously operating ovens.

Periodic ovens are of the ordinary dome type and bricks burned have to be graded according to hardness. In the continuously operating ovens the brick is placed in racks on trucks and these trucks move continuously through the ovens, the time of burning being about one hour and a half.

The manufacture of silica brick is very similar to that of fireclay brick except that the chief constituent, silica, is a rock. This necessitates considerably more work in crushing and grinding and because of the dry nature of the crushed material, it is necessary to add a certain quantity of lime to the silica. This mixture is then dried and burned, the burning requiring a somewhat higher temperature than fireclay.

Magnesite and chrome refractories are also manufactured. These require even more careful handling in moulding and also require a higher temperature for burning than silica brick.

Fireclay, silica, chrome and magnesite brick each have their uses in commerce. In the lining of boilers, cupolas, furnaces, converters, etc. one or the other plays its part. The research carried on by refractory manufacturers has been for the purpose of obtaining practically insoluble refractories for the various slags found in smelting of metals and the success achieved along these lines is greatly due to their efforts.

Calgary Branch

A. W. P. Lowrie, A.M.E.I.C., Secretary-Treasurer.
W. H. Broughton, A.M.E.I.C., Branch News Editor.

ARTIFICIAL REFRIGERATION

A general meeting, held in the Board of Trade rooms on the evening of Thursday, February 20th, was attended by about sixty-five members and friends to hear a paper by Kenneth Moodie, B.Sc., M.E.I.C., on the subject of "Artificial Refrigeration."

Mr. Moodie was introduced by J. A. Spreckly, A.M.E.I.C., and traced the development of artificial refrigeration from the early days when food was kept cool in running streams, through the evaporation dish and the "chattie," or evaporation bag, used in the eastern countries, to the elaborate and highly specialized systems now in use.

The speaker showed how dependent we are upon the transfer of heat; in cooking and preserving our foods, in heating our homes, to melt metals and temper tools. All these, however, utilize the absorption of heat, while this most modern use of heat transfer—refrigeration—deals with the removal of heat, and it is fast developing from a luxury into a necessity.

He traced the rapid increase in the consumption of ice in the United States since the installation of the first ice plant built in America in 1805 until today the consumption is about 60,000,000 tons per year in that country.

We are only at the beginning of the use of mechanical refrigeration in the home; undoubtedly it will extend to house cooling, especially in the warmer climates.

The speaker outlined the principle of the modern refrigerator in liquifying vapours under high pressure and allowing them to absorb their heat of vapourization at a low pressure and pointed out that these principles were stated by Dalton in 1801, and in 1823 Faraday produced, first liquid chlorine and then a number of other liquids from gases (or vapours) which were previously considered as permanent. This may be considered as the beginning of mechanical refrigeration.

The speaker defined the unit of heat and the commercial unit of refrigeration, the latent heats of the various refrigerants, their vapourization temperatures at the pressures generally used, and discussed their suitabilities from their relative refrigerative effects, pressure required and volumes occupied. He also outlined the cycle in the modern refrigerating machine.

Refrigerating machines, stated the speaker, may be divided into two groups:

1. Air, which is not condensible.
2. Vapours, which are condensible.

and the second group into three classes:

1. Machines in which the refrigerant is lost.
2. Machines in which the refrigerant is recovered by absorption into a liquid, usually water.
3. Machines in which the refrigerant is recovered by compression and condensation.

He outlined the principle of absorption and rejection of heat and the essential parts required for each type of machine. Air and carbon-dioxide are used in ships, carbon-dioxide and ammonia in abattoirs and ice-plants, while the domestic machine uses sulphur-dioxide, ethyl-chloride or methyl-chloride as the refrigerant.

It appears possible, said Mr. Moodie in conclusion, that solid carbon-dioxide may become more used as a refrigerant during transportation of goods and it may be that the day is not far distant when a solid block of CO_2 will be left each morning at the householder's door instead of a block of ice and so dispense with the necessity of turning on the refrigerator or filling the ice-box.

The interest of the sixty-five members and friends who heard the address was evidenced by the live discussion which ensued; unfortunately Mr. Moodie could not see any prospect of recovering and selling the enormous quantities of CO_2 resulting from the burning of some 300,000,000 cubic feet of natural gas per day which is being wasted in the Turner valley oil field.

A hearty vote of thanks was accorded the speaker following a motion by P. Turner-Bone, M.E.I.C.

ANNUAL DISTRICT DINNER MEETING OF PROFESSIONAL ENGINEERS OF ALBERTA

The Association of Professional Engineers of Alberta held its Annual District Dinner Meeting in Calgary on Saturday, February 7th, at the Renfrew Club. All local members of The Institute were invited to attend, and a majority of about sixty present were also members of the latter organization.

The chair was ably occupied by Dr. J. Allen, Professor of Mining and Geology at the University of Alberta.

Dr. Allen briefly reviewed the legal developments during the past year. Steps are being taken, for the first time, to prevent a non-professional from advertising, or to bring him into the Association.

Mr. B. F. Hake was introduced by the chairman and gave a splendid address on "The Age of Specialized Engineering." He traced the influence of the engineer on the development of the race and the progress of civilization from ancient times up to the present and showed how dependent our present civilization is upon work of an engineering nature. The speaker went on to show that it is impossible for any one individual to comprehend the whole of engineering knowledge at the present time and how the field has been subdivided into many highly specialized branches; he gave some very interesting comparisons of ancient and modern ideas of speed in transportation of people and goods and transmission of speech, of the problems arising from the displacement of labour by machinery and of new jobs continually being created.

The outstanding problem facing the professional classes—engineers, teachers, doctors and lawyers—is to prevent the world from becoming excessively materialistic.

B. L. Thorne, M.E.I.C., gave a résumé of the progress to date towards closer relationship between the various Provincial Professional organizations and gave much credit to The Institute and to S. G. Porter, M.E.I.C., for the efforts being made towards this end. He expressed the hope that considerable progress would be made under Mr. Porter's presidency of The Institute during the present year and he though, that the overtures of The Engineering Institute should be sympathetically received in promoting this object.

B. Russell, M.E.I.C., spoke along the same lines as the chairman of the Calgary Branch.

Mr. R. A. Brown, superintendent of utilities of the city of Calgary, released his usual collection of humour, this year largely at the expense of the geologists, who have quite recently considerably swelled the membership of the P.E.A.

Mr. R. A. James gave an interesting address on "Russia," which was a summary of conditions in that country and of the aims and progress of the "Five Year Plan," as reported in current literature.

The Secretary, Mr. Debney, gave an account of the membership and finances, which showed that a very healthy condition exists in the organization of the P.E.A. of Alberta.

A. Griffin, M.E.I.C., gave an interesting address on some of the problems of "Irrigation."

Hamilton Branch

J. R. Dunbar, A.M.E.I.C., Secretary-Treasurer.
J. A. M. Galilee, Affil.E.I.C., Branch News Editor.

The first students' meeting ever held by the Hamilton Branch took place in the Royal Connaught hotel on March 10th, 1931, with W. F. McLaren, M.E.I.C., in the chair.

Before calling on the Student and Junior members who were presenting the papers, the chairman outlined briefly the history of the various prizes offered by The Institute, and then called upon the Secretary to outline the conditions under which the Branch Student prizes are offered.

The three speakers drew lots to see who spoke first. The papers presented were as follows:—

P. R. Adams, S.E.I.C., "A Brief Résumé of the Development of the Air Brake and its Relation to Transportation."

D. E. Bridge, S.E.I.C., "Electric Furnaces as Applied to Industrial Heating."

H. W. Blackett, Jr.E.I.C., "The Power Supply of Southern Vancouver Island."

Air Brakes

The first speaker was P. R. Adams, S.E.I.C., who dealt with air brakes. He pointed out that starting and stopping of any type of transportation agent are complementary factors in the problem of making time between stations. Therefore, it is evident that the best results can only be obtained where both factors are given due consideration.

A practically perfect brake must be automatic, durable, simple, always ready, responsive and flexible.

The first steps toward the complete solution of braking problems were taken in 1869 by George Westinghouse, who patented his non-automatic air brake, since known as the "Straight Air Brake." This apparatus had many good qualities but nevertheless shortly afterwards gave way to the "Plain Automatic Brake." This type was almost immediately superseded by the "Quick Action Automatic Brake" which was a very decided improvement, chiefly from an emergency standpoint. By using this equipment, the time taken to apply the brakes fully on a fifty-car train was reduced to one-sixth of what was formerly necessary.

The air brake has played an important rôle also, in the development of our electric railway systems. The complete "Air Brake and Safety Car Control Equipment" must be given credit for the prominent part it has taken in the remarkable success of street railway transportation. The fast schedules, short headway, and elimination of one man could not have been possible, with safety, without this equipment.

The air brake has also invaded another division of transportation and is being associated with highway traffic, and it wields as potent an influence here as in the railway field.

The Automotive air brake is a power braking system which delivers a maximum braking force much greater than that which can be produced by the ordinary foot brake. Consequently, the high power, extreme flexibility, absolute equalization, and the fact that it operates without physical exertion, stamps it as an outstanding contribution to motor vehicle transportation.

Electric Furnaces as Applied to Industrial Heating

The second speaker was D. E. Bridge, S.E.I.C., who took up the subject from an engineering and technical standpoint, reviewing some of the fundamental principles which should be considered in the design and construction of electric furnaces of various kinds; also giving a brief description of the construction and application of the more important types of furnaces.

The early progress of electric heating was retarded by the high cost of electricity, the low price of fuel and the lack of stable apparatus to which it could be applied. These handicaps have been largely overcome due to the increased cost of fuel, to the rapid development of water power which has greatly reduced the electrical rates, and to the development of dependable and efficient heating devices.

In an electric furnace the electrical energy is converted to heat for industrial purposes by:

(a) The Resistance Method.

(b) The Electric Arc Method.

Both of these methods have their applications with some overlapping, for example the resistance method operates more satisfactorily for temperatures below 2,000 degrees F. while the electric arc is used for high temperatures.

The resistance method includes all applications of electric heating where the heat is produced by an ohmic resistance. The heating may take place by direct resistance or indirect resistance.

For direct resistance heating the current flows in the material itself and is more or less limited to material of uniform cross-section. For induction heating the heating currents are induced in the material to be heated. The distinctive advantage of this type of heating is that the heat is developed within the material to be heated without a transfer of the heat across space and without terminals attached to the material being heated. The material in this case acts like the secondary of a transformer. Should the material being heated not be a conductor of electricity, the walls of the container may form the secondary of the transformer, thus producing the heat.

In the indirect resistance class of electric heating the material to be heated is independent of the resistor and heat has to be transferred across space to the surfaces to be heated either by conduction, by convection, by radiation or by a combination of any or all three methods.

The arc furnace is of two types, single-phase and 3-phase. The former is extensively used for the melting of non-ferrous metals and is of cylindrical shell construction with a refractory lining and having horizontal electrodes along the axis of the cylinder. Carbon electrodes are usually used as they produce the hottest arc although tungsten iron and nickel may be used.

The heat given to the charge is chiefly by radiation from the arc, although a part is by re-radiation and also conduction from the walls of the furnace. The transfer of heat is at a rate proportional to the difference of the fourth power of the absolute temperature of the hot and cold surfaces.

A homogeneous metal is obtained by stirring the alloy during the melting process. To do this the cylinder is rotated, thus exposing all parts more directly to the arc, washing the inner surface of the walls, cooling the refractory lining and preventing excessive volatization of the metal.

Due to the fact that the arc dies to zero every half cycle, and a considerable value of voltage is required to start it again, the current fluctuates. Stability of the current is obtained by placing a reactor in the primary side of the supply transformer.

The 3-phase arc furnace is quite similar to the single-phase furnace except that the electrodes are in a vertical position and in a triangular arrangement. During the melting the slag forms at the surface and serves as a shield to protect the molten metal from the high temperatures of the arc, thus limiting the volatization of the metal and acting as a temperature equalizer.

The essentials for an arc furnace are a transformer, a reactor, a circuit breaker in the primary circuit, an indicating wattmeter, a watthour meter, a motor for rocking the furnace, and a motor for the automatic adjustment of the electrodes.

A description of each type of furnace was given pointing out the application of each with its distinctive advantages and disadvantages from an engineering viewpoint.

Furnace atmospheres were discussed, especially the normal atmosphere, and the application of hydrogen, carbon dioxide, and methane atmospheres, at varying pressures.

The chief advantages of electrical heating were shown to be:

(1) Improvement of the quality of the product.
(2) Closer regulation of the temperature.
(3) Heating becomes. an exact science, no combustion temperatures entering into it.
(4) Elimination of rejects and the increase in production.
(5) Better conditions for the operators to work under.
(6) Reduction in fire and explosion risk.
(7) Perfect automatic control.

The Power Supply of Southern Vancouver Island

The last speaker of the evening was H. W. Blackett, Jr.E.I.C., who dealt with the power supply of southern Vancouver island.

The period of greatest expansion of the use of electricity in the city of Victoria and the neighbouring municipalities dates from 1902 when the total connected load was 500 h.p. By 1927 this had increased to 28,000 h.p.

At the present time, southern Vancouver island is supplied with power by two hydro-electric plants and one steam plant; the combined capacity of the former being 44,000 h.p., while the latter has a capacity of 6,000 h.p., and is used mainly as a standby to take care of peak loads.

Of the three plants, the first to be installed was that at Goldstream, some 13 miles from Victoria. The original installation consisted of two 600 h.p. Pelton wheels direct connected to 350 kv.a., 3-phase, 60-cycle, 700-volt generators. The powerhouse was subsequenly enlarged and the original equipment supplemented by a 1,000 h.p. single-runner Pelton wheel and a 2,000 h.p. double-runner machine driving a 500 kv.a., and a 1,000 kv.a., generator respectively. The power is transmitted to Victoria at 17,000 volts, two banks of 400 kv.a., air-cooled transformers being used to effect the transformation.

At the steam plant at Brentwood bay, water tube boilers are used supplying steam turbines direct connected to two 2,000 kv.a., 3-phase, 60-cycle, 2,300-volt generators. The plant is tied in to the 60,000-volt Jordan river network.

The source of the water used at the Jordan river plant is Jordan meadows, the area of the watershed being some 82 square miles. The water is conserved by means of two dams, one on Bear creek and the other on Jordan river itself. The dam on Bear creek is 55 feet high and 1,150 feet long, flooding an area of 285 acres. The diversion reservoir on Jordan river is of the Ambursen slab and buttress type, 128 feet high and 860 feet long, with a crest elevation of 1,286 feet above sea level. At the west of the dam are the outlet gates through which the water passes into the surge chamber and thence to the flume.

The flume follows the Jordan river valley a distance of about 5.3 miles to the forebay which acts as a balancing reservoir between the flume discharge and the intakes of the pipe-lines. The difference in elevation between the powerhouse and the forebay is 1,145 feet, giving a pressure of 497 pounds per square inch at the needles.

Two pipelines conduct the water from the forebay to the powerhouse. The first, 48 inches in diameter, extends part way down the hill to a "Y" piece whose outlets are 36 inches in diameter. From the "Y," two pipes proceed to the powerhouse with a diameter of 31 inches at the lower end. The other pipe is a single one from the forebay to the powerhouse. Of the three pipes entering the powerhouse the first two feed the 6,000 h.p. Pelton-Doble water wheels driving the two 4,000 kw., 3-phase, 60-cycle, 2,300-volt generators which comprise the original installation. The remaining large pipe feeds a double-runner 13,000 h.p. Pelton wheel direct connected to an 8,000 kw. machine of the same characteristics as the original units. The voltage is stepped up to 60,000 volts for transmission to Victoria.

During the past two years a fourth unit of 13,000 h.p. has been added to the main plant and a small plant of 2,000 h.p. has been installed at the diversion dam.

After the speakers had finished they were requested to withdraw while those present decided on the order of merit of the oral presentations. The vote put H. W. Blackett first and P. R. Adams second. All three papers are now being judged by the Branch Prize committee for subject matter and style. The prizes will be presented at the annual meeting of the Branch on May 6th.

The meeting was very successful but should have been better supported by the senior members, there being only twenty-five present, which included a large number of students. Those who were not present missed a very interesting and instructive meeting.

Lethbridge Branch

Wm. Meldrum, A.M.E.I.C., Secretary-Treasurer.

The Story of Steel

The Lethbridge Branch held its regular meeting on February 21st in the club dining room of the Marquis hotel, when Mr. G. B. Davies, Manager of the Lethbridge Iron Works, was the speaker of the evening.

A special musical programme was arranged and greatly enjoyed during the dinner hour, the programme being broadcasted over CJOC for the benefit of the radio fans. Miss J. McIlvena gave a very entertaining monologue, while Master George Brown and R. S. Lawrence, A.M.E.I.C., gave vocal solos. Master Clifford Palmer also gave a violin selection. Mr. Brown and his orchestra were in attendance.

During the evening the balloting for election of chairman, for the ensuing year, resulted in the very popular choice of Nat Marshall, M.E.I.C., provincial government boiler inspector.

The chairman, C. Clendening, A.M.E.I.C., then introduced the speaker, who gave a brief introduction to the six-reel motion picture on "The Story of Steel, from the Ore to the Manufactured Product." Mr. Davies pointed out that next to aluminium, iron forms the largest percent of the earth's crust of all the other elements. The many iron ore and limestone deposits and coal fields in America made it one of the largest producers of steel in the world. The early methods used to wrest iron from its ores were very crude, fuel and ore being piled in a heap in alternate layers, the fuel ignited and the wind acting as an artificial blast. There followed many contrivances for producing a blast until the building of the first furnace with tuyeres in Spain. From that time on there has gradually developed, by natural stages, the large blast furnace of the present day. The speaker drew special attention to the rapid progress that has been made in the mechanical inventions used for the handling of the iron from the time it is mined as iron ore through its long journey to the time it becomes a finished manufactured product.

The motion pictures of the United States Steel Corporation's plant at Gary, Indiana, illustrated the many mechanical devices that were used in the manufacture of steel products and the handling of ores, including underground and open pit mining.

At the smelter the ore and flux, limestone usually, and coke are charged into the blast furnace through a hopper at the top. The coke and limestone forms one layer, the ore forming another layer, the whole is supplied with air, under pressure, necessary for the combustion of the fuel, at the bottom. The speaker then described the modern blast furnace, its function and operation.

The handling of the blast furnace products was also described and a short account given of the Bessemer and open hearth processes, the materials used and the tests made on the resulting products.

The electrolytic purification of cast iron was briefly described and the method of rolling and forging steel ingots.

Rolling mills have undergone much development, with resultant increase of output and elimination of hand labour and consequently a greater safety to labourers.

Most standard sections—rails, I-beams, channels, angles, round and square bars, etc.—are produced in three-high mills with rolls of fixed centre distances and grooved to the special shapes.

Specialized lines of manufacture include plates, sheets, lap-weld pipe, barbed wire, woven-wire fences, cable, nails, tin-plate and galvanized iron, and a brief description was given of the methods used in manufacturing these.

The Branch was very fortunate in being able to obtain these most interesting and very educational pictures, and in having Mr. Davies to answer the many questions that naturally ensued.

A vote of thanks was tendered by G. S. Brown, A.M.E.I.C., to Mr. Davies and the programme committee.

Engineers' Close Season Meetings

On Saturday night at the Marquis hotel the members and affiliates of the Lethbridge Branch of The Engineering Institute of Canada held the last meeting of the season, under the chairmanship of C. S. Clendening, A.M.E.I.C. The meeting commenced with the usual dinner at 6.30 p.m. at the Marquis. During the dinner Mr. Brown's orchestra very ably entertained with appropriate music. The 46 present were also quite evident in the vocal attempts in community singing with a welcome variety put in by the solos of Mr. G. Evans and Mr. W. Meldrum.

The reading of the minutes of the last meeting, and the reading of the annual Secretary-Treasurer's report by Mr. Meldrum, was very well received and appreciation of Mr. Meldrum's splendid work for the season was shown by the hearty applause and unanimous passing of the report.

The chairman reviewed the progress during the past season, mentioning the excellent work of the various committees and the result of the purchase of the projector.

At 8.15 the meeting was addressed by Mr. Cottam, of the Baalim Motor Company Limited, on the modern gas engine. Mr. Cottam very ably reviewed the progress of the gas engine from the original one-cylinder 4-cycle type to the present day including 2, 3, 4, 6 and 12 and 16 cylinder engines. He also indicated the reason for the increase in the number of cylinders whereby the increase of overlap of the power stroke due to the increase of all cylinders gave smoother operation.

Moving picture reels operated on the new projector by Mr. Cyril Watson showed very clearly the manufacture of the 6-cylinder motor from pig iron to the finished product. The moulding, casting, boring and honing of the cylinder block was shown in a very clear manner. The stamping of oil pans and forging of crank shaft and timer shaft all showed the effect of modern heavy presses and forging machines enabling manufacturers to produce cars at prices decreasing much more rapidly with average commodities prices.

The unceasing inspection was shown to be necessary to control the sizes and weights of the parts of the modern motor including the cylinder, crank shaft, drive shaft, connecting rods, pistons, etc. A number of questions were asked Mr. Cottam, and after able answers, G. N. Houston, M.E.I.C., moved a hearty vote of thanks.

Due to recent bereavement, the recently elected new chairman, N. Marshall, M.E.I.C., was not present and the meeting was presided over by Mr. Clendening, the retiring chairman. The result of the ballot gave the new Executive as Messrs. J. Haines, A.M.E.I.C., R. Livingstone, M.E.I.C., J. B. de Hart, M.E.I.C., N. H. Bradley, A.M.E.I.C. In addition the executive would be ably assisted by the retiring chairman, Mr. Clendening, the Councillor, Mr. Houston, and the Secretary-Treasurer, Mr. Meldrum.

It was not expected that any regular meetings would be held until the fall, but mention was made by Mr. Sauder of two or three construction jobs in the vicinity which might profitably be visited by members of the Branch in summer field tours.

London Branch

Frank C. Ball, A.M.E.I.C., Secretary-Treasurer.
John R. Rostron, A.M.E.I.C., Branch News Editor.

Railway Signalling

The County Council chamber, where the regular monthly meeting was held, was crowded to capacity to hear Mr. C. H. Tillett, Signal Engineer, Central Region, Canadian National Railways, speak on the subject of "The Purposes of, and Methods Employed in Railway Signalling."

The meeting was held on February 18th, under the chairmanship of the newly elected Branch chairman, W. Raywood Smith, A.M.E.I.C., and was attended by members of the Branch, C.N.R. officials, and a large body of electrical students from the technical school.

The chairman, in opening the meeting, pointed out that as this was the first meeting over which he was to preside he would like to make a few remarks with regard to his proposals for the year's programme. Under the regime of former chairmen, papers had been given and engineering works visited more or less synchronizing with the particular branch of engineering in which the various chairmen had been engaged. In his case, as township engineer, he was very much interested in re-afforestation and he proposed to promote interest and advancement along these lines during his term of office. He pointed to the present condition of Middlesex county where many wells were dry and the farmers were put to great expense in transporting water—sometimes of doubtful quality—from the nearest river or stream. This condition, he maintained, could largely be prevented by the proper proportion of bush and undergrowth and it would also have the effect of promoting an increased yield from the surrounding land. He quoted figures to show that while 10 per cent of bush land was considered ideal with 5 per cent the minimum, Middlesex had less than ½ of 1 per cent of bush land. He gave instances to show where land which was sheltered from the dry arid winds of summer in this manner yielded richer and larger crops than land not so protected and furthermore the ground supply of water was conserved. Of course, the undergrowth in the bush should be preserved by keeping cattle out. After these remarks, Mr. Smith called upon Mr. J. Piggott, Superintendent of the London Division, C.N.R., to introduce the speaker.

Mr. Tillett commenced with an illustrated description of the old mechanical means of operating the signals and switches by wires and rigid rods from signal cabins. The distance from the cabin at which signals and switches could be worked was of course limited, but it must not be supposed that these systems were obsolete; on the contrary, they were still in operation in many places. However, they were gradually giving way to the electrically controlled and automatic devices, as the facility and reliability of the latter are being demonstrated.

The whole principle of the automatic control was based on what is called the track circuit in which the electric current travels along each rail in the section or area desired and the circuit is completed by the contact of the wheels and axle of any vehicle entering the section.

On the completion of the circuit an electro-magnet becomes active and attracts a small relay switch which sets the machinery in motion for the operation of the semaphore arm, or the light, or switch as the case may be. As the train passes out of the section the circuit is again broken and the original order resumed. At junctions, crossings, passing sidings, etc., complications and duplex situations arise but the track circuit is the fundamental principle of operation. The power machinery for operating the various units is of various types, electric, pneumatic, and in some cases soda-water gas. The two former are most generally used but the electric motor was, he thought, coming into more general use. Views were shown of different types of semaphore arms with their attendant light arrangements for night time. However, these are now being replaced by lights only, as by means of special lenses these can be made sufficiently powerful for use in the daytime even in the strongest sunlight. Views were given showing the various systems of light signals, some with three lights—green, yellow and red, alternately—and others (and newer types) of only one light which gave the necessary colours as required.

In the former there are three lenses with the separate colours to each while in the latter only one lens with the operating automatic device simply controlling the colour elements and the light. Views were shown of the motors controlling these operations which, in turn, were controlled by the relay switch formerly mentioned; also illustrations were given of the machinery—mostly compressed air—for operating the ground switches of the tracks and electrically controlled either from the track circuit or a distant station. Regarding the latter, cut-out systems were shown by which, if necessary, the switches could be operated by hand. Also interlocking devices were shown, which make it impossible to operate a switch when a train is too near or passing over it. The speaker outlined the next advance in automatic signalling, viz. that of having the light signals in the engine driver's cab instead of or in addition to the fixed signals by the track side. These are in use at present, but not extensively, and views were shown of the attachment on the engine which is operated by a device connected with the signal control and which is situated close to the rails and with which contact is made by the attachment on the engine. Should the signal be at danger this machine also puts the brake in action on the train and so automatically stops it, or puts the driver on guard.

This electrical operation of signals and switches had the effect of greatly extending the mileage of track under the control of one despatcher and illustrations were given of the modern despatcher's board. Lengths of track of 40 or 45 miles are controlled by one despatcher, the position and direction of each train being indicated on a diagram on the board and the signals and switches operated by the control levers on the same board.

When the new Brantford cut-off on the main line of the C.N.R. has been completed a central traffic control station will be erected at Paris junction and switches and signals of the double track at either end of the cut-off will be operated from this central signal station and in this way the movements of all trains controlled from it.

As many as 37 units, signals, switches, etc., can be controlled over two wire lines by what is known as the codal system. Many of the installations shown were located on various railways in the United States and in this category the speaker gave an illustrated description of what is known as "hump" shunting into sorting siding yards. In this process the cars are shunted over a high spot on the tracks and run by gravity into the sidings, laid out fanwise, on the lower level. Again this operation is electrically controlled; at the neck of the fan-shaped group of sidings a control cabin is situated and all the switches into the numerous sidings are controlled from it. As each car or group of cars is shunted by the engine past this cabin the operator sets the various switches which will take the unit into its proper siding. It will be understood that in many cases these cars gain too much momentum by gravity and would run out of the siding at the bottom end if not slowed down. This operation was formerly accomplished by men stationed at various points who, when necessary, applied the brakes on the cars in motion. This was a dangerous operation, but it is now done away with and the cars are slowed down by "retarders" which are electrically operated from the control cabin. These retarders consist of solid strips or plates of metal fixed on each side of the rail and extending for a considerable distance along it. They may be said to form a jaw for the whole length of the plates and standing a few inches above the rail. When in action these jaws grip each side of the rims of the wheels of the cars and so retard them in passing.

The latter part of the speaker's talk was devoted to the matter of level crossing protection. He favoured the wig-wag system and gave a detailed description, with the aid of blackboard sketches, of the automatic operation of these signals by means of the track circuit.

He strongly stressed the necessity of motorists waiting till the wig-wag signal stopped before attempting to cross the tracks, particularly where there was more than one track. If a motorist started up immediately the train had passed there was always the danger of another train or engine approaching unseen and unheard.

In the discussion, many points were brought up showing the interest which the subject had aroused. One of these points was the possible derangement of the electric equipment through flooded tracks after heavy rainfall. The speaker admitted that this contingency was a source of trouble but it was gradually being overcome. He stated, however, that there was no danger from this cause, but only possible delay, inasmuch as when any derangement of the apparatus occurred from this or any other cause the signals affected reverted to danger and traffic was stopped.

Chas. Talbot, A.M.E.I.C., county engineer, stressed the need of adequate level crossing protection and in his opinion "Stop" signs should be provided and fixed on the highways at all level crossings. In furtherance of his argument he cited the case of side roads leading on to through roads where by the sign the motorist was compelled to stop (although he could see there was nothing coming on the highway) or run the risk of being hailed up by some police officer. The railway was a through road just as much as any highway and a far more forcible one in the sense that a motorist on the highway might be able to avert a collision while the engine driver on the railway was unable to do so. He also advocated special measures for removing obstacles at these crossings which interfered with clear visibility.

Several others commended the speaker for his discourse and a hearty vote of thanks was ably proposed by D. M. Bright, A.M.E.I.C., consulting engineer, London, and seconded by G. E. Martin, A.M.E.I.C., assistant engineer, department of Public Works, western Ontario.

Montreal Branch

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

Annual Meeting

On January 8th the annual meeting of the Montreal Branch was held. The reports of the retiring Chairman, D. C. Tennant, M.E.I.C., and of the executive were read. Then following the report of the Nominating committee the new Chairman, A. Duperron, M.E.I.C., took over the chair.

J. L. Busfield, M.E.I.C., then introduced a motion covering a recommendation to Council that they should exercise more freely their power to waive examinations in the case of applications for Associate Membership. After considerable discussion pro and con the motion was finally put and carried by a vote of 36 to 31.

After the meeting was adjourned refreshments were served in the reading room.

Diesel Electric Suction Dredge

Mr. B. G. Flaherty, chief engineer for the General Dredging Contractors Limited, addressed the Montreal Branch on January 15th on the subject of the new Diesel electric suction dredge—"General Brock."

In describing the equipment of this most modern dredging plant Mr. Flaherty pointed out that with the existing low first cost of Diesel engines it was now found more economical to use this form of motive power in place of steam engines for requirements below 5,000 h.p. The power plant on the "General Brock" consisted of Diesel engines direct connected to D.C. electric generators which in turn supplied the necessary current to D.C. motors driving the pumps and other equipment.

I. J. Tait, M.E.I.C., occupied the chair.

The Lighthouse Service of Canada

A most interesting address was presented before the Montreal Branch on January 22nd by J. G. Macphail, M.E.I.C., Commissioner of Lights in the Department of Marine at Ottawa. His subject was "The Lighthouse Service of Canada" and with the assistance of slides and moving picture films, Mr. Macphail presented a most realistic picture of the wonderful work carried out by this branch of the service.

Most of us, no doubt, consider, that we have a fair realization of the size of this vast country of ours but even so it must have come as something of a surprise to learn that Mr. Macphail's department was responsible for the protection of no less than 50,000 miles of coast line extending from Sable island on the east to the Queen Charlotte islands on the west. The aids to navigation which number over 12,000 comprise lightships, lighthouses, buoys of every description and fog signals. In this connection Mr. Macphail paid tribute to the pioneer work done by Canada in the invention and development of the diaphone, a siren used for giving warnings through fog which was now in service in practically every country in the world.

The personal side of the work was not overlooked and a very sincere tribute was paid by the speaker to the honesty, devotion and fortitude of the hundreds of men, women and children who are engaged in the lonely and arduous tasks of the service.

The Chairman of the Branch, A. Duperron, M.E.I.C., presided.

The British Grid

The January 29th meeting of the Montreal Branch marked a unique and most interesting development in engineering achievement when a capacity audience was addressed by Mr. Clifford C. Patterson, O.B.E., President of the Institution of Electrical Engineers, speaking from London, England.

Unfortunately a severe atmospheric disturbance earlier in the week made reception very difficult. However, with the assistance of printed copies of the paper and the slides it was possible to follow the speaker's remarks throughout. The two-way communication established between the headquarters of The Institute in Montreal and Mr. Patterson in London was made possible through the co-operation of the British Post Office, Imperial and International Communications Ltd., Canadian Marconi Company and the Bell Telephone Company of Canada.

Mr. Patterson chose as his subject for this important paper, "The British Grid," and was introduced to the audience by Julian C. Smith, M.E.I.C., who occupied the chair. The greetings of his organization and colleagues were first conveyed by Mr. Patterson, after which he referred briefly to the Faraday Centenary to be celebrated in London next fall.

Acting upon the authority of the Parliament of Great Britain, a committee headed by Lord Weir had organized a scheme for the national supply of electricity. Under this arrangement the generation of electrical energy was concentrated in some 130 selected stations each supplying the area in which it was located and all connected together by means of a complete system of transmission lines into a network or "grid" covering the whole country. This "grid," it was explained, was not so much a huge transmission line as a system of bus-bars, through which the generating stations are kept running in synchronism and in parallel with each other and through which equalization of load could be effected.

At the close of the paper the thanks of the meeting were conveyed to the speaker by Mr. Smith and brief discussions were offered by Messrs. R. A. Ross, M.E.I.C., and John Morse, M.E.I.C.

Niagara Branch

Paul E. Buss, A.M.E.I.C., Secretary-Treasurer.

One of the regular dinner meetings was held at the Leonard hotel, St. Catharines, on Feb. 26th, with Dr. R. W. Boyle, M.E.I.C., of Ottawa, as the speaker. About thirty members and guests were present.

The Engineer in the Nation

Dr. Boyle, who is Director of the Physics division of the National Research Council at Ottawa, has had ample opportunity for the study and analysis of the engineering complex. The theme for his address was the result of close analytical studies made into the life, manner and habits of engineers—both embryo and mature. His opportunities for these studies were wide and varied and he had come to the conclusion that engineers were psychologically different from the rest of mankind. Science students were characterized by soundness, sanity and common sense but they did not appear to take a great part in the social life of the university. They preferred to delve into the origin of things and discover fundamental truths. In consequence of this concentration they became retiring and lost much of that faculty of oratorical expression which is so highly recognized and rewarded by the present-day world.

All of the great advances in civilization have been made in the realms of pure and applied science, so that engineers have no cause to be ashamed of their profession. Art, philosophy and law have barely moved since the Grecian era and politics, ethics or economics have retrogressed if anything. The half-truths with which these pseudo-sciences deal and are largely based upon have no place among the exact values which are demanded by the true engineer.

Such being the case it is the engineer's own fault if he is not recognized. He is very often over-trained and under-educated and if he wants to succeed as a world-builder he must forsake the straight, narrow path and be content with the half-truths which were formerly scorned. (See page 713 Eng. Journal, Dec. 1930).

Dr. Boyle did not follow his remarks to the logical conclusion and state just what might happen to science if it's devotees forsook intensive training for worldly pursuits. Probably he preferred his hearers to figure that point out for themselves.

At C. G. Cline's suggestion, Dr. Boyle gave a short resumé of the Research Council's activities. Plant pathological studies were centred in Alberta, timber researches in British Columbia and T.B. studies in Quebec. The new building in Ottawa will house four main divisions, namely the Bureau of Standards, Department of Inventions, Industrial research and lastly pure science.

A Journalist on the R 100

At the meeting of the Branch held at St. Andrews Hall, Thorold, Ont., on March 6th, Mr. Thomas Wayling, free lance journalist of the Press Gallery at Ottawa, was the speaker, the subject of his address being "A Journalist on the R 100."

Mr. Wayling gave a most interesting description of life on board the R 100 from the time the ship left St. Hubert, Que., on August 13th, until it reached Cardington, England, fifty-seven hours later.

Prior to the address a dinner was served, the attendance being about seventy-five, and many others attended the lecture. Members of the flying club were also present.

Walter Jackson, M.E.I.C., was in the chair, and John C. Moyer, A.M.E.I.C., introduced the speaker.

Ottawa Branch

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

Joint Meeting With United Service Institute

At the Chateau Laurier on March 12th a noon luncheon was held under the joint auspices of the local branch of The Engineering Institute and the United Service Institute of Ottawa, at which Commodore W. Hose, C.B.E., R.C.N., spoke upon the subject of "Naval Conferences in the Scheme of Armament Reduction and Limitation." The meeting was presided over by G. J. Desbarats, C.M.G., M.E.I.C., chairman of the local branch of The Engineering Institute, who called upon Colonel J. G. Rattray, president of the United Service Institute, to introduce the speaker. In addition, at the head table there were the following guests: Major G. H. Brown; Major K. Stuart, A.M.E.I.C.; Dr. J. A. Amyot; John McLeish, M.E.I.C.; Dr. R. M. Stewart, M.E.I.C.; Group Captain E. W. Stedman, M.E.I.C.; F. H. Peters, M.E.I.C.; Commander C. T. Beard; Admiral Sir Charles Kingsmill; Commander H. B. Hynes, R.N.; L. B. Pearson; Lieut.-Col. H. D. G. Crerar; Dr. Charles Camsell, M.E.I.C.; Colonel J. L. H. Bogart, A.M.E.I.C.; D. Barry, A.M.E.I.C.; V. Lawson.

Commodore Hose in his address briefly outlined the various efforts made by the great powers since the armistice toward working out the problem of naval limitation. "The avowed object," he stated, "of all governments since the armistice has been the production of a system for the settlement of international disputes which will eliminate war as a final recognized arbiter."

Complete disarmament is impracticable at the present time. Nations, for their own security, must retain sea, land and air armaments, but these should be reduced to figures essential to self-preservation only, until such times as the international machinery of investigation, discussion and, if necessary, economic and military assistance can be brought to bear by other powers.

In his address Commodore Hose endeavoured to show where the various naval conferences and discussions have been of practical value in the naval sphere towards attaining the main objective—security against the scourge of war. He characterized security as of two kinds: first, "preventive"—security against the possibility of war breaking out; and second, "bellical"—security of a nation already embroiled in war. The real difficulty has been to strike a true balance between these two types of security.

The speaker stated that the years from the armistice to the present day, so far as naval limitation was concerned, could be divided into three periods, these periods being marked with four special major obstacles to the attainment of mutually agreed naval limitation. They were, first, the period up to the Washington conference; second, that between the Washington conference and the London Naval conference of January, 1930; and, third, the period subsequent to the last mentioned conference. The four problems were: the problem of the first period of "bigger and better battleships"; second, the problem relating to parity with the United States resulting from the terms of the Washington conference; third, the question of limitation of naval forces by their "global" or total aggregate tonnage and their global tonnage subject to categorical designation. The fourth problem was the matter of parity between France and Italy which has more recently come to a head.

A brief résumé of the efforts toward limitation during these three periods was then given. The five great naval powers—Great Britain, United States, Japan, France and Italy—attended the Washington conference and arrived at a ratio in actual capital ship allotment, which in brief was fixed as follows with the powers in order as named—5: 5: 3: 1⅔; 1⅔; the actual tonnage allowed Great Britain being 525,000 tons. An important political result was also attained in the "Quadruple Pacific Treaty" whereby the four powers interested in the Pacific ocean agreed to respect each others' insular possessions there, and to meet in joint conference in the event of any controversy arising which could not be satisfactorily disposed of by arbitration.

Following the Washington conference there was much in the way of conversations carried on between the powers relating to the question of the interpretation of its provisions. The obstacle mentioned above as the second of the four problems, namely the matter of parity between the naval forces of the British Empire and the United States, came to a head. The question of respective relative strengths in capital ships and aircraft carriers had been arrived at, but agreement as regards cruisers, destroyers and submarines was unattainable at the time.

The next particular naval phase was the third session of the Preparatory commission for the Disarmament conference. At this third session the third big obstacle to agreement came to a head. This difference of principle was found to be irreconcilable and the session terminated after an unacceptable measure of compromise was put forward.

The next naval conference was the Coolidge Naval Conference at Geneva in June, 1928, which lasted six weeks. Of the five powers, France and Italy declined to participate, although they sent observers.

This conference was not entirely successful and as an aftermath Great Britain "marked time." The United States introduced a bill which, after modification, was passed by the Senate on February 15, 1929, and which provided for the construction of fifteen big cruisers.

What the fate of this bill would have been had it not been for another set of negotiations which were going on in Europe, can only be left to speculation. By these negotiations between Great Britain and France an agreement was reached which settled between themselves the fundamental difference between global and categorical systems of limiting naval armaments. This agreement was communicated to Washington, Rome and Tokyo in July, 1928.

The London Naval Conference was called for January, 1930, at which the five naval powers attended. It lasted three months. An immense amount of technical detail was discussed, and agreement reached as to the classification, definition and individual limitation of the various types of warships. At this conference a general agreement extending to the five powers was also reached regarding global and categorical systems of limitation. Mutually agreed total tonnage figures for each and every category was accepted and inserted in the treaty for the three powers of Great Britain, United States and Japan.

Unfortunately, however, the problem of Franco-Italian parity was still left over, and consequently actual tonnage figures to be inserted in the accepted table of naval strengths were unobtainable from France and Italy.

Within the past few days the text of the Franco-British-Italian naval accord has been published, and all the world has been led to hope that this difficulty need no longer be a bar to the efforts being put forward toward naval limitation.

Peterborough Branch

F. G. A. Tarr, S.E.I.C., Secretary
B. Ottewell, A.M.E.I.C., Branch News Editor.

Research Problems in General

The ever-interesting subject of research, with particular reference to the work of the Ontario Research Foundation, was presented to the Branch in a very able address by Mr. O. W. Ellis, on the evening of January 22nd, 1931.

In introducing the speaker, chairman W. E. Ross, A.M.E.I.C., mentioned that he received his early training in England, with the Great Western Railway. He was a graduate of Birmingham university, and first came to this country in 1910. Mr. Ellis was for some time a professor of engineering at the University of Toronto, and subsequently with the Research department of the Westinghouse Company. He received his present appointment as director of metallurgical research, Ontario Research Foundation, Toronto, some two years ago, when it was established under the chairmanship of Sir Joseph Flavelle, with Dr. H. B. Speakman as director.

Research on such widely different subjects as packing house problems, chemical engineering, the woollen industry, farm economics and metallurgy, is carried on by the Foundation.

The metallurgical division co-operates with a group of manufacturers known as the Ontario Metal Industries Research Association, and as the results obtained are available to the members of the Association only, Mr. Ellis explained that he was not permitted to describe them in detail.

Referring to the work of this division up to the present as having been mostly for the purpose of locating the source of trouble rather than fundamental research, the speaker stated that during 1930 some forty-four problems and eighty enquiries had been handled.

As particular examples of some of the investigations carried out, Mr. Ellis mentioned the effect of nickel on bronze, on the improvement in yield point with the somewhat erratic tensile strength; and also the increase in the strength of metals, particularly copper and steel with cold working.

Another interesting subject dealt with was tin base bearing metals, extensive tests being made in compression, microstructure, Brinell hardness, etc., for a wide range of alloys.

Other investigations included the brittleness of silicon steel sheet, and the effect of oxide in brass on the mechanical properties. The many interesting methods employed and the general results obtained were described and well illustrated by diagrams and slides.

After answering a large number of questions following his address, Mr. Ellis was accorded a very hearty vote of thanks.

Water Supply and Sewage Treatment

On several previous occasions the Branch has been favoured with addresses by William Gore, M.E.I.C., of Messrs. Gore, Nasmith and Storrie, consulting engineers, Toronto, and was therefore prepared for an interesting talk on the above subject at the regular meeting on February 13th, 1931.

Ross Dobbin, M.E.I.C., as chairman, introduced Mr. Gore.

With the aid of a large number of fine lantern slides, the speaker described modern trends in construction of works for water supply and sewage treatment. He emphasized the similarity in processes and that both branches are intimately related to health and to each other.

The stream, river or lake drainage systems of the country are the sources of municipal water supplies and such waters after use are again returned to the drainage systems possibly to be used again for water supplies. For this and other reasons the safeguarding of streams from excessive contamination is a public charge of considerable importance.

It is realized, however, that surface waters at least cannot be secured entirely free from contamination and purification processes, sometimes very elaborate, are essential to treat modern water supplies in order to secure waters that are clear, sparkling, safe and palatable. This can only be provided if the sources are relatively pure; otherwise the purification processes may become over-loaded and the filtered water unsafe. Generally speaking the larger the works the greater the difficulties experienced.

Sewage treatment works are required so that the streams and other surface waters shall not become heavily contaminated and otherwise objectionable in odour or appearance. In this connection great difficulties have been experienced in preventing such treatment works from becoming nuisances in themselves and intelligent, scientific operation is required to prevent this as well as to prevent stream contamination.

An active discussion followed, and the speaker was tendered a cordial vote of thanks.

Radio Direction Finding as an Aid to Navigation

One of the most interesting and entertaining addresses ever given to the Peterborough Branch was presented by Commander C. P. Edwards, A.M.E.I.C., Director of Radio Service, Department of Marine, Ottawa, on February 26, 1931. The speaker was introduced by W. E. Ross, A.M.E.I.C., chairman of the branch, who in stating that this was the Commander's first visit to Peterborough was, strictly speaking, not making allowance for the fact that the lecturer passed over the city in the British dirigible, the R 100, on the occasion of its Canadian tour last summer. Commander Edwards' style of narrative is conversational and extremely humorous with nothing suggestive of the professional lecturer.

The address was illustrated by a large number of slides and was followed by a showing of some fine moving pictures of the visit of the R 100 to Canada last year.

By way of emphasizing that navigation is not an exact science and that even with the best of instruments and most skilled navigators ships occasionally go ashore, a number of photographs of wrecks were first shown. The speaker then proceeded to outline the development of radio direction finding as an aid to navigation. The ordinary straight aerial being non-directional is useless for this purpose hence the early use of the loop aerial, giving the "figure 8 diagram" or signal strength proportional to the cosine of the angle. The ordinary small movable loop was however at that time, some 20 years ago, not sensitive enough, and to overcome this Bellini and Tosi invented a large antenna with two fixed loops at right angles from which the signals were transferred to a small movable loop beneath.

Other difficulties encountered were the "vertical antenna effect" of the loop aerial, overcome by the shielded transformer and balancing methods, and the direct reception effect of the set itself, now eliminated by enclosing all parts in metal boxes.

The determination of the sense of direction, while not necessary for land stations, is important for ships receiving at sea, and is accomplished by the use of an auxiliary vertical antenna or its equivalent. This combination produces the "heart" shaped diagram, with minimum signal strength shifted 90 degrees, from that of the "figure 8" diagram.

Errors due to refraction as the radio waves pass over land near coast stations were illustrated by diagrams for typical Canadian stations on the Atlantic coast, the necessary correction factors being determined by transit.

Reflection from the "heaviside layer" at night is another disturbing element, which can however usually be detected by skilled operators.

Ships bearings determined by the intersection of lines from two radio stations, known as the "cocked hat," are guaranteed within plus and minus one degree and usually come much closer than this.

In the early days of direction finding, D.F. instruments aboard ships were not as accurate as those on shore, but of late years tremendous improvements have been made in this apparatus and the whole trend of the art for the past few years has been the use of ship direction finders in conjunction with automatic radio beacons on shore. These beacons might be described as 75 mile lighthouses. The Canadian type work automatically once an hour for six minutes in fine weather and once every three minutes in thick or foggy weather. They are located at strategical points and ships can take their bearings therefrom at any hour of the day or night long before they are in sight of land. Seventeen of these automatic beacons have so far been established in Canada.

Commander Edwards stated that the first D.F. station was erected in Canada in 1917 and there are now twelve such stations with some sixty operators. On the Hudson Bay route navigation is entirely dependent on D.F. stations, as there are no lighthouses or fog alarms.

The great value of this work in assisting navigation and consequently as a means of saving life, was stressed by the speaker. Thousands of bearings annually are given by stations such as Saint John, N.B., and Cape Race, Nfld.

At the conclusion of his talk Commander Edwards showed several reels of moving pictures of the R 100 during its landing at Montreal last summer and gave a fascinating personal account as a passenger, of its voyage over Ontario.

A. B. Gates, A.M.E.I.C., moved a vote of thanks to the speaker which was heartily endorsed by all present.

Students and Juniors Meeting

A very successful "Students' and Juniors' night" was held on Thursday, March 12th, the arrangements being in the hands of D. J. Emery, S.E.I.C., who also acted as chairman for the meeting.

Papers were presented by H. Ainsworth, non-member, H. E. Barnett, Jr.E.I.C., and T. Woodhall, S.E.I.C., and are summarized as follows:—

Synchronized Sound and Screen, by H. Ainsworth

A short résumé of the principles of sound, involving the loss of energy, pitch or frequency and resonant frequency as important features in the production of "talkies" was given.

The equipment was divided into two parts, the recording and reproducing equipment. Each part consists of two corresponding types, namely disc and film systems.

Disc recording was dealt with first. The pickup is effected through a capacity microphone, amplified and recorded by an electro-magnetic recorder on records. Characteristic curves for recorders were shown. The film recorder, using similar pickup and amplifiers, was described in more detail, and characteristic curves and a comparison of the two types was made. The different systems of monitoring the two recording systems was dealt with.

The reproducing equipment was next described, including the various integral parts. The record was discussed giving reasons for its size and speed of rotation also curves showing the effect of successive playings. After discussing the magnetic disc pickup, the characteristic curves were shown for various types in use. The film pickup equipment and its characteristic curve was then dealt with. The last individual part of the equipment was the horn receiver, types and characteristic curves of which were described. Mention was made of the types of screens and horns that are used.

The theatre installation as a unit was then discussed and a wiring diagram of a typical theatre installation was shown.

Selectivity Without Distortion Using Band-Pass Filters,
by H. E. Barnett, Jr.E.I.C.

One of the main advantages of radio communication is the ability of the transmitting medium — the ether — to carry a large number of messages simultaneously. This is essentially due to the fundamental properties of the tuned circuit.

To obtain undistorted reproduction, a certain band of frequencies must be amplified and transmitted from stage to stage of the receiver in equal proportions. It is usually considered that if frequencies within five kilocycles of the carrier frequency are equally reproduced the quality of reproduction will be good. To pass this band of frequencies, using simple tuned circuits the resistance of the circuit must be considerably above the minimum, limiting amplification, and to obtain adequate selectivity several stages of radio-frequency amplification are necessary.

Now that transmissions are becoming more powerful and more numerous and their carrier frequencies are closer together—it may often happen that an unwanted signal produces a greater first stage voltage than the signal to which the set is tuned. If the wanted signal is fully loading the first valve, the unwanted signal will in part be taking the first valve off the straight portion of its characteristic. Then partial rectification of the unwanted signal ensues, and the desired signal has impressed on it an audio-frequency modulation, which is unaffected by successive tuned circuits and is amplified with the desired signal.

Under such conditions the only satisfactory solution is to use a tuning arrangement in the first circuit having a response curve with a fairly flat top over the 10 K.C. band to be transmitted and steep sides.

Coupled tuned circuits, variously known as pre-selectors, band-pass filters, or 3-circuit tuners, have a characteristic response curve with two resonant frequencies. The coupling impedance may be capacity, inductance, mutual inductance, or any combination of these. To obtain constant peak separation (constant width of band of transmitted frequencies) the coupling impedance must vary with frequency in a definite manner. The speaker showed that, excluding mechanical devices to this end, which have practical disadvantages, this condition cannot be fulfilled by capacity or inductance, alone, or in series or parallel, but a combination of capacity in series with negative mutual inductance, can, for very definite values of its constants, depending on the other constants of the coupled circuits, give almost constant peak separation over a wide range of carrier frequencies.

The disadvantages of the double-humped response curve in actual use, can, if desired, be corrected by the use of a tuned anode stage following the first valve, without impairing quality of reception.

The use of reaction with this type of tuning does not introduce high-note loss as in ordinary circuits, but accentuates the high notes, making reproduction more than usually brilliant. It also increases selectivity to a certain point by increasing the steepness of the sides of the response curve, but if used to excess would separate the tuning peaks so much that low notes would be badly reproduced and selectivity would be impaired by making the transmitted band too wide.

Photo-Electric Cells, Their Theory and Application,
by T. Woodhall, S.E.I.C.

The subject was introduced through reference to the wider field of electronic cells including both the thermionic and light-sensitive type. The law governing the liberation of electrons from a material was reviewed with reference to Einstein's equation. The effect of the wave length of the light energy on the response of the material was discussed, only the alkali metals being responsive in the visible spectrum.

Photo electronic cells were classified under the following types: Photo Conductive, Photo Voltaic, Phototube, with a short description of each.

The phototube was then enlarged upon as the most used at the present time. The sensitive material of which the cathode is made was discussed as to its requirements and the means of meeting these. The effect of filling the cell with gas was also considered. The amplifiers used with the photo tube were stated to be of two kinds, those employing the 3-electrode vacuum tube and those employing the grid glow tube, the characteristics of each being given.

The ideal properties of a photo electric cell were outlined as: Sensitivity, Speed of Response, Linearity of Response, Reproducibility, Colour Sensitivity.

A short reference was then made under these heads to the present day type of cells.

In reviewing the industrial applications the following classifications were made, with reference in each case to the type of cell used.

(1) The control of a process and the indication of an event or condition; as in automatic manufacturing methods, traffic control, smoke detection, burglar alarms, etc.

(2) The quantitative translation of variation of light intensities into corresponding variation of current in an electrical circuit; reference being made to the talking picture and television field.

(3) The replacement of the human eye in the evaluation of light intensity and colour determination; as exemplified in photometry and colour standardization.

In concluding, the wide field open to the application of the photo electric cell was stressed, with a prediction that human operators would in the future be relieved of routine work dependent on the eye.

An active discussion took place on each paper, after which the thanks of the Branch were tendered to each of the speakers by B. L. Barns, A.M.E.I.C.

Saint John Branch

A. A. Turnbull, A.M.E.I.C., Secretary-Treasurer.
(Reported by F. M. Barnes, A.M.E.I.C.)

AIR TRANSPORTATION

The regular monthly meeting of the Saint John Branch of The Engineering Institute of Canada was held at the Admiral Beatty hotel, Saint John, N.B., February 18th, 1931, at 8 o'clock p.m.

W. J. Johnston, A.M.E.I.C., chairman of the Branch, presided. The meeting was open to the public and there was a large attendance of members of the Branch, also the Saint John Flying Club and the Civic Division of the Board of Trade, to hear Captain A. F. Ingram, general manager of Canadian Airways Limited, give a talk on "Air Transportation."

The address was broadcast from Station CFBO, Saint John, N.B.

Captain Ingram in his opening remarks mentioned that Great Britain, at the end of the war, was supreme in the air, and that over 60 per cent of the British Air Force were young Canadians, 90 per cent of whom gave up flying at the end of the war because commercial aviation in Canada had not come into its own and there was insufficient capital available to promote aviation companies. There were, however, small companies endeavouring to operate at this time, but eventually these succumbed and went into liquidation. A few of these pioneer companies did very well in the north country carrying freight and passengers for mining and prospecting companies in remote districts.

During the last few years the Dominion government has inaugurated air mail routes, competing against competent rail service in populated districts where difficulties were met with in endeavouring to improve the service. This was not the case in remote districts. Take, for instance, mail service along the north shore of the gulf of Saint Lawrence, which by the old method required about one month, is now accomplished in three and a half hours flying time. Also the case of the Magdalen islands. The people on the islands were, previous to the advent of air mail service, practically isolated during the winter months, due to ice and storm conditions. The Christmas mail for 1930 was delivered February 18th, 1931, the mail plane taking off from the Moncton airport and making two trips on February 18th and 19th, the delay being due to bad weather and the inability to land. In order to expedite this service, night flying is now being carried on between Winnipeg and Calgary, a distance of 1,200 miles.

During the transition period of freight carrying by the railways of the Dominion and the inauguration of the motor truck as a competitor on the highways, the railway companies did not appreciate the effect motor transport would have on their freight business and neglected taking part in the advancement. This was not the case in air transportation. The railways were not going to miss the opportunities offered by air transportation. When the merger of the several companies were brought under one control, the two large railways in Canada took an equal share in the company with President James Richardson, Winnipeg, and Vice-Presidents E. W. Beatty of the Canadian Pacific Railway and Sir Henry Thornton, M.E.I.C., of the Canadian National Railways. Many prominent financial and business men in most of the large cities throughout the Dominion are on the directorate, the real object being to put aviation in Canada on a sound basis and ultimately to have a transcontinental air mail service from Halifax to Vancouver; also during the season when the straights of Belle-Isle are open to navigation to have especially designed aeroplanes meet the mail steamers at Belle-Isle, take on mail and passengers and save at least two days time between Belle-Isle and Montreal.

Captain Ingram spoke inspiringly of the efforts made to build a civic airport at Saint John, portions of which have actually been carved out of solid rock, abundance of which is prevalent in this locality.

Lantern slides of an educational character were then shown on the screen which had been taken in a number of the larger aviation centres of the United States.

Maps of Canada and the United States showing air mail routes were also shown. Chicago and Montreal appear to be the centres of aviation in North America at this stage of development. Moving pictures were then screened, showing some wonderful scenic views of the Rocky mountains and flying above the clouds.

A hearty vote of thanks was then proposed and carried unanimously by the Branch to Captain Ingram for his splendid address.

Sault Ste. Marie Branch

A. A. Rose, A.M.E.I.C., Secretary-Treasurer.

Manufacture of Refractory Materials

The regular monthly meeting of the Sault Ste. Marie Branch was held on Friday, February 27, at the Y.M.C.A. The speaker of the evening, Mr. F. B. Cornell, was entertained at dinner previous to the evening programme.

Mr. Cornell is the district sales manager at Detroit for the Harbison-Walker Refractories Company of Pittsburgh, whose products are largely used by the industries of Sault Ste. Marie. He showed moving pictures illustrating the manufacture of their refractory materials, in particular fire-clay and silica brick.

In his introductory remarks he pointed out how closely refractories are connected to everyday life, through processes of manufacture; as, for example, the metals in an alarm clock, table knife, or an automobile. Some of the commonest refractories are fire-clay, silica, magnesite and chrome and their use depends on chemical conditions of the product, fire-clay being used for acid and magnesite and chrome for basic materials.

Consideration of refractories is important in the design of a furnace, as special shapes are expensive. The operator of a furnace can prolong the life of the bricks by careful operation. Bricks should be carefully handled when being placed as breaking and chipping decrease the efficiency of the furnace.

The picture showed the improvement that is taking place in methods of manufacture. As far as possible errors due to human elements are eliminated. For example, the moisture of the mix is not now tested by feel but by weighing. The screened size of flint-clay and plastic materials is also emphasized.

Bricks are burned at a temperature of about 2,400 degrees F. and the time of burning is from three to three and a half weeks. Tunnel kilns with oil or gas fuel are replacing the periodic or down draft kilns.

The company are carrying on extensive laboratory research work in an effort to give greater service and a better product to their customers.

Following a short discussion of the paper, a very hearty vote of thanks was tendered Mr. Cornell on motion of W. Seymour, M.E.I.C., and L. R. Brown, A.M.E.I.C.

Toronto Branch

J. J. Spence, A.M.E.I.C., Secretary-Treasurer.
A. B. Crealock, A.M.E.I.C., Branch News Editor.

Grain Elevators

On the evening of Thursday, January 22nd, the members of the Toronto Branch were privileged to hear C. D. Howe, M.E.I.C., of Port Arthur, who spoke on "Grain Elevators." Mr. Howe's vast experience as consulting engineer for many grain boards, wheat pools and Canadian National Railway placed him in a most advantageous situation in order to give his most interesting paper before this Branch.

The speaker introduced his subject by explaining the function of the five thousand town elevators scattered throughout the west, and the part they play in rushing the grain to the outlet ports of Vancouver and Fort William for export. He discussed the total world's crop and compared the Canadian production to this, giving carry-over figures for the Canadian grain production for several years back. To-day the surplus is about 540,000,000 bushels on the North American continent but by the end of the present year this figure, according to the speaker, will probably be cut in half.

Although the North American continent has more carry-over wheat in storage at present than Canada would produce in a normal year (about 400,000,000 bushels), and although Russia is preparing to make a larger bid for world markets by introducing bulk handling methods, the outlook for the grain trade in this Dominion is improving. Mr. Howe illustrated his paper with slides showing the primitive country elevator of years gone by and the progressive development arising out of this by what is known as the following types, crib, steel, tile and the latest construction, concrete, as used in the terminal elevators. Among the slides was one of the terminal elevator at Port Churchill. Among those taking part in the discussion which followed were J. M. Oxley, M.E.I.C., J. W. Falkner, A.M.E.I.C., Mr. Wyman, Mr. Bennett and A. T. Perrin, M.E.I.C.

Alexander Power Development

The meeting of the Toronto Branch, held on Thursday, February 19th, was addressed by Dr. T. H. Hogg, M.E.I.C., chief hydraulic engineer of the Hydro-Electric Power Commission of Ontario, on the Alexander Power Development on the Nipigon river.

The speaker commenced by outlining briefly the power development on the river, where the Commission now has two plants. The first of these at Cameron falls, which has a capacity of 75,000 h.p. under a head of 76 feet, was commenced in 1919 when the first two units were installed, and completed in 1926. In October of 1930, the second development at Alexander Landing, a mile and a half downstream from Cameron falls, commenced operations. This development has a capacity of 54,000 h.p. in three units of 18,000 h.p. each, under a head of 60 feet. The principal market for power is in the cities of Port Arthur and Fort William, about 70 miles distant.

Dr. Hogg also described the possible future developments on the Nipigon river, stating that there remained undeveloped a head of about 110 feet between the headwater of the Cameron falls plant and Lake Nipigon. Lake Nipigon has been developed as a storage basin by the construction of a control dam at Virgin falls at the outlet of the lake.

Going on to a description of the Alexander development, Dr. Hogg described the conditions at the site of the main dam, which necessitated the use of a structure of the earth fill type and complete dewatering of the main channel of the river by means of a diversion channel. The main dam was built by the semi-hydraulic fill method, material for construction being deposited by train fill at the sides of the central pool, and the impervious core was then formed by sluicing material from the sides to the centre part of the dam. An unusually heavy rock toe was placed, excavated material from the diversion channel and the power house site being available for this.

The author also described special features of construction; as, for example, in the tie between the earth and concrete sections of the dam, where the structures were designed to prevent leakage due to shrinkage of the earth fill away from the concrete. In the design used, as shrinkage occurs a close contact will always be maintained between earth and concrete. Another feature of interest is the omission of a headworks structure. A low extension, close to the power house wall, houses the winches for the head gates, but, aside from this, there is no construction above the headworks deck. The headworks deck is closed by close-fitting covers, and provision is made for the admission below the deck of warm air from the power house, in order to prevent freezing of head gates and racks.

A moving picture film, illustrating the events during the closure of the diversion channel and the succeeding period when the headpond level was raised, was shown, and interesting explanatory comments during its showing were made by Otto Holden, A.M.E.I.C., assistant hydraulic engineer of the Commission.

Vancouver Branch

W. O. Scott, Jr.E.I.C., Secretary-Treasurer.

The annual dinner of the Student section of the Vancouver Branch was held on Wednesday, January 21st, 1931, at 7.30 p.m.

The purpose of this dinner was to bring about a better acquaintance of the younger and older members of the Branch.

Following the dinner short talks were given by the Chairman, H. B. Muckleston, M.E.I.C., Dean R. W. Brock, M.E.I.C., of the University of British Columbia, Mr. A. H. Findlay also of U. B. C., Major G. A. Walkem, M.L.A., M.E.I.C., and John C. Oliver, Jr.E.I.C.

The speakers touched on early engineering, modern engineering, the outstanding bridges constructed or under construction 1928-1930, and the value of The Engineering Institute of Canada to the student, engineer and public.

There was an attendance of thirty-one, about twenty-two of which were students.

Forest and Game Conservation in Canada

On Wednesday, February 18th, Mr. A. V. Ablett, of the Canadian Forestry Association, gave a very interesting talk accompanied by motion picture illustrations on "Forest and Game Conservation in the Dominion of Canada."

One film gave a very interesting review of the logging and lumber industry from the cutting of the raw material (under the modern system) in the woods, to the finished product in the mill.

The attendance was disappointingly small, possibly due to a large extent on the inclement night on which it happened to be held.

Annual Meeting of Students' Section

The Student section held their annual meeting at which the Student members read a paper or gave a talk, on Wednesday, February 25th, in the University Science building at Point Grey.

W. Hall, S.E.I.C., in fourth year forestry, gave a very educational talk, accompanied by slides, on "Mapping from Aerial Photography." Mr. Hall has had some experience in this line of work with the Pacific Great Eastern Railway and presented actual photographs to illustrate the methods of transferring to paper the results recorded on the film or plate.

H. L. Thorne, S.E.I.C., in fourth year geology, spoke on "Oil and Gas Wells of Commercial Importance in Alberta." He traced the early developments and concluded with the output of the various fields at the present time. He is confident that there is a big future for the oil and gas industry in that province.

R. V. Anderson, S.E.I.C., in fourth year civil, took as his subject "Problems and Characteristics of the Modern Skyscraper." This talk was also accompanied by slides illustrating all the newer skyscrapers of the United States and included such places as New York, Chicago, Detroit, etc.

Mr. Anderson stressed the need of further co-operation between architects and structural engineers. He touched on wind stresses, foundations, trend of modern design, elevator systems, by-law restrictions, traffic congestion and so forth, points which arise in this connection, showing a very thorough knowledge of the subject.

Following the talks, the chairman, H. B. Muckleston, M.E.I.C., moved a vote of thanks to the Student section for the very educational and entertaining evening and at the same time complimenting the speakers for their very able presentations; W. H. Powell, M.E.I.C., seconded.

The attendance totalled about thirty-four, of which eleven were members of the parent branch.

Preliminary Notice

of Applications for Admission and for Transfer

March 21st, 1931.

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, 1931.

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

ANSON—CLEMENT MATTHEW, of Sydney, N.S., Born at Rotherham, England, Sept. 9th, 1901; Educ., B.Sc., McGill Univ., 1925; 1915, quick test helper, Sydney, Australia; 1916-19, open hearth helper, G. C. Hoskins, Ltd., Lithgow, Australia; 1919-20, supt., elec. furnace dept., Commonwealth Steel Products Ltd., Newcastle, Australia; 1926-28, asst. supt., blast furnaces, 1928, asst. supt., mills, 1928-30, asst. gen. supt., Dominion Iron & Steel Company, and from 1930 to date, asst. gen. mgr., Dominion Iron & Steel Divn., Dominion Steel & Coal Corpn., Sydney, N.S.
References: A. P. Theuerkauf, K. H. Marsh, T. L. McCall, F. W. Gray, W. L. Stuewe, W. E. Bown.

CARRIERE—JEAN PAUL, of 77 Laurier Ave., Hull, Que., Born at Hull, Que., Nov. 15th, 1907; 1922-23, Ottawa Univ., Ottawa. 1923-24, LaSalle Academy, Ottawa; 1924-25, Hull Tehcnical School; I.C.S. diplomas, Surveying and Mapping, and Civil Engrg.; 1924-26, chainman and rodman, and 1926-28, asst. engr., Corpn. of City of Hull; Nov. 1928 to Mar. 1929, asst. engr., E. B. Eddy Co., Hull, Que.; at present, dftsman, chief engr's dfting room, Dept. Public Works Canada, Ottawa, Ont. (1931, Jan.-Mar., asst. engr., Corpn. of City of Hull, by special permission of Deputy Minister.)
References: F. G. Smith, J. E. St. Laurent, R. de B. Corriveau, K. M. Cameron, S. J. Chapleau.

DUNN—HAROLD STEWART, of New Glasgow, N.S., Born at Moncton, N.B., Dec. 14th, 1891; Educ., Aberdeen High School, Moncton, N.B. I.C.S. Diplomas, Mining and Railroad Engrg.; 1908-09, chainman, Intercolonial Rly., Moncton; 1909-10, rodman, 1910-11, transitman, National Transcontinental Rly., N.B.; 1911 (July-Nov.), transitman, G.T.P. Rly., Sask. and Alta., 1911-13, transitman, C.N.O. Rly., Ontario; 1913-14, res. engr., C.N.O. Rly., Ontario; 1914-16, transitman, C.N.R., Nova Scotia; 1916-19, overseas, Lieut., Can. Engrs.; 1919-20, transitman, C.N.R., New Glasgow; 1920-26, mining engr., Bras d'Or Coal Co., North Sydney, N.S.; 1926-29, chief engr., A.Q. & N. Rly., Quincy, Ill.; at present, res. engr., C.N.R., constrn., Sunny Brae to Guysboro, N.S.
References: C. H. F. Donkin, L. H. Wheaton, F. O. Condon, C. W. H. Perley, J. H. Clark.

DWYER—THOMAS EDWARD, of Montreal, Que., Born at Halifax, N.S., May 22nd, 1903; Educ., B.Sc., N.S. Tech. Coll., 1929; 1927-28 (summers), instr'man., Geol. Survey; 1929-30, quantity surveyor on dam, 1930-31, quantity surveyor on wharf, New Brunswick International Paper Company.
References: R. P. Freeman, F. R. Faulkner, W. P. Copp, H. R. Theakston, L. Sterns, A. M. James, P. E. Cooper.

FERGUSON—JOHN HENRY, of 122 Osgoode Street, Ottawa, Ont., Born at Glasgow, Scotland, Aug. 20th, 1906; Educ., B.Sc. (Civil Engrg.), Univ. of Man., 1929; 1929-30, flying duties, Camp Borden, and 1930 to date, headquarters' workshop officer, R.C.A.F., Ottawa, Ont.
References: E. W. Stedman, S. G. Tackaberry, A. Ferrier, E. P. Fetherstonhaugh, J. N. Finlayson.

GRAY—DONALD WALKER, of Parry Sound, Ont., Born at Sydney, N.S., Feb. 24th, 1908; Educ., B.Sc. (Forestry), Univ. of Toronto, 1930; Four summers and from spring of 1930, to date, asst. forester with Ontario Forestry Branch. Work includes forest survey work (ground work in form of an elaborated timber cruise), use of aeroplane photographs, and mapping and dfting in preparing summaries.
References: F. W. Gray, A. W. McMaster, W. C. Risley, S. C. Mifflen, J. T. Farmer, C. Stephen, W. S. Wilson, A. P. Theuerkauf, K. H. Marsh.

INGRAM—ARTHUR FERGUSON, of Montreal, Que., Born at Standish, England, Sept. 17th, 1892; Educ., 1916, course in Aeronautical Engrg., Reading Univ., England; July 1916. passed British Air Ministry Exam. obtaining Commission in R.F.C.; 1919-20, undergraduate (medicine), Queen's Univ., Belfast; 1915-16, early training under British Air Ministry in aeronautical engrg.; 1916-18, Flt.-Commdr. No. 27 Squadron on active service in France and Egypt; 1918-19, in charge of flying school at Fowlmere, Cambridge, England, including flying instruction and other aeronautical subjects; 1919-25, transferred to School of Army Co-operation and responsible for Air Force co-operation with the Army in aeronautical matters; 1925-28, transferred to Air Force Training Camp, Uxbridge, England, as Adjutant in Charge of Instruction; 1928-29, Flt.-Commdr., Adjutant in charge of Canadian Air Force Training, Camp Borden, Ontario, and Flying Instructor; 1929 to date, operating manager of flying operations, Canadian Airways Limited, Montreal, in charge of all air mail operations in Eastern Canada from Windsor, Ont., to Halifax, N.S.
References: J. A. Wilson, R. H. Mulock, E. W. Stedman, L. S. Breadner, J. L. Busfield, A. Ferrier, C. K. McLeod.

JACOBS—MILTON, of Montreal, Que., Born at West Stewartstown, N.H., May 14th, 1891; Educ., B.S. in C.E., Norwich University, Northfield, Vt., 1912; 1912-14, dftsman., pulp and paper mill extensions and mtce., Burgess Sulphite Fibre Co., Berlin, N.H.; 1914-16, field engr., grade crossing elimination, Pennsylvania R.R., Cleveland, Ohio; Feb. 1916 to Aug. 1920 (except Mar. 1918 to Jan. 1919, 2nd Lieut., C.A.C., U.S. Army), constrn. engr., pulp and paper mill extensions and hydro-electric developments for International Paper Co., Berlin, N.H.; 1920-21, asst. engr., hydro-electric development, Brown Company, Berlin, N.H.; 1921-23, designing engr., pulp and paper mill developments, Fort William Paper Co., Fort William, Ont., Provincial Paper Co., Port Arthur, Ont., and Mead Fibre Co., Kingsport, Tenn., with Management Engineering and Development Co., Dayton, Ohio; Feb. 1923 to May 1924, res. engr., paper mill extensions, Sonoco Products Co., Hartsville, S.C., with H. S. Taylor, M.E.I.C., consltg. engr.; May 1924 to Feb. 1931, Montreal manager and chief designing engr., with H. S. Taylor, M.E.I.C., consltg. engr., and at present, associate engineer and member of firm, H. S. Taylor and Company, Consltg. Engrs., Montreal, Que.
References: H. S. Taylor, D. C. Tennant, B. R. Perry, R. E. Chadwick, E. P. Cameron, F. O. White, S. J. Fisher.

LUDGATE—JAMES VERNON, of 188 William St., Kingston, Ont., Born at Parry Sound, Ont., Jan. 30th, 1901; Educ., B.Sc., Queen's Univ., 1923; 1923-25, asst. to manager, Schroeder Mills & Timber Co., Pakesley, Ont.; 1925-27, res. engr. for same company; 1927-28, woods engrg. dept., Canadian International Paper Co., Montreal; 1928-30, manager, Tudhope & Ludgate, Ardkeg, Ont.; 1930 (7 mos.), land surveys and topographic surveys, Parry Sound, Ont.; at present, inspr. for Canadian Terminals System on constrn. of transfer grain elevator, Kingston, Ont.
References: J. A. H. Henderson, T. A. McGinnis, W. P. Wilgar, A. Macphail, D. S. Ellis.

McFARLAND—WALTER IRVING, of Beauharnois, Que., Born at Havelock, N.B., Nov. 10th, 1902; Educ., B.Sc. (E.E.), Univ. of Alta., 1929; 1927 (5 mos.), electrn's. helper, 1928 (5 mos.), night electrn., Marlboro Cement Works, Marlboro; 1929-30 (8 mos.), student ap'tice, Canadian Westinghouse Company; Feb. 1930 to date, elect'l. engineering dept., Beauharnois Construction Company, Beauharnois, Que.
References: B. K. Boulton, R. G. Watson, J. A. Knight, C. A. Robb, R. S. L. Wilson.

PRENTICE—WILLIAM RAMSAY, of Hawkesbury, Ont., Born at Edinburgh, Scotland, Jan. 21st, 1895; Educ., Toronto Public and High Schools. Three or four years evening classes, mech'l. drawing and applied mechanics, Toronto Technical School; 1911-16, articled student, Geo. M. Miller & Co., Architects, Toronto; 1916-21, gen. dfting, Fairbanks Morse Co., Toronto; 1921-22, gen. dfting, Massey Harris Co., Toronto; 1922-25, chief dftsman., Canada Foundries and Forgings Co. Ltd., Brockville, Ont.; 1925-29, research lab. engr., and 1929-31, asst. mill engr., Canadian International Paper Co., Hawkesbury, Ont.; at present, machine designer, Geo. J. Manson, A.M.E.I.C., Consltg. Engr., Hawkesbury, Ont. (Design of special pulp products machinery).

References: C. B. Thorne, S. Wang, A. K. Grimmer, G. J. Manson, J. Tomkins, C. B. Shaw.

RYBKA—KAREL R., of Montreal, Que., Born at Vienna, Austria, Jan. 28th, 1900; Educ., Mech. Engr., States Colleges at Bruo and Prague, Czechoslovakia, 1923; 1924 (Jan.-Nov.), junior dftsman., M. Becker machine shops, Prague; 1924-25, dftsman., W. Merlet foundry and machine shops, Prague; 1926 (Jan.-Oct.), field supt. and dftsman., T. Kozeluh, consltg. engr., Prague and Dresden; 1926-28, heating engr., Emile Stohr, heating, plumbing and ventilating contractor, Prague and Vienna; 1928 to date, designing dftsman., engrg. dept., Ross & Macdonald, arch'ts., Montreal.

References: W. J. Armstrong, G. S. Townsend, G. L. Wiggs, A. H. Ross, A. C. Fleischmann.

YATES—JOHN MUNRO, of 18 Grafton Avenue, Toronto, Ont., Born at Toronto, June 24th, 1905; Educ., Diploma in Arch'ture and Bldg. Constrn., Technical Institute, Toronto, 1927; 1925-30, dftsman., with the following firms: Browne & Cavell, Willis Chipman, C.E., Bell Telephone Company of Canada; at present, dftsman., Dept. Public Highways Ontario, Port Hope, Ont.

References: A. M. Reid, R. E. Smythe, A. A. Smith, R. M. Smith, A. Hay.

YOUNG—JOHN DOUGLAS, of Montreal, Que., Born at Boston, Mass., Nov. 30th, 1900; Educ., B.Sc., Queen's Univ., 1927; 1922-24, operator, marine gas engine, Upper Ottawa Improvement Co., also marine diesel operator; 1925-26, steel detailing, Chelsea power house, Gatineau Power Company; 1927 to date, sales service engr., Bailey Meter Co. Ltd., Montreal, Que. Work includes sales with service requirements on equipment, consisting of installation, repair, recalibration and combustion test work for meter adjustment purposes, also considerable consulting work as to best methods of handling power and process flow sheets.

References: L. M. Arkley, L. T. Rutledge, W. L. Yack, H. G. Thompson, W. G. Scott.

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

HALL—JOHN G., of Montreal, Que., Born at Cornwall, Ont., Sept. 2nd, 1891; Educ., B.Sc., McGill Univ., 1921; 1911-12, G.T.R. shops, Pt. St. Charles; 1914-16, G.T.R. shops, Chicago; 1917-19, U.S. Shipping Board, Montreal and Cleveland; 1921-24, engr. and asst. supt., Back River Power Co., Montreal; 1924 to date, with Combustion Engineering Corporation Ltd., as follows: 1924-27, manager, Winnipeg office; 1927-30, in charge of sales, prairie provinces and from Montreal to maritimes; and at present, vice-president and general manager, Montreal. (*S. 1919. A.M. 1924.*)

References: J. T. Farmer, C. M. McKergow, J. W. Sanger, E. V. Caton, K. Moodie, J. Haddin, T. S. Morrisey.

MacAFEE—RALPH EVANS, of 4156 Dorchester West, Montreal, Que., Born at Newton, N.B., April 15th, 1887; Educ., B.Sc., McGill Univ., 1910; 1909 (Apr.-Sept.), Angus shops, elect'l mtce., C.P.R.; 1910-11, ap'tice course, Canadian Westinghouse Co. Ltd., Hamilton, Ont.; 1911-13, with same company, correspondence dept., Hamilton and Calgary; 1913-15, with McMullen Riley & Durley, Consltg. Engrs., preparation of plans and specifications including designs covering elect'l and heating systems for large buildings; 1915-19, overseas, Capt. Can., Engrs.; M.C. and mentioned in Dispatches; 1919-23, steam power plant engrg. contracts and sales, Babcock & Wilcox Ltd., Montreal; 1923-29, steam power plant engrg. contracts and sales, Babcock-Wilcox and Goldie-McCulloch, Ltd., and from April 1929 to date, manager, eastern branch (covering Quebec and Maritime Provinces), for same company. (*A.M. 1920.*)

References: C. V. Christie, F. A. Combe, R. J. Durley, S. J. Fisher, C. M. McKergow, E. J. C. Schmidlin.

FOR TRANSFER FROM THE CLASS OF JUNIOR TO A HIGHER CLASS

MARCHAND—EUGENE F., of St. Jerome, Que., Born at Ottawa, Ont., May 28th, 1897; Educ., 1914-16, Ottawa Collegiate Institute. Passed maths. exam. for D.L.S., Ottawa, 1916; 1917-19, overseas; 1919-20, with P. E. Marchand, Ottawa, Ont., on transmission lines and small power plants; 1920-21, Bathurst Company, steel transmission line, contractors, Morrow & Beatty, Peterborough; 1922, in charge of constrn. for Rockland Electric Light Plant and lines; 1924-27, in charge of finishing constrn. and also operating of system and plant for Laurentian Hydro-Electric Ltd.; 1927 to date, manager of Laurentian division, Gatineau Electric Light Co. Ltd., St. Jerome, Que. (*Jr. 1925.*)

References: F. B. Brown, G. G. Gale, J. S. Parker, J. E. Woods, H. B. Fisk.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

BELL—HARRY HEARTZ, of Calgary, Alta., Born at Halifax, N.S., Nov. 9th, 1906; Educ., B.Sc., Dalhousie Univ., 1927. B.Sc., N.S. Tech. Coll., 1929; 1924-25, marine surveyor, Biological Board of Canada; 1927 (2 mos.), instr'man., Anglin Norcross Ltd.; 1928 (June-Sept.), ap'tice, industrial control, Can. Gen. Elec. Co., Peterborough; 1929-30, technical work, mech'l. and elect'l., on 132,000 v. transmission line, and 1930 to date, load and voltage survey of system, Calgary Power Company, Calgary, Alta. (*S. 1928.*)

References: W. P. Copp, F. R. Faulkner, K. L. Dawson, R. E. Heartz, H. B. Sherman, G. H. Thompson, W. Anderson.

EVANS—JOHN MAURICE, of Outremont, Que., Born at London, England, Oct. 7th, 1905; Educ., B.Sc. (Hons. in E.E.), McGill Univ., 1929; 1925-27, test engr. and research, 1928, shift operator, Marconi beam system, Canadian Marconi Co.; 1927 (5 mos.), forest cruise and transitman, International Paper Co.; 1929-30, (1 year), special engrg. problems and system planning, and from 1930 to date (9 mos.), industrial engr., Shawinigan Water and Power Co., Montreal, Que. (*S. 1929.*)

References: F. S. Keith, J. Morse, S. Svenningson, P. S. Gregory, R. H. Mather, C. V. Christie.

LOCHHEAD—STUART GEORGE, of 309 Brock Ave. North, Montreal West, Que., Born at Montreal, Que., May 18th, 1905; Educ., 1924-27, McGill Univ. (completed all but one course in second year); 1926 (summer), chainman, C.N.R.; 1927-28, dftsman., Dominion Bridge Co.; 1928-29, chief of party and instr'man., Canada Power & Paper Corpn.; April 1929 to date, junior engr., City of Westmount. (*S. 1928.*)

References: F. F. Clarke, D. C. Tennant, P. E. Jarman, P. G. Delgado, S. E. Oliver, A. Peden.

WARDLEWORTH—THEOPHILUS HATTON, of 168 Cote St. Antoine Road, Westmount, Que., Born at New Brighton, Cheshire, England, June 7th, 1903; Educ., B.Sc. (Civil), McGill Univ., 1925; 1924-30, with Fraser Brace Engrg. Co. as follows: 1924 (summer), rodman, Deer Lake, Nfld.; 1925-26, estimator, Montreal; 1926-28, instr'man., Colombia, S. A.; 1928-29, estimator, Montreal; 1929-30, instr'man., Copper Cliff, Ont. (*S. 1923.*)

References: J. B. D'Aeth, C. D. Norton, E. Brown, R. DeL. French, J. Weir.

Meeting of The Joint Committee on Concrete and Reinforced Concrete

The Joint committee on Specifications for Concrete and Reinforced Concrete met in Chicago, on February 27 and 28, 1931. This committee, which is made up of five representatives each of the American Society of Civil Engineers, American Society for Testing Materials, American Railway Engineering Association, Portland Cement Association, and the American Concrete Institute, is a reorganization of the committee that made reports on concrete specifications in 1921 and 1924.

A number of developments since the 1924 report makes certain changes in the specification desirable. Among the advances which have been made, relating to concrete as a material in recent years, the most significant are the developments in cement, use of ready-mixed concrete, and a more widespread understanding of the design of mixtures with increasing attention to field control.

In the field of design, an outstanding development which should be covered in future reports of the committee is the tendency towards the greater use of rigid frame construction.

All these developments are to be given consideration by the reorganized committee in addition to a general study of the 1924 report with a view to improving its presentation and widening its scope.

The committee proposes in its report to separate portions which are in the nature of specifications and those which are in the nature of recommended practice. It is planned also to add as an appendix the technical data upon which the recommendations of the report are based. The committee is considering the necessity of distinguishing between the requirements for so-called outdoor concrete and concrete in locations such as heated buildings not exposed to the effect of weather. Water-tightness as an element of durability will be recognized as one of the essentials of concrete for outdoor exposure. The necessity for this has been brought about by the recent development of generally higher strengths in portland cements. Following the practice which has become quite general of designing concrete for a given strength requirement, it is possible with these newer cements that mixtures will result which are too lean for proper durability. Some limitation will, therefore, be placed upon the cement content to avoid this difficulty.

In the field of design of reinforced concrete, the committee proposes to present the recommendations in regard to moment coefficients by putting primary emphasis on the general case of unequal spans, thus reversing the arrangement in the 1924 report in which the emphasis is placed on a series of equal spans. Moment coefficients will be given only for the case of equal spans and these will be presented with separate coefficients for live and dead load.

The American Institute of Steel Construction, Inc., has published a 48-page booklet entitled "True Economy in Highway Bridge Design," by T. W. Dodd, with a discussion by J. G. Greiner. This booklet contains a comprehensive treatment of the economics of the small highway bridge, and includes many diagrams and illustrations. It is obtainable gratis upon application to the offices of the American Institute of Steel Construction, Inc., 200 Madison Avenue, New York, N.Y.

The Burlington double-leaf bascule bridge being built by the Hamilton Bridge Company will be the largest of its kind in Canada, and the second largest on the continent. Each leaf measures 160 feet long and weighs 600 tons. The primary power is supplied by two Canadian Westinghouse 125 h.p., 100-kw., 550-volt, D.C. motor generator sets. There are four 48 h.p. motors, which act as main lifting motors, and there are two 5 h.p. motors, which drive the locks into the bridge.

The Dominion Oxygen Company Limited have this winter opened a new training shop in their Toronto plant, offering greatly increased facilities for giving instruction to their customers' welders. For some years instruction has been given in the various applications of the oxy-acetylene process to welders employed by users of Dominion Oxygen products, but the value of this service to the users of the process has taxed to capacity the facilities available.

This training shop, is equipped so 15 to 20 welders can receive instruction at one time. Pipe lines distribute the gases to each welding and cutting table and a straight line cutting machine, capable of cutting and bevelling plate up to 12 inches in thickness, has been installed for preparing material. The shop is completely equipped with oxy-acetylene welding and cutting blowpipes for sheet metal, aircraft, pipe and general repair welding. A tensile machine for testing welds assists greatly in the instruction of welders who can be shown the results of improper handling of the blowpipe by destructive testing of their own work.

This shop is operated five days and five nights a week for welders employed by customers of the company and special instruction is given in automotive repair work, aircraft welding, pipe welding and the fabrication of pipe fittings, as well as general instruction in welding cast iron, malleable iron, steel plate and castings, aluminum, monel metal, brass, bronze, copper and the various alloys and other metals used in industry.

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This Service is operated for the benefit of members of the Engineering Profession and Industrial and other organizations employing technically trained men—without charge to either party.

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ELECTRICAL OR MECHANICAL ENGINEER. A young electrical or mechanical engineer with some experience in statistics. Application should state fully education and experience. Apply to Box No. 693-V.

BUYER required by large corporation in Eastern Canada. Applicant must be graduate engineer and have had at least three years practical experience. Should not be over 30 years of age. Apply to Box No. 697-V.

SALES REPRESENTATIVE. Young engineer with about two years experience required for sales work in Ontario and Quebec. Apply giving full particulars as to training and experience to Box No. 698-V.

PARTNER wanted with $3,000 to further develop exclusive agency for British product of engineering nature, in good demand. Location Montreal. Apply to Box No. 701-V.

YOUNG ENGINEER, as sales representative for industrial and building products, with some experience on general contracting estimating. Location central Ontario. Apply at once to Box No. 703-V.

MECHANICAL ENGINEER. Technically trained engineer, fully familiar with modern shop practices and costs. Experience in coal mining, oil well and miscellaneous mechanical equipment and repair work desirable. Splendid opportunity. Location Western Canada. Apply, giving full information regarding education and experience, to Box No. 704-V.

GENERAL SHOP SUPERINTENDENT. Familiar with modern shop practice in modern shop, foundry and miscellaneous iron and steel construction. Must be hustler and able to handle men. Location Western Canada. Apply, giving full information regarding experience, to Box No. 705-V.

WANTED, engineer with good knowledge of combustion principles, to organize and carry on sales of automatic stokers. Must be energetic, have good personality, with executive ability. Apply to Box No. 706-V.

PARTNER WANTED. Engineer with extensive construction and mechanical experience, speaking French and English, desires to make connection with engineer or firm engaged in engineering work. Will make investment. Apply to Box No. 708-V.

Situations Wanted

CIVIL ENGINEER desires to represent manufacturers of industrial products or specialties selling to industrial and other markets. Experience includes engineering and building construction, municipal works, administration and operation, purchasing and sales, etc. Record of integrity. Apply to Box No. 14-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E. (Ont.), 15 years experience, available on short notice. Experienced surveys, draughting, reinforced concrete design, municipal engineering, construction work, inspection, estimating. Apply to Box No. 107-W.

ELECTRICAL ENGINEER, B.Sc., age 30. Experienced in power distribution and electrical communication, including design of carrier current systems. Apply to Box No. 110-W.

ELECTRICAL ENGINEER, B.Sc., McGill '27. Experience in the electrical design of power houses and substations. Available on short notice. Apply to Box No. 154-W.

ELECTRICAL ENGINEER, B.Sc., McGill 1926. Five years experience in the design of switchboards, layouts and wiring diagrams. Considerable experience in high and low tension switchgear design. Fifteen months experience in switchboard estimating. At present employed; available on short notice. Correspondence invited. Apply to Box No. 247-W.

CIVIL ENGINEER, A.M.E.I.C., of long field experience on reinforced concrete, water purification, steel buildings and bridges, seeks employment on supervision or inspection. Temporary or otherwise. Apply to Box No. 277-W.

ELECTRICAL ENGINEER. Graduate '25, wide experience in hydro-electric power stations, desires position on power plant design or related work. Apply to Box No. 278-W.

MECHANICAL ENGINEER, B.Sc. Pulp and paper, hydrometallurgical, design and operation, capable draughtsman, very resourceful in mechanical development. Single. Any locality. Apply to Box No. 306-W.

CIVIL ENGINEER, A.M.E.I.C., Canadian, R.P.E., Nova Scotia, 21 years engineering experience, both field and office, in railway, highways, foundations, concrete structures, water power and conservation, electric transmission lines, etc., experience comprising both surveys and construction, desires employment. Single. Will go anywhere. Working knowledge of French and Spanish. Available immediately. Apply to Box No. 327-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. Also some experience in ventilating and heating work and calculators. Accustomed to structural design and details. Good references. Present location Montreal. For interview apply to Box No. 329-W.

ENGINEERING REPRESENTATIVE. Experienced civil and mechanical engineer wishes to communicate with engineering or equipment manufacturing firm with a view to becoming Ontario or Quebec representative. Apply to Box No. 334-W.

CIVIL ENGINEER; age 48; married; A.M.E.I.C., R.P.E., Ontario and New Brunswick; 32 years experience in municipal engineering, on roadways, sewers, waterworks and buildings, desires position with either municipality or as engineer superintendent with contractor. Ten years with City of Toronto, construction engineer on roadway work; four years consulting engineer; three years engineer in charge of construction work; one year resident engineer, Dept. of Public Highways. Available immediately. Maritimes or Ontario preferred. Apply to Box No. 336-W.

Situations Wanted

CIVIL ENGINEER, S.E.I.C., graduate '29, desires engineering position with possibilities of advancement. Past experience consists chiefly of survey work and municipal construction. Location in western provinces preferred. Apply to Box No. 338-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., R.P.E., Ont., with twenty-four years experience embracing dams, wharves, grain elevators, foundations, pile driving, highways, municipal engineering, water power surveys, road locations, inspections and estimating is open for engagement as engineer or superintendent in construction, operation or maintenance. Location immaterial. Apply to Box No. 358-W.

CIVIL ENGINEER, graduate, age 32, A.M.E.I.C. Ten years experience; seven years on design, construction, erection work and maintenance of paper mill and mine buildings and machinery. Three years on hydro-electric work in charge of surveys and field investigations; associate hydro-electric engineer, U.S. Engineers, on office investigation, design and estimates; desires permanent position in Canada. Apply to Box No. 362-W.

ENGINEER, age 31, married. Experience includes two years mechanical, two years railway, six years structural and instrumentman and structural engineer on erection, desires position in Toronto. Apply to Box No. 377-W.

SCOTS ENGINEER, 28 years old, desires situation as junior executive or some similar situation. Wide experience in mechanical, civil and hydraulic fields and four years as junior executive; A.M.I.C.E. exam., Jr.E.I.C. Will go anywhere. Apply to Box No. 381-W.

ELECTRICAL AND MECHANICAL ENGINEER, S.E.I.C., educated Oundle and Manchester, age 24. Studied course, Brit.-Westinghouse. Three years design, production, advertising, sales and control of sales force on mechanical and electrical goods. One year outside plant engineering leading public utility company. Desires work in sales, production or engineering capacity. Available immediately. Location immaterial. Apply to Box No. 415-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E. (Ont.), graduate. Eighteen years experience in survey and construction, railway, hydro-electric and buildings. Experience comprises both office and outside work. Desires responsible position. Would consider position with commercial or manufacturing firm. Available immediately. Apply to Box No. 425-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate of Nova Scotia Tech. with experience as plane table topographer, instrumentman and draughtsman and particularly interested in hydro-electric power development and reinforced concrete design, desires position. Willing to go to foreign fields. Available at a few weeks notice. Apply to Box No. 431-W.

ELECTRICAL DESIGNER, Jr.E.I.C., age 28, B.Sc., McGill University '26. Five years sales and engineering experience, seeks immediate employment. Apply to Box No. 436-W.

CIVIL ENGINEER, B.A.Sc., A.M.E.I.C., Jr.A.S.C.E., age 29, married. Experience over the past eight years upon hydro-electric developments in construction, design and reports. Also some experience in railway construction. Permanent work preferred. Location immaterial. Available May 1st. Apply to Box No. 447-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., (McGill Univ. '27), age 26. Fifteen months outside plant engineering with large public utility. Twenty months sales engineering experience with electrical manufacturing company. Available on reasonable notice. Apply to Box No. 463-W.

Situations Wanted

CIVIL ENGINEER, s.e.i.c., 1930 graduate. Experience as instrumentman on city and railroad construction, desires to enter structural or hydraulic field. Available at once. Will go anywhere. Apply to Box No. 467-W.

CIVIL ENGINEER, experienced in road construction, mine surveying, transmission line survey and construction; paper mill construction; age 27. Available on short notice. Apply to Box No. 468-W.

CIVIL ENGINEER, a.m.e.i.c., age 39, with wide experience on design and construction of reinforced concrete structures, desires position. Apply to Box No. 475-W.

CIVIL ENGINEER, b.sc., six years experience in paper mill and hydro-electric work, desires position with paper or power company. Paper mill experience covers design, layout, some estimating, and construction. Hydro experience covers preliminary and flowage surveys, transmission line location, design, and six months as resident engineer on construction. Available at once. Apply to Box No. 482-W.

DESIGNING ENGINEER, a.m.e.i.c., p.e.q., with extensive experience in design and construction of power plants, industrial buildings and hydraulic structures, desires position as designing engineer or resident engineer on construction. Apply to Box No. 492-W.

STRUCTURAL ENGINEER, technical graduate, age 40, married, seeks position with architect or contractor. Fully experienced in design and supervision of all types of office and industrial buildings, structural steel or reinforced concrete. Available on short notice. Apply to Box No. 501-W.

ELECTRICAL ENGINEER, b.sc., McGill University, jr.e.i.c., age 32. Five years practical experience before graduating. Since graduation two years course with International Paper Co., including six months as electrical foreman, engineer in charge of installation of electrical equipment for two 28,000-h.p. units. Also electrical equipment for large coal-fired boiler house, designing some of the features. Apply to Box No. 506-W.

WEST INDIES, Engineer, a.m.e.i.c., etc. Experience with engineers and contractors, railway, harbour and concrete construction, desires position in West Indies. Apply to Box No. 518-W.

MECHANICAL ENGINEER, jr.e.i.c., b.sc., '26. Ten months experience in pulp and paper steam control. Four years experience in detail and design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

CIVIL ENGINEER, b.a.sc., '29, with experience in supervision of construction and general office engineering, desires permanent position with contractor or engineer. Available at once. Apply to Box No. 524-W.

CIVIL ENGINEER, a.m.e.i.c., with twelve years experience embracing survey and construction, railway, hydro-electric and highways, foundations, pile driving, municipal engineering, water power surveys, road location, inspection and estimating, is open for engagement as resident engineer on construction or other responsible position. Experience comprises both office and outside work. Available immediately. Apply to Box No. 527-W.

MECHANICAL, CONSTRUCTION, AND DESIGNING ENGINEER, with special training in hydro-electric power development, underground steam distribution systems, and the operation of large electrical machinery. Active work desired. Apply to Box No. 528-W.

SALES REPRESENTATIVE, civil and mechanical engineer, with office in Toronto, desires to hear from manufacturers of high-grade building materials or industrial equipment, with the view of representing their interests in the promotion and effecting of sales to architects, engineers and contractors. Excellent connection. Apply to Box No. 529-W.

ELECTRICAL ENGINEER, s.e.i.c., about to graduate (1931), desires to become associated after graduation with some branch of electrical engineering offering good opportunity for advancement. Sixteen months experience in draughting of electrical apparatus with large manufacturing concern; including layout work, and making of detail working drawings. Bulk of experience with industrial control apparatus. Apply to Box No. 532-W.

ELECTRICAL ENGINEER, married, graduate of McGill University, desires position in Ottawa, Montreal or Toronto. Experience includes four summers with a building concern as instrumentman and assistant engineer, two and one-half years with the Canadian Westinghouse Co., this time being distributed between tests, design and sales. At present employed but available on short notice. Apply to Box No. 533-W.

CIVIL ENGINEER, b.sc., McGill University, jr.e.i.c., age 32. Seven years general experience in hydro-electric power investigations and construction. Has been in charge of high power transmission lines location, also in charge extension surveys. Experience in office and field. Thorough knowledge of French. Best of references from former employers. Apply to Box No. 537-W.

STRUCTURAL ENGINEER, a.m.e.i.c., b.a.sc. Wishes to join established firm of consulting engineers. Age 37. Married. Ten years experience design of reinforced concrete and steel on buildings. Two years practical contracting experience. Apply to Box No. 540-W.

CIVIL ENGINEER, McGill '20, a.m.e.i.c., p.e.q., age 31, single. Experience includes general engineering, especially reinforced concrete work, and eight years of pulp and paper mill construction and layout. Best of references. Available on short notice. Apply to Box No. 547-W.

UNDERGRADUATE ENGINEER, s.e.i.c., junior year standing (Sask.), desires work to complete course. Electrical or mechanical work preferred. Apply to Box No. 553-W.

A.M.E.I.C., graduate of University of Toronto, 1915. Building engineer and superintendent, with considerable experience as installation, sales and promotion engineer. Present connection, four years in responsible position with large utility corporation. Open for immediate connection where he can use his past experience. Location immaterial. Apply to Box No. 560-W.

ELECTRICAL ENGINEER, a.m.e.i.c., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, s.e.i.c., graduating this year. Experience in railway maintenance, and instrumentman on location and construction. Desires to enter any branch of civil engineering or industrial work affording technical experience and an opportunity for increasing responsibility. Will go anywhere. Apply to Box No. 567-W.

CIVIL ENGINEER, a.m.e.i.c., ten years experience as mining engineer of a colliery, six years railway construction, including location, construction, bridge construction, and maintenance. Also one year on hydro transmission lines; one year government land surveys. Would consider position in any branch of construction, as resident engineer or instrumentman. Apply to Box No. 569-W.

CIVIL ENGINEER, b.sc. McGill Univ., jr.e.i.c. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

YOUNG ENGINEER, jr.e.i.c., experienced in design, details and erection of steel and concrete structures. Also a good theoretical and practical knowledge of steam, hydraulic and I.C. engine power plant. Good practical mechanical and electrical engineer, able to operate and maintain any type of machinery or power plant. At present in England on visit, returning in May. Location immaterial. Apply to Box No. 572-W.

CIVIL ENGINEER, jr.e.i.c., b.a.sc. (Toronto), 1928, age 25, married. Experience in field and office of surveying, general structural design, hydro-electric structures. Present location Montreal. Apply to Box No. 576-W.

MECHANICAL ENGINEER, s.e.i.c., b.a.sc., (Univ. of B.C. '30), Undergraduate experience in pulp mill. One year's experience, Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

For Sale

FOR SALE. Gurley transit, without tripod, in good condition. Price $150. Can be seen at Institute headquarters. Apply to Box No. 9-S.

It is announced that the Montreal offices of Affiliated Engineering Companies, Ltd., have removed from the Southam building to suite No. 1606, University Tower, 660 St. Catherine Street, west. The following is a complete list of the accounts now held by Affiliated Engineering Companies: American Engineering Company, Taylor Stoker Company, Ltd., Bernitz Furnace Appliance Company, Coppus Engineering Corporation, Andale Engineering Company, Allen and Billmyre Company, Inc., James MacIntosh and Company, Victory Valves Ltd., Thomas Clarkson, Ideal Commutator Dresser Company, Ernst Company, National Company, Ellis Drier Company, Keystone Refractories Company, Inc., Terminal Engineering, Inc., Frank H. Paquin Company, Rolland Gardner and Company, Vulcan Soot Cleaner Company, Canadian Kellog Company, Ltd., B. G. Carpenter Company, Inc., Troy Engine and Machine Company.

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The National Electricity Supply Scheme of Great Britain

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Presented before the Montreal Branch of The Engineering Institute of Canada, January 29th, 1931

SUMMARY.—In this address Mr. Paterson points out that in Great Britain the control of the supply of electricity has now been placed in the hands of the Central Electricity Board, a body receiving its authority and constitution from Parliament, but which is financially self-supporting and which has all possible freedom and independence in the handling of its policy and administration. The board is appointed by the Minister of Transport, and administers the Electricity Supply Act of 1926, schemes for the local supply of electricity being submitted by the Electricity Commissioners for the approval of the Board. Such schemes can only become effective when adopted by the board after full consideration by the parties affected. The board, whilst controlling and administering the generation of electricity, has no jurisdiction over its distribution to the ultimate consumer. The centralized authority of the board has been a great advantage in rendering possible the replacement of the individual schemes of some 580 local electricity authorities by a comprehensive supply system known as the Grid. This now includes some 3,000 miles of 132,000 volt transmission, which enables all the connected stations to be operated at good efficiency under a central control authority.

The paper describes briefly the constructional details of the main network and points out the many advantages of this bold scheme of nationa electrification.

Foreword.—The delivery of this address in Montreal by wireless from London on January 29th, 1931, marked the first occasion on which two-way radio communication overseas has been used at a meeting of one of The Institute's Branches. While atmospheric conditions were by no means favourable, transmission both ways was effective, and the thanks of The Institute and congratulations were duly accorded to the President of the Institution of Electrical Engineers and to the following organizations whose co-operative effort made the transmission possible:

The British Post Office—Office of the Engineer-in-chief;
Canadian Marconi Company, Montreal;
Imperial and International Communications, Limited, London, Eng.;
Bell Telephone Company of Canada, Montreal.

Great Britain is a small country measured in square miles, and when the almost limitless tracts of Canada are contemplated it causes wonder as to what are likely to be the respective futures of these countries, as the two wonderful agencies of electric power transmission and electric communication exert their inevitable and complete influence on the social and industrial evolution of Canada and Britain. For this new electrical age has just been entered and no one can predict what it will be when it comes to its maturity.

Michael Faraday discovered exactly one hundred years ago next August, those secrets of electromagnetic induction which are the basis of electrical engineering, and in this time the world has been establishing fundamentals in electrical engineering, and evolving through study and experience, systems and methods which are worth perpetuating and such as can be handed on with pride to our successors.

The problems peculiar to each country are handled in different ways and the solution is not and should not necessarily be the same for different countries. This should be emphasized because, while the people of Great Britain are in doubt as to what systems are best for Britain, they are far from suggesting that they would therefore be applicable elsewhere. Thus some thirty years ago the Engineering Standards Association was started in Britain and while this has been a most successful agency in establishing a high and uniform standard for products made by a number of competing concerns, its precise form has been the result of spontaneous evolution under British conditions, and has required modification to make it suitable in other countries.

In the early days of broadcasting, as suited conditions, a central nationally organized authority was established which was made responsible for the administration of the broadcasting service and for establishing such a system of radio stations that the whole country would be efficiently served. It was a type of organization with state authority but designed to be without those trammels which are so often liable to lead to official lethargy, and lack of business enterprise.

It is always valuable to study such systems in another country provided one is equally careful to study the institutions and the mentality of the nation for which the system has been evolved. Great Britain has had in the past two generations or more, every kind of control for public services—from the purely private concern to the completely state owned and controlled service. But there has been a marked tendency during recent years towards a type of organization which receives its authority and constitution from Parliament, but which has a maximum measure of freedom and independence in the handling of its policy and administration, and furthermore which must be financially self supporting.

In broad terms, this is the authority which has been set up by Parliament, following the recommendations of

Lord Weir's committee, for unifying, developing and lowering the cost of production of electricity in Great Britain.

The authority consists of a Central Electricity Board of eight members appointed individually by the Minister of Transport for a period of years. The members are mostly business men detached from politics and chosen on account of the confidence which they enjoy of different sections of industry. The board is in no sense a government department nor is it subject to any more control than any other statutory body which receives its power from Parliament. The members are paid a small salary and their duties encroach but to a limited extent on their business time.

There is a whole time chairman, Sir Andrew Duncan, and the board appoints its own chief engineer, secretary and staff.

The Electricity (Supply) Act of 1926 which is the Charter of the board has a good many references to the Electricity Commissioners, a body of five in number three of whom are experienced electrical engineers of the highest standing, established in 1920 for the purpose of promoting, regulating and supervising the supply of electricity. The commission prepares district schemes and submits them to the board. After giving opportunity for full consideration by the parties affected these schemes are adopted by the board with any amendment which may have been found necessary.

The work of the commission is mainly, however, concerned with the administration of the electricity supply statutes, it has certain judicial functions and in this connection the board, as an executive force, has to obtain the consent of the commissioners in compliance with the statutory provisions and regulations. The commission also advises the government on electrical matters and acts in accordance with the general directions of the Minister of Transport.

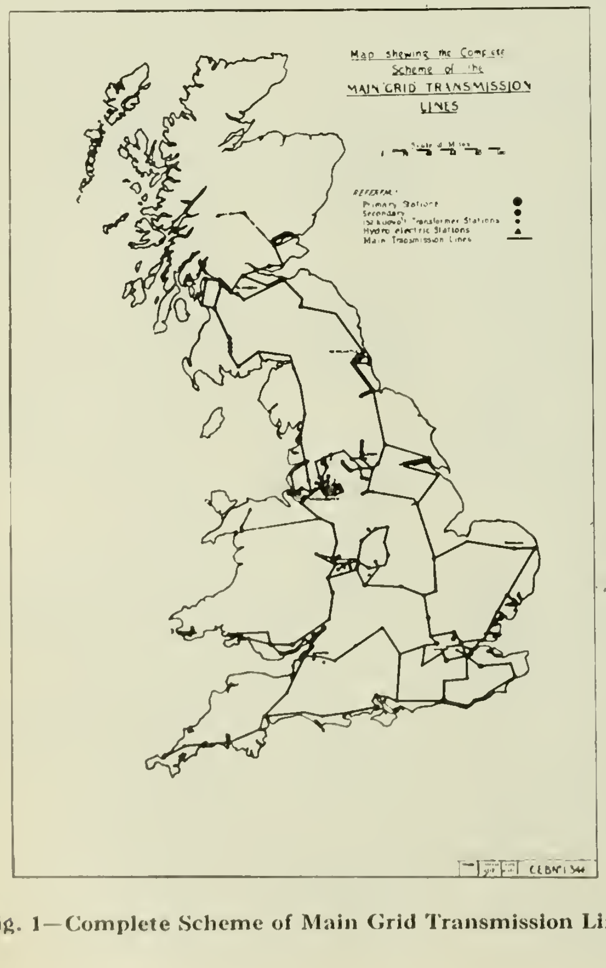

Fig. 1—Complete Scheme of Main Grid Transmission Line.

This machinery may appear somewhat complicated but in practice it works very well and it is an advantage to have within the government service a small independent court of trusted engineers. Their presence ensures that the uninstructed critic who tries to impose on the non-technical official or member of Parliament has little chance of causing mischief.

The Central Electricity Board whilst controlling and administering the generation of electricity has no control over its distribution to the ultimate consumer. That part of the service is still to be handled by the companies and municipalities who have hitherto been the bodies to deal direct with the public. These numerous distribution concerns are to buy their power from the central generating authority.

You will see at once what are the advantages of such a centralized authority to a country like Great Britain. Hitherto there have been some five hundred and eighty electricity authorities, each with its own city or area to supply. Most of these authorities have been self-contained units each with its own spare generating plant, and its generators of a size to suit its own limited requirements.

If this should be surprising, it must be remembered that Britain has no huge water power resources which would tend to concentrate generation in a few centres, and occur throughout the country. This facility,—of being able to set up a fairly economical generating station in almost every town of the country where there is suitable water for condensing purposes,—was an asset up to a point, as pioneer work was stimulated. But the arrangement has its disadvantages, for, as the uses of electricity extend, the lack of unification and of standardization becomes serious. It was therefore realized some fifteen years ago that some change would eventually have to be made.

The legislation, the negotiation and bargaining which took place before the present clean cut and statesmanlike plan was evolved were considerable, as the process of securing the support of powerful companies and municipalities to a scheme which puts the whole control of the generation, transmission and sale of bulk supply into the hands of one authority was not easy to obtain. This was finally achieved in 1926—and to-day the enormous system is well on the way to completion. The instigators are convinced of its suitability for existing conditions and this is shown by the fact that $250,000,000 are being spent on the system—of which some $95,000,000 is for standardization of frequency. The capital charges of the major part of this expenditure (i.e. on the "Grid") are to be borne by the Central Electricity Board and paid for out of the generation economies which will result under the new system.

The Electricity Supply System in Great Britain—The Grid

In designing a unified system of electricity generation for Great Britain, those responsible did not discard the advantage of the widely scattered coal resources which Great Britain enjoys and they have decided to concentrate the generation of electricity in approximately one hundred and thirty selected stations. The position of each selected station has been chosen so that it can feed direct to the city and area near which it is situated. It was not, however, possible to find all the desired resources amongst existing stations, and at upwards of twelve additional centres, new generating plants are being erected.

The second portion of the scheme consists in the interlinking of all these one hundred and thirty generating stations with a complete system of transmission lines which

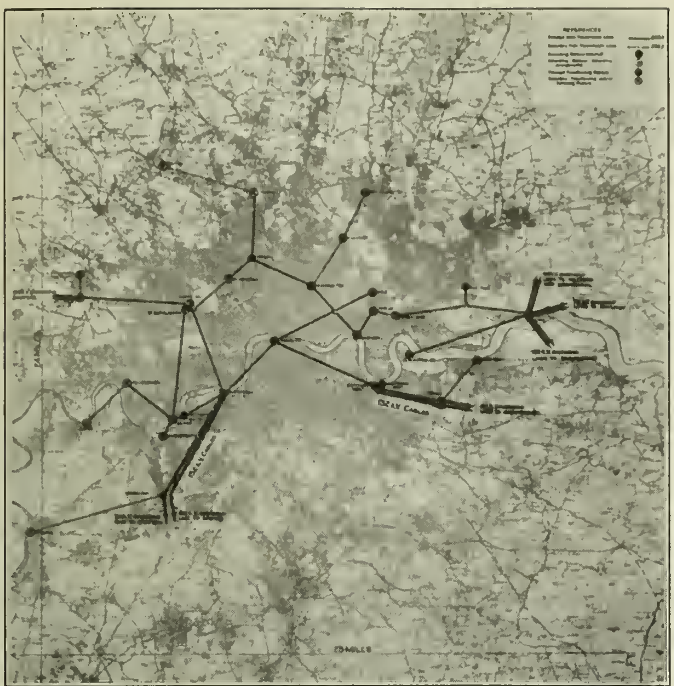

Fig. 2—London Cable Grid.

will form a network or "grid" over the whole country, and give supply to the less important intermediate towns. It will thus be apparent that this "grid" is not so much a huge transmission line, as a system of bus-bars through which all the generating stations are kept running in synchronism and in parallel with each other, and through which equalization of load can be effected.

The complete system of primary overhead transmission lines (Fig. 1), comprise about 3,000 miles of 132,000-volt 3-phase transmission. A steel core aluminium cable 0.77 in diameter is used—the resistance being equivalent to that of a 0.175 square inch copper conductor, and capable of transmitting up to 50,000 kilowatts. It will be seen from Fig. 1 that the system covers the whole country with the exception only of one or two sparsely populated areas which are also mountainous. The system is also to be extended to the north of Scotland but details are not yet settled.

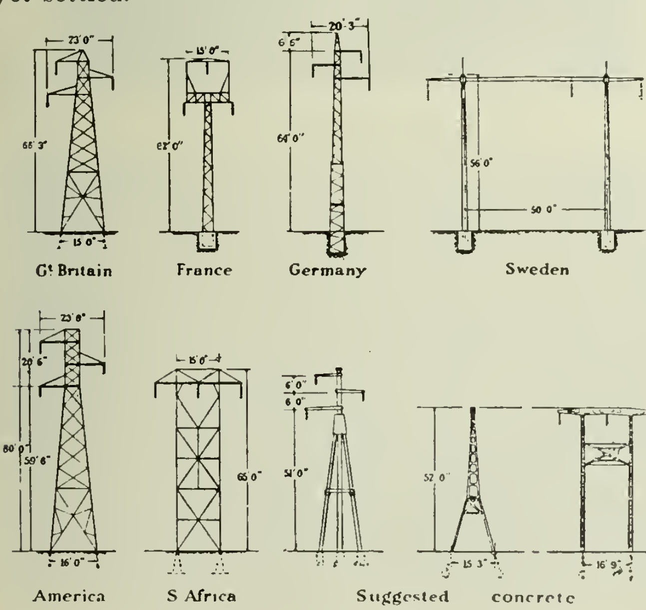

Fig. 3—Single-Circuit Towers.

One of the reasons for the choice of 132,000 volts is the probability of the experimental work on cables for operation at this voltage proving successful. Such cables involve very large expense but it is particularly desirable that they should be available when circumstances warrant their adoption. Oil-filled cables of this class are being tested on three sections of the grid in the London area.

Method of Operation of the Grid

The first function of the network is to enable all the connected stations to be operated at their best efficiency and to ensure the use of the spare plant throughout the country to its maximum extent. The power stations are divided into two main categories "base load" and "peak load" stations. The base load stations operate continuously, and the peak load stations operate for two shifts or for one shift. The choice of any station for one category or the other, depends on its operating costs and its capacity. Power will flow in any direction over the grid according as the requirements of economic running may demand—for the relatively short lengths of transmission line between stations makes the interchange of energy a simple matter. There is no intention or need to interchange energy over extreme distances. For convenience, therefore, in administration and in arranging operating programmes, the system is divided into ten sections which largely depend on the geography of the country.

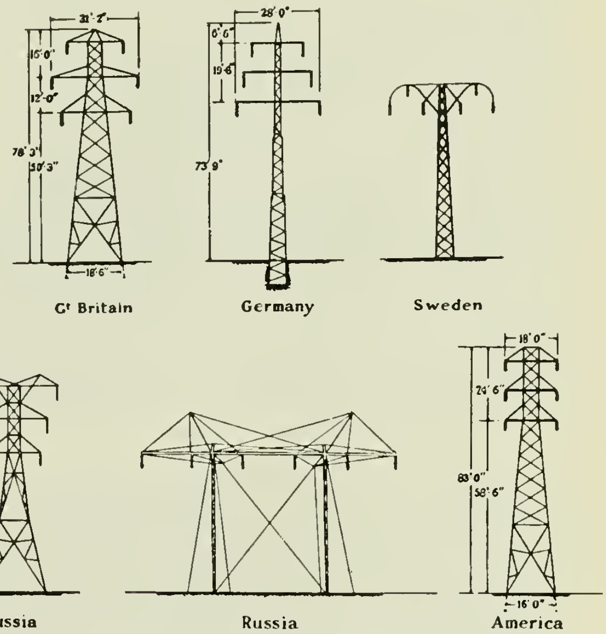

Fig. 4—Double-Circuit Towers.

The central authority controls and administers the generation and transmission of bulk supply, but this does not prevent the generating stations remaining the property of, and being manned by the body who distributes to the public. All that the central board requires, is power to dictate what stations shall run and how much energy they shall deliver at any time to the grid. The central board pays to the owners of a station all the costs of running it, including interest on its capital; and the board becomes the owner and seller of all the electricity generated. It is the deliberate policy of the board not itself to own and man generating stations.

A good deal of interest will attach to the scheme which is being evolved for the technical control of so large a system. Each section has its area control engineer, whose control station is in communication with each power station in his area, through special lines which are part of the general telephone system of the country. He will have

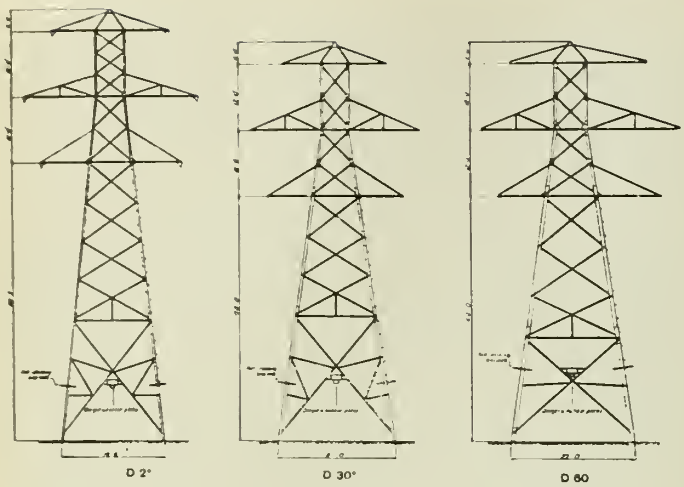

Fig. 5—Types of Double-Circuit Towers.

continuous automatic indication of five of the principal operating data of each station—including its power output, circuit breaker connections and such like.

Each station will adjust its generator voltage to suit the needs of its local supply, and the voltage at which it supplies the grid will be regulated by a ratio changing gear incorporated in the main transformers.

It is the intention to maintain the frequency of the whole network rigidly to a constant figure of 50 cycles per second, and the load exchanging throughout the system must be carried out without disturbing this.

The neutral point of the high voltage 3-phase system of the network is earthed at each transformer—a decision which has been the result of careful investigation of the conditions calculated to cause least interference with the communication circuits of the country.

The line protective gear for automatically isolating a faulty section is based on the use of pilot wires for short distances of the order of 10 miles, and on "distance impedance protection" without pilot wire for long distances. The maximum time of operation for clearing a fault in the case of the latter is two seconds.

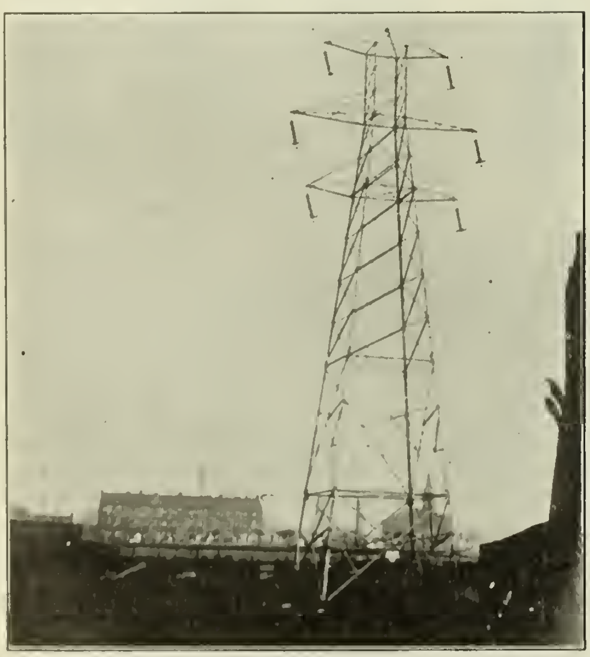

Fig. 6—Overhead Grid Passing Through an Industrial Part of the City of Glasgow.

The large number of existing generating stations which will not ultimately form part of the electricity supply system of the country are not to be rapidly eliminated. They will serve to supply the peak load to their local areas until it ceases to be economically sound to run them for this purpose. This will take a number of years and therefore the capital value of a large proportion of this plant will not be lost.

The London Grid—and the Secondary Network

London cannot be crossed by overhead lines, and the grid system for energy equalizing and transfer in London, is being arranged by a system of some 300 miles of 3-phase cables (Fig. 2). These cables have to be carried through the existing highways, and are at the moment in the process of being laid. Fifteen miles are for 132,000 volts and 285 miles are mainly for 66,000 volts. The principles of control and operation for London are to be identical with those for the rest of the country. Fig. 2 shows the London area and the positions of the selected stations and their connecting cables. The width of this area from border to border scales about 24 miles.

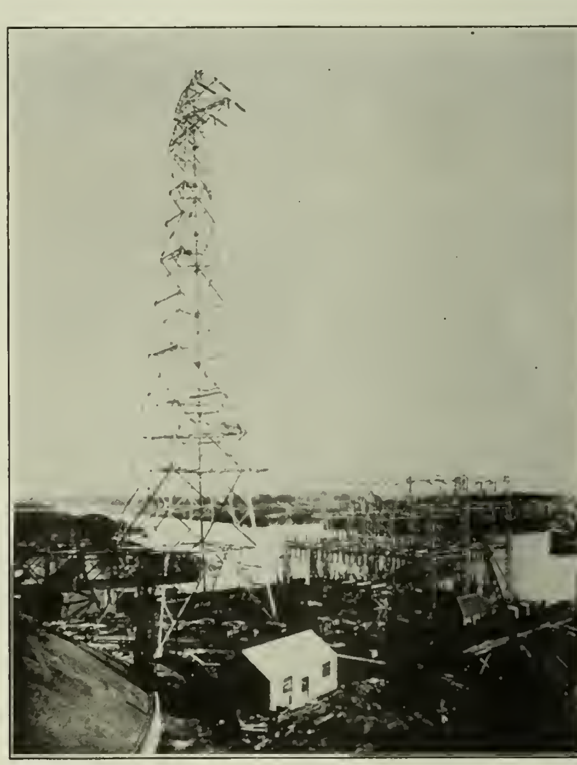

Fig. 7—Crossing the River Clyde.

Before illustrating constructional details of the 132,000-volt network, the explanations given above will not be complete without a mention of the secondary network. This is to transmit energy from the primary network to transforming centres at a distance from the primary lines. There will be upwards of 1,200 miles of such secondary transmission lines completed by 1934. The voltages will generally be 33,000. These lines will form regular distribution networks and will not be used so much for the purpose of load transfer and equalization, which is the principal function of the primary lines. There is, of course, already a large mileage of this kind of line which will now be incorporated in the main system.

The whole of the plant has been designed and manufactured in Great Britain and the opportunity of manufacturing so much high voltage large capacity plant has been warmly welcomed by engineers and manufacturers in this country.

Fig. 8—Crossing the River Forth.

CONSTRUCTIONAL DETAILS OF TOWERS, ETC.

The outline of the towers used on the British grid is the same throughout, this being determined so far as aesthetic considerations were concerned after a consultation with an eminent academician. The engineers were very pleased to be able to pass on to other shoulders this burden of responsibility, for there is a numerous and influential body of people in this country who fight hard, and rightly so, for the preservation of the beauty of the countryside in England.

Fig. 3 is reproduced from a recently published paper by Wright and Marshall, and shows typical constructions used in different countries.

In Fig. 4 are similar designs for double-circuit towers, and whether the British designs are considered more attractive than others is a matter of opinion.

Altogether there are eight standard types of single-circuit towers and eight types of double-circuit towers.

One example will suffice, showing respectively the 2 degrees, 30 degrees and 60 degrees double-circuit towers, these designations implying the maximum combined angles which the arrival and departure cables may make with the straight-through line (Fig. 5).

Fig. 6 shows the overhead grid line passing through an industrial part of the city of Glasgow,. This gives an idea of the appearance of the 132,000-volt transmission as now erected.

Fig. 7 shows the crossing of the River Clyde. The span is 960 feet, the heights of the towers are 270 and 283 feet, and the clearance at the lowest point of the span wires is 228 feet.

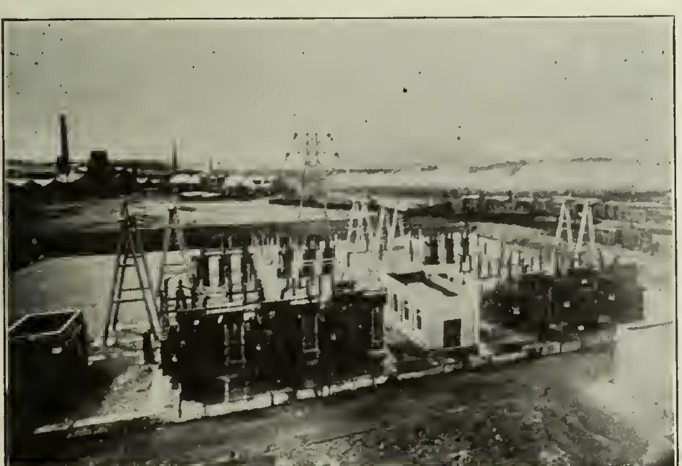

Fig. 9—Sub-station "Low" Type.

Fig. 8 is of the crossing of the River Forth. Here the towers are 3,050 feet apart, 338 feet high, and the clearance at the lowest point of the conductors is 158 feet.

The transformers for feeding the grid are of the 3-phase type, having capacities of up to 75,000 kv.a. in one unit. The ratio changing gear for adapting the station voltage to that of the grid is incorporated in each transformer.

Fig. 9 illustrates a "low" type of transformer and switch station, designed for places where land is cheap. It avoids the elaborate overhead gear of the more usual "high" type and is in itself inexpensive and has a low maintenance cost, and Fig. 10 one of the more usual design of "high" type transformer and switch stations.

STRENGTH AND TESTING OF TOWERS

The testing of the towers to withstand any load which could come on them accidentally has been carefully worked out, and Fig. 11 shows a tower testing plant at Wembley. The towers must have a factor of safety of 2.5 when, with unbroken conductors there is a wind pressure of 8 pounds per square foot on the conductor when coated with ice, and a wind pressure of 25 pounds per square foot on one and a half times the projected area of one face of the tower. The factor of safety must be 1.5 under the above conditions

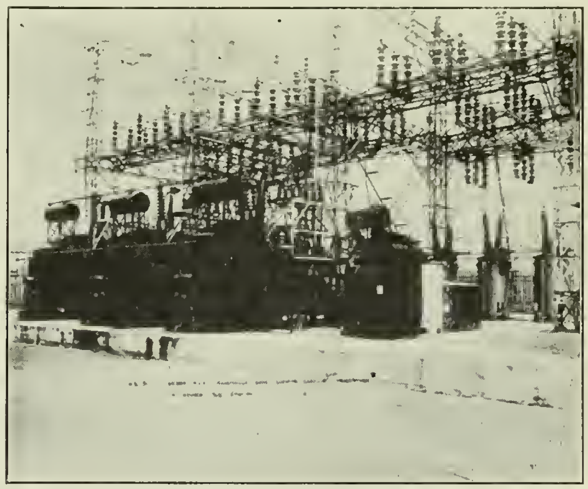

Fig. 10—Sub-Station "High" Type.

when two-thirds of the conductors are broken. These conditions involve applying loads at the top of the towers which may reach 70 tons. All the tower designs are type tested to ensure that they comply, and they are then tested to destruction to ascertain their ultimate strength.

Fig. 12 shows a tower after being tested to destruction. Usually, when carrying out this test, one of the members is observed to buckle and the load can then be released before complete collapse takes place. In the instance illustrated here, the collapse was too sudden for this to be done.

CONCLUSION

In conclusion, and quoting from the inaugural address of a predecessor in the presidential chair of the Institution of Electrical Engineers—Sir Archibald Page, who is chief engineer of the Central Electricity Board. In enumerating the advantages to be obtained from this bold scheme of national electrification, he stated:—

(*a*) It will constitute, with the selected stations, a complete system for the production and transmission of electricity on a wholesale scale, and thus enable full advantage to be obtained from the diversity of loads, from the correct apportionment of the total load between stations of varying efficiency, and from the elimination of obsolete and unsuitable plant.

Fig. 11—Tower Test Plant.

Fig. 12—Tower Test to Destruction.

(*b*) It will enable the capital cost per kilowatt installed in the selected stations to be kept down, owing to it being possible to use the largest and most efficient plant. This can be done because the stations will form part of a really widespread system.

(*c*) It will be possible for these stations to be correctly located away from the centres of population, thus reducing the railway congestion caused by the carriage of coal to them and ensuring all the other advantages which accompany freedom in the choice of site.

(*d*) It will enable individual stations to be employed of larger output than would otherwise be possible; and extensions to be co-ordinated in accordance with a plan, which will both avoid premature expansion and at all times closely relate the plant capacity to the actual load.

(*e*) It will allow the aggregate amount of spare plant to be considerably reduced.

(*f*) It will enable "blocks" of waste heat or energy from blast furnaces, coke ovens and other sources to be transformed into electricity and thus usefully employed.

(*g*) It will level up (without levelling down) the efficiency of generation throughout the country.

(*h*) It will enable such water power resources as we have, to be tapped, and thus supplement the energy from coal in a more complete and less costly manner than would otherwise be possible.

(*i*) It will facilitate railway electrification by reducing the capital cost of the necessary transmission lines, since the "bars" of the grid will follow the railway routes to a considerable extent.

(*j*) It will reduce the cost of secondary or regional transmission by increasing the number of points at which the supply can be taken; and, for the same reason, it will encourage the opening up of new areas of supply in rural and agricultural districts.

These are all factors which will make for financial gain. But there are other considerations which may ultimately mean more than the financial ones.

(*k*) The existing population and industries in the rural districts of England would not have obtained supplies for many years, and the establishment of new industries in such districts would have remained very difficult.

(*l*) The general availability of electricity for domestic and industrial use in such districts will undoubtedly help to make country life more attractive and should help to check the drift of the population towards the larger towns and cities which has been a marked tendency in the past.

(*m*) The scientific use of coal in large electric generating stations instead of its crude consumption in smaller plants and in the domestic grate, should help the movement towards purification of the atmosphere in large cities.

Great Britain undertook the pioneer work in high tension distribution, when in 1887 Ferranti laid his 10,000-volt transmission from Deptford power station to the west end of London, and supplied energy over these mains before there was any high tension transmission elsewhere. The comprehensive national system of electric trunk mains which have been described is another piece of pioneer work of a similar kind. Whether or not the idea is applicable to other countries remains to be seen, but the result will be worth careful study by those in all communities who believe that electricity has but just begun its great social and civilizing work in the world.

DISCUSSION

Julian C. Smith, m.e.i.c.[1]

Mr. Smith remarked that there was a possible danger in such a comprehensive development, that lines would be built and equipment installed that could not be justified by immediate economic considerations. If those in charge of such a development allowed themselves to be carried away by the magnitude and perfection of the plan, it might be found in later years that a plant had been installed that was not properly located to give maximum service and that money had been spent that was not giving a maximum possible return. Experience in a rapidly expanding industry in Canada had taught the wisdom of not making commitments for expansion too far in advance.

John Morse, m.e.i.c.[2]

Mr. Morse, while appreciating that the electric power problems of Great Britain and Canada are vastly different, observed that in the past we had been in the habit of considering a transmission system as essentially for the transmission of power. The Grid included all the elements of a transmission system, but he understood that its purpose is not to transmit large amounts of power, but to act as a system bus bar through which all the generating units will be held in synchronism, regulating the frequency, permitting the equalization of load, and facilitating the better utilization of the higher efficiency plants. It seemed rather surprising that under these circumstances such a high line voltage was used. It would be interesting to know what the maximum transfer of power would be between some of the larger stations where load transfer takes place.

Tap changing under load would appear to have decided advantages on a system such as the Grid.

He had noted that in many cases small banks of 10,000 to 20,000 kv.a. transformers connect the lines to a station, thus forming part of the lines, and these banks were paralleled on the low voltage side. This would appear to

(1) Vice-President and General Manager, Shawinigan Water and Power Company, Montreal.

(2) General Superintendent, Shawinigan Water and Power Company, Ltd., Montreal.

indicate that the lines, which were designed to carry upwards of 50,000 kv.a., would be limited in load to the capacity of the connecting banks.

The author had stated that the neutrals of all power banks are solidly earthed on the 132 kv. side, and that "this decision was the result of careful investigation of the conditions calculated to cause least interference with the communication of the country." This was a particularly interesting point in Canada, as interference with communication has been quite a problem in this country.

He noted that pilot wire protection is being used on 132 kv. lines up to 10 miles in length. It would appear that this would be rather an expensive protective scheme for such distances.

The number of generating stations in the country was given as 580, but there were only 130 selected stations in the Grid, 12 of which were being newly built. It might be interesting to learn what would become of the remaining 462 generating stations.

Mr. Morse felt that with regard to certain features of this system further information would be of interest, and desired to ask the following questions:—

(1) Has any difficulty been experienced with regard to the stability of the system, when a three-phase short-circuit has been cleared on the longer relay times?
It would appear that with so many generating units in parallel, certain stations might go out-of-step with the main system during an extended short-circuit, and result in faulty relay action, possibly at remote parts of the system.
(2) If a loop is broken by the automatic clearing of a faulty line, is there any fear that any of the smaller banks in the loop will become seriously overloaded due to the redistribution of the loads?
(3) When a by-pass breaker is closed between two lines, making a metallic connection between these lines, will the impedance type of line protection used function with equal effectiveness as for the normal method of operation?
(4) Has it been necessary to resort to directional or (reverse power) relays in connection with the distance impedance protection? If so, has this feature proved successful in operation?
(5) Is overhead or underground construction used for the pilot wires, and would it be possible to give approximate cost per mile?
(6) Is the tap changing on power banks under load done by remote manual control, and what provision is made to insure that taps are also changed on the potential transformers used for relay protection?
(7) Have any interference problems been experienced with the star, solidly earthed method of operation of the 132 kv. lines?
(8) Are there any separate generating systems in the Grid area not connected to the Grid, and if so, will these be included eventually?

Mr. Morse expressed the hope that Mr. Paterson at some future time would add to his kindness by contributing a paper on the actual operating experience on the completed scheme.

C. C. Paterson, O.B.E.[3]

The author replied that Mr. Morse had raised some most interesting points regarding the features of the British Grid and that he would deal with each of his questions as far as was possible, though one would appreciate that as the grid system was not yet complete, and that the part now in commission had been working for only eighteen months, operating experiences particularly concerning abnormal conditions, was somewhat meagre at present.

With reference to the stability of the system on short circuit, the author observed that so far there had been no 3-phase short circuits directly on the 132 kv. system. Repeated 3-phase short circuits had, however, occurred on the lower voltage systems without causing instability.

Regarding the opening of ring main loops, the design of the grid system was such that it should be possible to open any loop under normal load condition without causing serious overloading.

[3] Director, Research Laboratories, General Electric Company, Ltd., Wembley, England.

In reply to the question regarding bypass breakers and impedance protection, the normal method of operating the lines was with the section switches closed, and the impedance protective gear was designed for operation on the assumption that all the 132 kv. lines were directly connected.

Directional relays were incorporated in the impedance protective system. Up to the present, no faults had occurred on the lines so that no experience was available to state whether the scheme of protection was effective or not.

Under pilot wires were generally used, drawn into existing ducts where possible. Pilot protection was usually associated with sections of transmission line in the densely populated areas. The pilot routes were determined by the duct and other facilities available, and did not necessarily follow the routes of the power lines. The approximate cost per mile of the pilots was $4,000.

In connection with the tap changing gear control, the ratio changing gear on the power transformers had a remote electrical control which was worked by the operating engineer. Provision had been made for a later addition of automatic gear should this be found necessary. The taps on the potential transformers were changed automatically by auxiliary switches to correspond to the taps on the main power transformers.

No interference troubles had so far been experienced due to the use of a solidly earthed system of 132 kv. lines.

There were still a few privately owned generating systems in operation which were not connected to the grid. Since the inception of the grid system, however, many of the companies owning these generating stations had been considering the advisability of connecting up to the grid system. It was anticipated that in the long run practically every generating station of importance would be directly or indirectly connected to the grid system.

The author stated that he would like to add a few words about other points mentioned by Mr. Morse. Regarding the adoption of 132 kv. for a system in which transmission of power was not necessarily the main object, this voltage was chosen after careful consideration of the required power interchanges, the maximum load interchange per line being estimated at 50,000 kv.a. In fact, the actual costs of 110 kv., 132 kv., and 150 kv. systems were investigated and compared before making a decision, the 132 kv. scheme proving to be the most economical.

The load capacity of the lines was not affected in any way by the connection of transformer banks of only 10,000 or 20,000 kv.a. for as well as these being parallelled on the low voltage side, the high tension section switches were normally kept closed and the lines were therefore unbroken.

To refer again to pilot wire protection, this scheme was admittedly expensive, but the cost of the protective system was, in the opinion of the engineers, fully justified by the fact that the lines protected pass through densely populated industrial districts, and it was of great importance to ensure that adequate protection was afforded to the properties over which the lines pass, as well as to ensure continuity of supply.

Of all the generating stations in the country worked by the 580 electricity authorities, 8 per cent of the stations alone had between them half of the total plant, while 40 per cent of the stations—the smaller ones—aggregated less than 2 per cent of the total capacity. The largest, most economical and most conveniently situated of the stations would be included in the 130 selected to be developed for base load supply. Of the remainder, a proportion would be kept for peak load and emergency supply purposes, whilst some of the smaller and less efficient plants would be shut down, or used only as distribution centres.

Predicting Future Population in Western Canada

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Revised version of paper presented before the Edmonton, Calgary and Lethbridge Branches of The Institute in January, 1931.

SUMMARY.—Predictions of the probable future growth of population are necessary in many branches of engineering work, and in this paper the author has developed a method of estimating the future population in western Canada based on the separate consideration of urban and rural areas. Light is thrown on this question by a study of records for comparable districts and cities in the United States in the past, and the conclusion is reached that while the urban population in Western Canada will probably grow substantially in the next twenty-five years, it is not likely that under the present fundamental conditions there will be any marked increase in rural population over a large portion of the prairie provinces.

Introduction

This paper is the result of a study made in 1929 to answer an ordinary engineering question. There is nothing unusual in the question, but it is felt that some novel features and methods were developed out of the resulting study. The question was: "What is a reasonable assumption as to the population of Saskatoon, Saskatchewan, in 1955 for purposes of engineering planning and design?" The bare answer to that question is, of course, local in interest, but the investigation brought out facts and relationships which it is felt will be of interest to every one concerned about the future of Canada.

It is desired to emphasize the problem before the solution is offered. The question is not "What *will* the population be in 1955?" but "What is a reasonable assumption for purposes of design?" There is obviously a great difference between the two questions, and the writer is not so much concerned with the ultimate correctness of his estimates for one particular city as with the reasonableness of his method. In the case of a particular and phenomenal growth, a reasonable estimate is bound to be wrong and a correct guess must have been unreasonable when made. An engineer's estimate is soundest when it will approximate closest to the truth in the greatest number of cases. The writer is also fully aware that the problem is scientifically indeterminate and that nothing in the nature of a logical proof is to be found in this paper, but he also feels that the evidence submitted is very convincing and until more impressive proof to the contrary is submitted or until time itself reveals the truth, the estimates made, as a result of the following study, must be considered as reasonable.

Estimating Future Populations Not New

Estimating the future population of countries and cities is not a new problem: extrapolation however has always been recognized as uncertain and only when the growth curve is regular and of great length compared with the extrapolated portion can the method be considered reliable.

Extrapolation between census years has long been a necessary practice in most countries of the world, and the larger and well established cities have also been able to do this with satisfactory results.

The methods in most common use are:—

(*a*) Arithmetic Progression, i.e., assuming that the growth in actual numbers per year will continue as for the past census period.

(*b*) Geometric Progression:—i.e., assuming that the rate of growth per year will continue as for the past census period.

(*c*) Graphical Extrapolation:—i.e., plotting a curve of past growth and extending it by eye.

(*d*) Derivation of a formula:—i.e., fitting a higher order parabola, logarithmic or other curve to data of past and then extending it.

As already inferred some of these methods give very reasonable results when used in connection with older countries and larger cities and for periods of ten years and even longer, but when it becomes necessary to estimate population over much longer periods and especially where the history of growth is both brief and flashy, none of these methods as ordinarily applied to individual cities can be used with confidence. This is the case in western Canada as the following table will illustrate.

Table I

Method	Year of Estimate	Census Data Used	Estimated Population for 1936	
			Edmonton	Calgary
Arithmetic Progression	1916	1906–1916	133,000	142,000
" "	1926	1916–1926	76,000	74,000
Geometric Progression	1916	1906–1916	770,000	980,000
" "	1926	1916–1926	80,000	75,000

Take as an example the case of Calgary with a present population of from 85,000 to 90,000—the arithmetic method if used in 1916 would have given for 1936 an estimate double the figure obtained if applied in 1926, and both will be wrong by perhaps 50 per cent. If the geometric method be used the 1926 calculations give an estimate for 1936 which is about 20 per cent below the present (1931) population and the 1916 estimate of 980,000 is as ridiculous as the real estate boom of twenty years ago when land was subdivided and sold in quantity and price in all western cities on some such geometrical assumption. What has been shown to be the case for Calgary and Edmonton is true for all western cities. Fig. 1 which illustrates in graphical form the growth of Calgary, Edmonton, Saskatoon and Regina, will show that extrapolating any of these curves by eye is out of the realm of reason and that trying to fit a mathematical curve would be futile even if possible.

It is obvious then that ordinary methods cannot be used for estimating the future of cities in western Canada with any confidence. But estimates had to be made and one solution worked out is presented below.

Biological Theory of Growth

Professor Raymond Pearl, in his book "Studies in Human Biology" under the heading of Population Studies,

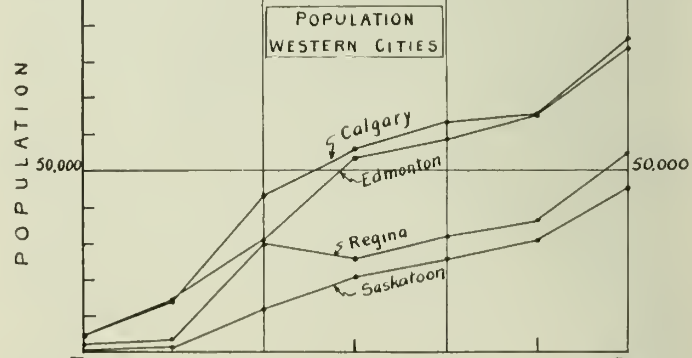

Fig. 1—Population of Western Cities.

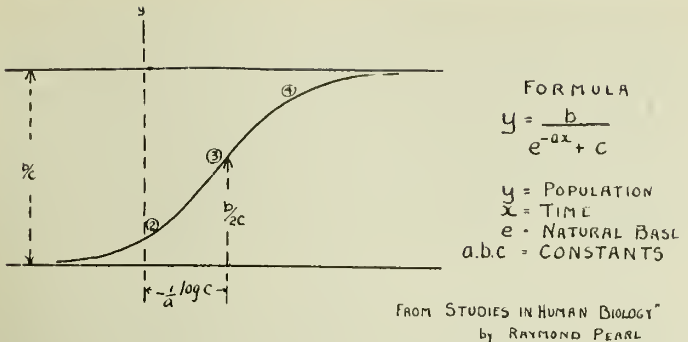

Fig. 2—Pearl's Curve.

offered several years ago some very pertinent observations on current methods of predicting population. He pointed out that most formulae for population curves take no account of the obvious truth that, in any prescribed area, the population can not increase indefinitely. He consequently sought a curve formula which he hoped would be comprehensive enough to cover the entire life history of large economic states. In discussing population growth he cited some interesting laboratory experiments made by him. Two flies were put in a bottle which was both comfortable in temperature and provided with an adequate and agreeable food supply. In this miniature garden of Eden the mathematical story of world population growth is, he contends, roughly paralleled. Fig. 2 shows graphically how the increase took place and indicates the suggested formula for the resulting sinusoidal curve.

It will be noted that for a while at first, the flies being only two in number, the increase, though large on a per capita basis, was actually small; shortly after, the increase, following the law of geometric progression, became very rapid (2-3); the reason being that the food was plentiful, the living conditions comfortable, the birth rate high, the death rate low and therefore the natural increase large. At the inflection point (3) a change occurs, although not abruptly, the curve of increase first straightens out and then begins to decrease, first slowly (3-4) then rapidly, until finally a stationary population is reached. The reasons are clear; with increasing numbers the strife for food becomes greater, living conditions become more cramped, the death rate increases; in general human terms, the economic pressure becomes great and the increase stops.

Professor Pearl suggested that for any country with definite boundaries the population increase would follow a curve of the form shown in Fig. 2, providing the basic form of civilization was not changed by any fundamentally

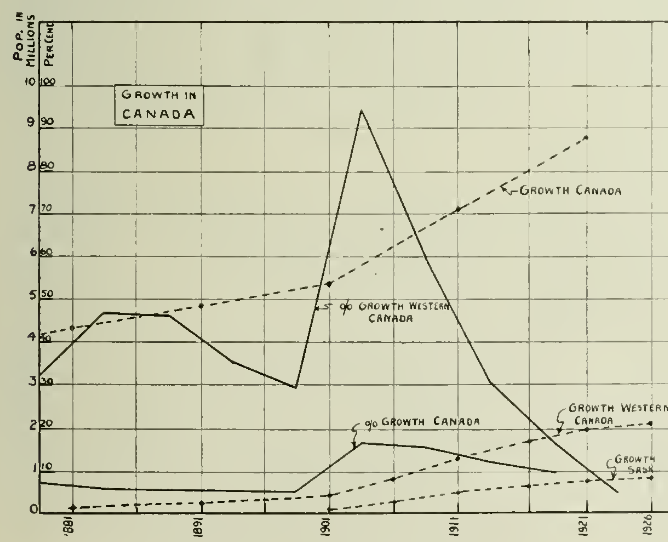

Fig. 3—Growth in Canada.

new factor or forces such as those which changed the culture of countries from the pastoral to the industrial stage. He successfully fits such curves to the growth data of over fifteen countries including the United States and most of the European nations. If one tries, however, to fit such a curve to Canada he will probably come to the conclusion that the theory is not sound, as it does not appear to be mathematically applicable, and Fig. 3 also seems to indicate that there is little regularity, rule or order to Canada's growth, and that there is little if any direct connection between the growth of the western provinces and that of Canada as a whole.

The writer is not advocating or concerned with the general mathematical correctness or applicability of Professor Pearl's formula but he does feel that from a qualitative viewpoint this theory of population increase is very suggestive. It must also be quite clear to thinking people of this day that Canada is not and probably never will be an economically confined bottle in the sense of the above experiment. To-day Canada grows enough food to supply well over 20 millions of people which means that over 10 million of Canada's human flies are living in other and foreign bottles. Western Canada, where the major portion of our exportable food stuffs are grown, is thus really more dependent upon conditions outside of Canada for its growth and prosperity than upon strictly Canadian conditions. Incidentally this may explain in part why the

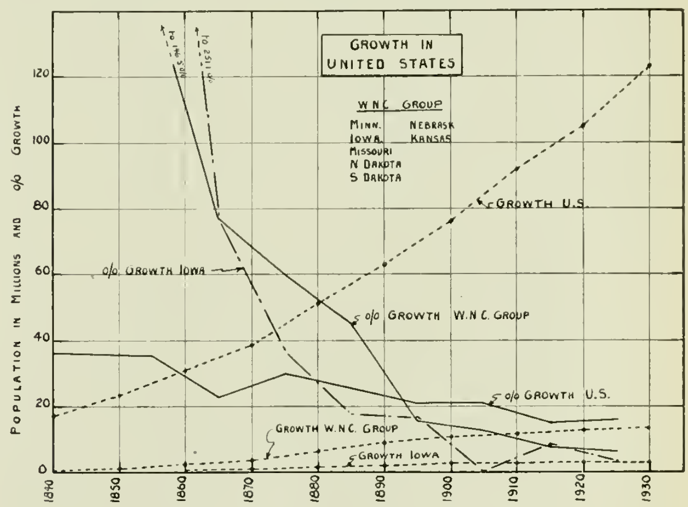

Fig. 4—Growth in United States.

common people of western Canada have on the whole been given to a more than usual interest in international considerations.

The study of the growth of Canada does not throw much light on the growth of Saskatchewan, but it is interesting to note that while western Canada was being filled up rapidly from 1905 to 1915, the urban centres in Ontario alone, which had been growing very slowly before 1900, increased by one man for every man placed on a western farm. While the writer feels that little guidance to western population problems is to be had from a study of the growth of eastern Canada, he does feel that those interested in the growth of eastern cities as a whole should consider as one of the many factors involved, the future growth of western Canada.

Comparison With Western States

It seems, then, that little help can be found in a study of general Canadian conditions, but it was felt that a study of the western agricultural states of the United States might throw light on our problem.

Fig. 4 shows the growth of the United States as a whole, the west north central group of agricultural states and the individual State of Iowa, which for reasons to be given later

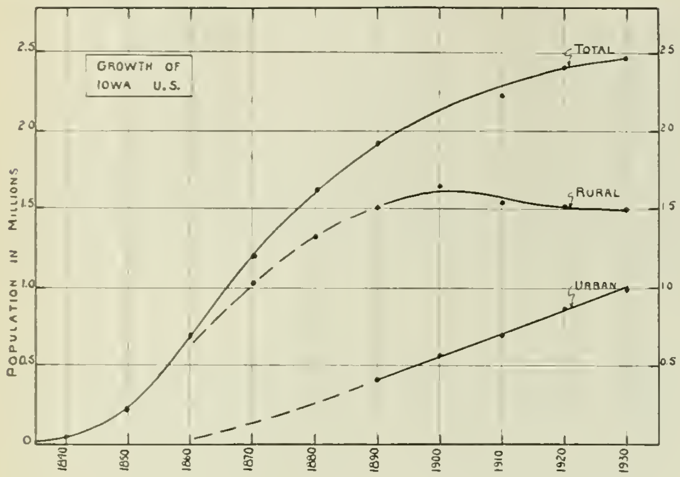

Fig. 5—Growth of Iowa.

seemed to offer the best comparison with Saskatchewan. It will be noted that, as was the case in Canada, the growth of the western agricultural states is not related even approximately to the general growth of the United States. The growth in the latter has increased from about seven millions during the 1860-1870 decade to about seventeen millions during the 1920-1930 decade while the rate only decreased from about 23 to 16 per cent. While in the former the actual growth decreased from 1.7 million during 1860-70 decade to about 0.7 million during the 1920-1930 decade and the rate decreased from 78 per cent to 6 per cent. It was concluded then that a general study of the western agricultural states should be undertaken and a detailed study of Iowa as the state most comparable to Saskatchewan in its economic setting. The following facts indicate the similarity of these two areas:

(1) Iowa is about 300 miles west of Chicago, the great regional city of the American states.
Saskatchewan is about 400 miles west of Winnipeg, the great regional city of the Canadian west.

(2) Iowa is cut off from a distributing standpoint on the north by Minneapolis-St. Paul, Minnesota, on the south by Kansas City and St. Louis, on the west by Omaha, Nebraska.
Saskatchewan is cut off on the north by a barren area, on the south by the international boundary and on the west by the cities of Edmonton and Calgary.

(3) Iowa is essentially an agricultural state.
Saskatchewan is essentially an agricultural province.

(4) The urban centres of Iowa, generally speaking, are state cities and see the needs of the area within the state, and do not partake of the nature of Chicago and Minneapolis and St. Paul which serve as manufacturing and distributing centres of many states. Likewise the cities of Saskatchewan, generally speaking, will serve the people of the province only and thus are dependent on the development of the local resources.

Rural and Urban Growth in United States

Fig. 5 illustrates the growth of Iowa. The curve showing the total growth is not illuminating but when the rural and urban curves are separated a very striking and novel generalization occurs to one. Namely "In agricultural states the rural population seems to grow according to a sinusoidal curve similar to that suggested by Pearl. The urban centres on the other hand get their greatest growth after the agricultural land has filled up." In the case of Iowa the rural population apparently reached the saturation point about 1890, while the urban population has increased from 400,000 to nearly 1,000,000 since that date, and it should be remembered that these cities are serving generally only the State of Iowa. Obviously a generalization based on one observation is questionable, the writer has, however, found a similar condition for nearly every state of the Union. Fig. 6 gives the curves for a few states and indicates that, as far as the United States is concerned, the above generalization seems to be reasonably sound. Many interesting points arise from a careful study of Fig. 6.

Rural

Considering rural growth first, it is seen that the group of old New England states, Maine, New Hampshire and Vermont, which are not excessively industrial in aspect, approached rural saturation in 1850, and while records are not available to plot the complete curve it apparently is of the sinusoidal type. In Ohio the country started to fill up rapidly about 1820 and reached rural saturation about 1880. Coming still farther west, Illinois started later than Ohio but grew faster, then still farther west Iowa started after Illinois was nearly filled up, and Minnesota lags behind Iowa in a similar manner. The curves of the Dakotas, which are not shown, in turn lag behind that of Minnesota. We have here in these curves of rural growth, each lagging behind the other as we proceed westward from the Atlantic coast to the far west, a graphic picture of the history of rural settlement in the United States. What the writer believes, however, has never been pointed out in this form before, is the very important fact that the rural growths follow curves of approximately sinusoidal form, differing of course in total height and steepness but nevertheless of the same general form. Naturally, with the great changes that have taken place in the mechanization of agricultural and other processes, the curves are not perfect, especially on the top asymptote, but no one can deny the general nature of the curves, and the reasons are, in the writer's opinion, to be found in the operation of general economic laws of international scope as already suggested.

Urban

Now consider the urban development. From the figures of Ohio the cities of Cleveland and Cincinnati have been deducted, also Chicago from Illinois and part of the twin cities from Minnesota. This was done because these cities are regional or national in character and it was desired to get a picture of the growth of the urban centres which were more dependent on the local conditions, although of course in the more eastern states this can be done only approximately.

In every case it will be seen that the urban growth did not really start until rural saturation was approaching; that in Maine, New Hampshire and Vermont the urban growth has continued for nearly 80 years after rural saturation, and in Iowa for about 40 years to date with no indication of decreasing, that in Minnesota rural saturation seems to be approaching while urban growth is still showing no sign of diminishing.

A significant observation is that in the more industrialized states the urban curves are steeper and tend, up to the present at least, to be concave upwards, while in the agricultural and less highly industrialized states the urban growth has more closely followed a straight line of more moderate slope.

One readily sees the economic history written in these curves. As settlement worked westward each new agricultural state was rapidly filled up by pioneers; at first the country was unproven, the settlers usually had little capital, their purchasing power was limited. What supplies they used were brought in from urban centres in established eastern states and the total urban centres usually were small trading centres. As the settlers became established and prosperous their purchasing power increased, manufacturing and distributing companies, realizing that a prosperous and permanent market was being built up which could be served more economically at close range, opened up wholesale houses and branch factories in local centres: to this impetus to urban growth was added the need and opportunity for financial institutions, professional services, governmental departments, printing establishments, industries using the local products as raw materials, and the many other activities of advancing civilization. Unquestionably with the shifting westward of branch factories, etc., many eastern centres were deprived of past business, but with the general advance in mechanization and new development, which has marked this century, new fields have been constantly opening up so that up to the present the losses in some fields have generally been more than counterbalanced by newer activities and markets.

If we study in detail the urban basis of Iowa we find that, in what is probably one of the most essentially agricultural states of the Union, the gross value of manufactured products is nearly double the gross value of the agricultural products, that the industrial activity is not centred in a few large plants producing a national product, but over 50 per cent of all employees are in small and diversified plants, employing fewer than one hundred men. The first ten principal industries in order of value of products are slaughter and meat packing, butter making, food preparation, railroad shops, glucose and starch, flour mills, printing and publishing, bakeries, foundries, and engine shops. It will be seen that most of these activities are either founded on the natural production or on the needs of an essentially agricultural state, and we know that the urban development of Saskatchewan will be founded upon a similar basis.

Urban and Rural Growth in Canada

In western Canada since 1905 settlement and development have taken place qualitatively as described in the preceding paragraphs. At first all manufactured articles came in from the east or south and for a while Winnipeg was the only distributing and manufacturing centre of the three prairie provinces, but gradually manufacturing is becoming a real factor in the west, and branch factories and distributing agencies are rapidly increasing in the larger urban centres in all three provinces. Fig. 7 shows in graphical form the past growth of western Canada and suggests future trends. The Canadian census data have been adjusted so as to be comparable with those of the United States, in which urban includes all towns of 2,500 population and over, while rural includes all towns and villages below that figure as well as the actual farm population, which in the United States amounted in 1920 to about 60 per cent of the total rural. However, if this adjustment be not made, the general shape of the curves will be the same and the conclusion reached about urban growth will also be the same.

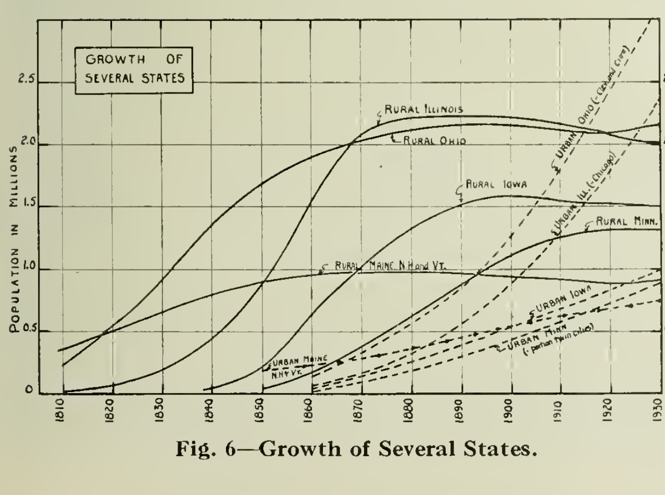

Fig. 6—Growth of Several States.

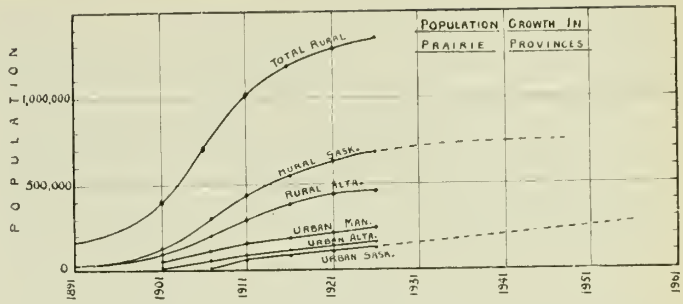

Fig. 7—Population Growth in Prairie Provinces.

Rural

From Fig. 7 the conclusion is reached that under the present fundamental conditions we can expect little more rural growth in Saskatchewan or in the other parts of western Canada. This statement when first made by the writer during the buoyant and prosperous days of 1929 was severely criticised but to-day when a more thorough appreciation of the effects of international economics on the value of exportable products is the order, it does not meet with the same reaction. However, to estimate that the future rural population of Saskatchewan will become stationary around 700,000 to 800,000 is novel, and can not be accepted lightly. The writer realizes that although a formula may be and has been fitted to the existing curve, according to methods explained, that is only evidence and not a proof. In addition, however, a general study has been made of the probable density of western agricultural areas by assuming that the rural population density economically suited to any of the western agricultural lands is a function of the quality of the soil, the yearly rainfall (between obvious limits) and the reciprocal of the freight rate to the European market, and such a method was applied to the western states of Iowa, Kansas, North Dakota and South Dakota. Using Iowa as a base, the calculated densities which the other states should have on that basis checked out quite well with the prevailing densities. When this method was applied to Manitoba and Saskatchewan the densities per square mile of usable agricultural land worked out to 15 and 7 respectively which correspond well with existing conditions. As there are about 105,000 square miles of such land in Saskatchewan, by this method an ultimate rural population of about 735,000 is indicated. While it is admitted that the second method is approximate only and can not be accepted as a proof, it at least reassures one in the general conclusion drawn from the curves. It will be protested that no account has been taken of the vast mineral possibilities of northern Manitoba and Saskatchewan, but the reply is that even admitting great potential developments in mining, the present portion of Saskatchewan will probably be no more affected than was Iowa with the development of Minnesota mines, or the farmer of Ontario with the mineral development in the north of that province. On the other hand Alberta offers a somewhat different situation; the Peace river district, if given a short outlet to tide water and thus a cheaper freight rate to world markets, would probably grow for reasons just given, but as far as the present settled portions of Alberta are concerned little effect would likely be felt in rural or urban centres. It is assumed then, that over the settled portions, rural western Canada is approaching saturation, that future growth will be slow and no more large immigration movements may be looked for.

Urban

Even although it is admitted that there will be little tendency towards increase of rural population, one concludes from a study of the curves of the western states that the urban population will grow substantially within the next twenty-five years. If the rural population does not increase greatly in numbers, this does not mean that business will not increase. In the nature of things (unless the present exceptionally severe depression completely ruins the west) as time goes on the wealth and purchasing power of the country will gradually increase; this taken into consideration with the definite movement, evident to-day, towards establishment of branch and moderate sized industries serving local needs will assure a healthy urban growth for some time.

At what rate will that growth take place? As was pointed out, in agricultural states of the Union the total urban growth taken over a number of years approximates a straight line. Fig. 7 indicates that a similar growth has been taking place in urban population in Manitoba, Saskatchewan and Alberta. Will this continue for twenty-five years? When will the curve for total urban growth begin to flatten out like the rural curves, as they, of course, must eventually? These are questions that cannot be definitely answered, but in western Canada the writer feels that this will not occur for at least twenty-five years, his reasons being as follows.

First, the 1930 census data show that the curve for total urban population of the United States as a whole is still slightly concave upwards but is approaching the point of inflection. Fig. 8 shows that in the old industrial state of Massachusetts there is a falling off, while the middle Atlantic states of New Jersey, New York and Pennsylvania are still increasing in a straight line, as also are the Dakotas, Iowa, Minnesota and the north west central group as a whole. The rapid growth of urban population in California and Florida has done much to keep the curve of total urban population from falling off, but the growth of these two latter states is of a type foreign to the economic considerations of this paper. The sharp increase in population of the southern states is due to the gradual industrialization

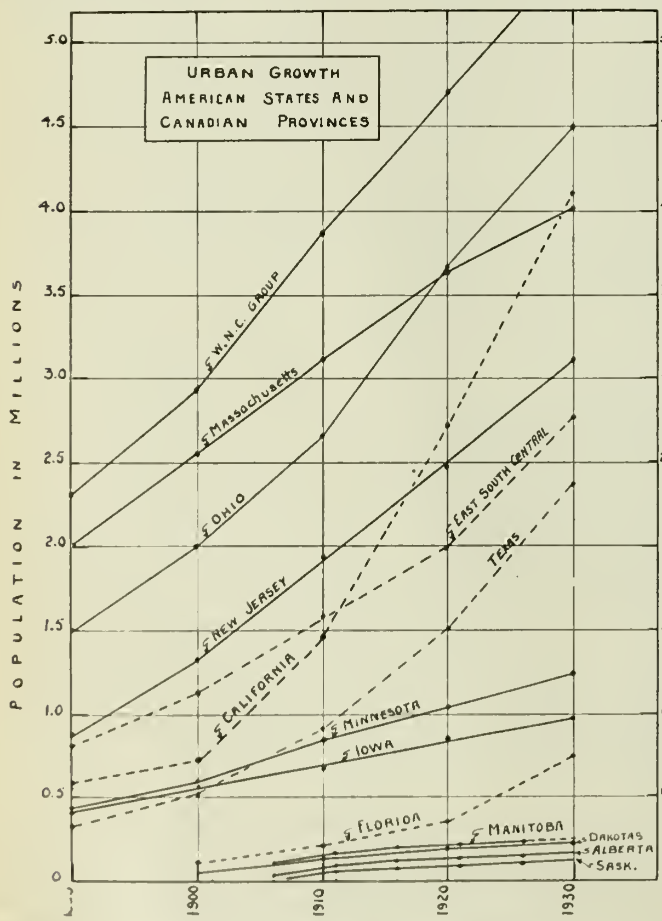

Fig. 8—Urban Growth in American States and Canadian Provinces.

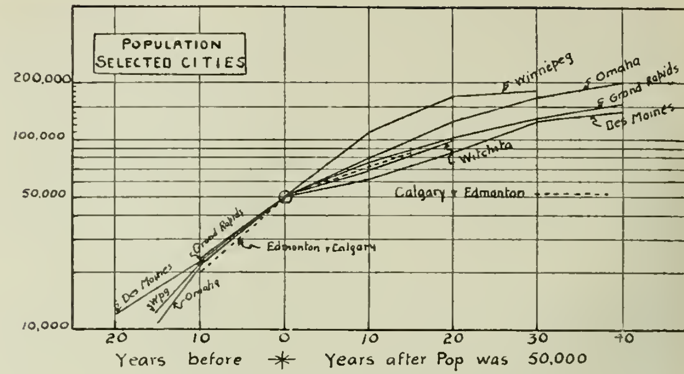

Fig. 9—Populations of Selected Cities.

of the southern states (probably at the expense of the New England states) and of course Texas has soared skywards on oil. It is seen then that generally speaking in the United States the increase in urban population as a whole has not yet started to decline, although there are indications of a general tendency in that direction.

Secondly, even if the turn in the United States is imminent, it seems reasonable to assume that in Saskatchewan there will be a considerable lag, and even after the inflection point is passed the decline will not be rapid for some years. Again, if we produce the Saskatchewan curve for twenty-five years we find that the ratio of that urban population, i.e., 290,000 to the assumed rural maximum of 750,000, is not greater than is to be expected from a study of similar ratios in comparable states. It is therefore concluded that in Saskatchewan the total urban population will continue to grow for at least twenty-five years in a straight line and in 1955 will amount to from 290,000 to 300,000.

The next question is: How will that population be distributed? For the purpose of answering that question a detailed study of the provincial conditions was made, in which the extent and productivity of the distributing areas served by each urban centre, the natural trade barriers such as rivers, and the existing trade routes such as railways and highways, were considered. At present, besides the small towns and villages which are merely local trading centres and for this study are classified as rural, there are two urban classes, larger or primary distributing centres and the secondary smaller centres. The development brought about by modern rapid transit facilities has tended to concentrate the major part of the urban population in a few larger centres. In Saskatchewan these are Regina, Saskatoon and Moose Jaw. Regina and Moose Jaw are relatively close together and their contributing areas largely overlap and it appears that the growth of each will affect that of the other. If we take Regina and Moose Jaw together as one urban unit, Saskatoon as another and all the other secondary centres as a third, Table II shows the relative trend in growth.

Table II
Percentage of Total Urban Population in Each Unit

	Regina and Moose Jaw	Saskatoon	Secondary Centres
1916	52 per cent	25 per cent	23 per cent
1921	51 "	24 "	25 "
1931 (estimated)	52 "	28 "	20 "

Saskatoon appears to be increasing its percentage, which is to be expected, as the northern parts of Saskatchewan, especially the more broken country, develop slower and the farmers have less capital. In twenty-five years it is estimated that Saskatoon will have about 33 per cent of the total urban population of 290,000 or about 96,000, while Regina and Moose Jaw combined will have about 54 per cent or about 160,000. This estimated relationship checks fairly well with the present rural population and areas of field crop contributary to each group.

Tentative studies only have been made for Manitoba and Alberta, but, by extending their curves, a total urban population of about 420,000 and 330,000 are respectively indicated. In Alberta, Calgary and Edmonton, which are approximately the same size, constitute about 90 per cent of the total, and in Manitoba, Winnipeg with its suburban centres represents about the same proportion. If these percentages are maintained, both Calgary and Edmonton should have in 1955 populations of approximately 150,000 and Winnipeg with its environs about 380,000.

As a further check on the above conclusion Fig. 9 was made, in which the curves of growth for several American cities of comparable character were plotted showing the population at various years after the population had reached 50,000. Des Moines is the largest and most rapidly growing city of Iowa; Wichita, Kansas, a very progressive prairie city; Grand Rapids, a progressive industrial city in Michigan; Omaha, Nebraska, a large distributing centre and for many years a jumping-off place for the territory to the west, somewhat similar to winnipeg in the Canadian west. If Des Moines, Grand Rapids and Wichita be assumed to represent the growth of active and progressive cities, and if the present population of Saskatoon be taken as 45,000 and Calgary and Edmonton as 85,000, it will be seen that additional support is given to the above estimates.

Conclusions

While the primary conclusion is, that, for purposes of design, it is reasonable to assume that the population of Saskatoon will be about 96,000 in the year 1955, it is felt that this study brings out many facts of general interest and that the method worked out might well be developed to serve as a guide for the laying out of long term programmes for provincial and national highways, railways, other utilities and public measures in western Canada.

Discussion on "The Structural Engineering of the Head Office Building of the Sun Life Assurance Company of Canada, Montreal"

Paper by A. H. Harkness, M.E.I.C.(1)

D. C. Tennant, M.E.I.C.(2)

Mr. Tennant remarked that at the meeting of the American Society of Civil Engineers held recently in New York two buildings were described—one was the Empire State building, and the other the Manhattan Company building. The Empire State building was of course a very large structure. The offsets in that building were attained by making them exactly conform to the panel lengths, so that it had not been necessary to carry the load from upper columns by girders to other columns down below. It had been aptly remarked that largely as a result of this arrangement, the steel work on the Empire State building was majestic in its simplicity. On the other hand the Manhattan Company building had a great many girders carrying columns above, also trusses and all sorts of troublesome details due to architectural requirements. It would be agreed, he thought, that the Sun Life building was more like the Manhattan building in this respect than like the Empire State building; that is, there had been a great many unavoidable architectural requirements in connection with the Sun Life building which caused difficulty in the structural features. These had been pointed out in the paper, but in his opinion, the author's modest disposition had prevented him from emphasizing them as he might have done. In many cases the columns had to be carried on girders because of the size of the set-backs. Then, again, there were cases where trusses in the building carried upper columns and certain columns had been splayed out. These things are not easy to arrange in connection with structural steel.

However, there was another feature about the Sun Life building which the author had also mentioned, making it even more remarkable, the transition from a small to a much larger building. In the first place there had been a very beautiful but comparatively small building. But when built it was not intended to become the large and wonderful building it was to-day. The design of the original building had been covered by specifications and plans; the design of the final building was similarly covered. Yet there were scarcely sufficient rules for making the transformation from one building to the other. This made the Sun Life building a special problem and the transformation was the most interesting feature to engineers.

In connection with the transformation some of the columns had to be reinforced. It was not sufficient merely to add the new steel to the columns. There had to be some way of taking the load off the steel already in place before the new steel could be added. That was done by shoring and jacking. In many instances considerable new material had to be added to an existing column. It was necessary to consider whether extra stiffening was required in these cases. Most of the columns in the Sun Life building were comparatively short for their sections, and therefore the consideration of the factor $\frac{l}{r}$ did not come into account. There were however some of the columns so reinforced which were very long, and it was thought advisable that this reinforcing should be stiffened in some way. Actually those reinforcing sections were put on in lengths of about eight or ten feet and in order to provide stiffness squares had been welded on to the outstanding legs of the reinforcing angles. Again, in the jacking up of the columns to replace the bases by stronger bases, as described by the author,—the loads which were to be lifted were very carefully calculated. It was calculated how much load was on each floor at the time the operation was done. After all the calculations had been made the jacks were chosen with considerable excess strength and the columns had to be actually lifted until there was a very slight crack appearing at the bottom of the column, between the column and the base upon which it rested. It was fortunate indeed that these jacks did have excess strength, because it was found that the load that was actually lifted, in order to bring the column clear, was greater than had been calculated. The reason was obvious, for in addition to the calculated load it was necessary to overcome the resistance or stiffness of the floors, and the stiffness of the beam connections made it harder to lift the columns than had been figured. Such problems, he thought, made this transformation the most interesting part of the whole construction. In such work, engineering showed itself, as the author said, in a venturesome light, and appeared as an art as well as a science.

(1) This paper was presented at the Annual General Meeting of The Institute, Montreal, February, 1931, and appears in the February, 1931, issue of The Journal.

(2) Designing Engineer, Dominion Bridge Company, Montreal.

C. J. A. Cook[3]

The following statement was presented by Mr. C. J. A. Cook of the firm of Cook and Leitch, general contractors for the building. It covers a number of points of interest regarding the quantities of materials, the rate of construction, and the contractors' equipment.

The building was constructed in three units, namely, the eastern portion facing Mansfield street, the westerly portion facing Metcalfe street, and the tower portion from the eighth floor to the pent house.

The following list gives the start and finishing dates of the main structure on the three units:—

	Easterly		Westerly		Tower	
	Start	Finish	Start	Finish	Start	Finish
Excavation..	May 1927	Dec. 1927	Jan. 1929	June 1929	..	..
Structural Steel.......	Jan. 1928	Apr. 1928	May 1929	Oct. 1929	Jan. 1930	July 1930
Floor Slabs..	Apr. 1928	June 1928	Sep. 1929	Oct. 1929	Mar. 1930	Aug. 1930
Granite and Brick Backing....	May 1928	Oct. 1928	Aug. 1927	Dec. 1929	May 1930	May 1931

The first excavation amounted to 40,000 yards earth and 8,000 yards rock; the main feature of this excavation was the underpinning of Loew's theatre on the north end of the property.

The second excavation amounted to 40,000 yards earth and 6,000 yards rock, making a total of 80,000 cubic yards earth, and 14,000 cubic yards rock. With the 20,000 yards excavated for the original building there is a total of 114,000 yards excavation.

It may be noted that the total weight of structural steel is 18,550 tons.

The floor construction which is of the concrete joist type was about 300,000 square feet for the easterly portion, done in three months, and the same area for the westerly portion which was completed in two months. The 650,000 square feet of floors in the tower section were completed in about six months, and with 200,000 square feet in original building, made a total floor area of 1,450,000 square feet.

The granite on the easterly portion, about 7,000 tons, was set in six months, on the westerly portion the same tonnage was set in five months, and on the tower portion a tonnage of 16,000 tons will have been set in less than twelve months.

All materials, including the structural steel for the tower section, were delivered and raised from the Mansfield street side and passed over at the various floor levels above the eighth floor to the Metcalfe street side.

The following is a list of materials estimated as being required for the construction of this building:—

	Tons
Cement in Bags (500,000)	25,000
Sand	40,000
Crushed Stone	40,000
Brick (3½ million)	9,000
Terra Cotta Partition Blocks, 2 inch, 3 inch, 4 inch and 6 inch (1½ million square feet)	12,000
Terra Cotta Beam and Girderfireproofing (176,443 square feet)	1,000
Reinforcing Steel	1,400
Plaster Material	2,000
Metal Lath (150,000 yards)	220
Metal Corner Beads (200,000 lineal feet)	20
Angles and Furrings	500
These figures total	131,140
Add 12½ per cent for original building	16,390
	147,530
Add structural steel	18,570
	166,100
Add granite	35,000
	201,100
Add for 2,650 Doors, 1,963 Windows, Marble Stairs, Plumbing equipment, Heating equipment, Electrical equipment, Elevators, Ventilating equipment, and Roofing	50,000
Grand Total	251,000 Tons

Total Floor Area .... 1,450,000 square feet
Total Cubic Contents .... 21,750,000 cubic feet

A few special details on the granite will finish this statement:—

Total number of courses in height	270
Total lineal feet of courses	237,156 or 45 Miles
Number of stones over 5 tons	818
Number of stones over 10 tons	53
Number of stones over 17 tons	2
Number of freestanding columns	114
Total length of columns	4,260 lineal feet
Total weight of columns	5,600 Tons
Total number of openings in granite windows and doors	1,963
Total weight of granite	35,000 Tons

Average stone weighs 1,000 pounds and is 4 feet in length.

In the setting of this granite stiff leg derricks were used. The following number of derricks may yet be seen on the job:—

2—15 ton all steel, stiff leg.
1—10 ton steel boom and mast, sill and legs on wood.
2— 5 ton all wood stiff leg.
1— 3 ton all wood stiff leg.
1— 1 ton all wood stiff leg.
3—Top point setters, 3,000 pounds capacity.
12—Circle swing, 2,500 pounds capacity.

During the year 1930, on the tower section about 100,000 tons of material were handled. This includes structural steel and granite, with an average of 750 men for 300 days; that means each man took from the street and put in place 1,000 pounds per day.

Professor E. Brown, m.e.i.c.[4]

Professor Brown inquired what clay pressures had been used in the design of the shoring for the basement walls, and also what main considerations had led to the extension of the steel columns, as shown in Fig. 5, when clay veins were encountered, instead of placing the concrete down to solid rock.

In shoring the floor beams to take the stress off the columns when the columns were reinforced, how were the loads determined? The author had explained how the whole column was shored, but he was not clear as to the extent to which the load was taken off a column, when the separate floor beams were shored.

A. H. Harkness, m.e.i.c.[5]

The author replied that there was no earth pressure directly against the walls, except that of back-fill, and that was of loose material which was there for only a short time before it was supported by the floors. A horizontal pressure of about 35 pounds had been assumed. Once the floors were in everything was secure.

In regard to the extension of the steel columns downwards for the east half of the north wall, rather than concrete piers, the Sun Life Company wished the second basement floor to open through between the old and new buildings, and concrete piers would have cut off too large a proportion of the space. This did not apply to the west half.

[3] Cook and Leitch, Montreal.

[4] Professor of Applied Mechanics and Hydraulics, McGill University, Montreal.

[5] Harkness and Hertzberg, Toronto.

The more heavily loaded columns were lifted with hydraulic jacks. The two posts with needle beams and wedges were used only for the lighter loads. The wedges were driven to lift the columns free at the base.

F. P. Shearwood, M.E.I.C.[6]

Mr. Shearwood observed that in connection with the jacking operations on the columns one of the greatest troubles was to get the load properly transferred to the blocking from the hydraulic jacks. It was necessary to grease the steel wedges very liberally so as to get them in and relieve the heavy load on the jacks. Again, the wooden blocks taking the load on the inside of the jacks were intended to carry 1,200 pounds per square inch, which they should have supported easily. As an extra precaution angle irons were placed on each side of the blocks and bolted through and it was fortunate that this was done, as when the load came on the blocks, shakes in the wood began to show up quite prominently.

E. V. Gage, A.M.E.I.C.[7]

Mr. Gage understood that the height of the building above sidewalk level would have been 399 feet 11 inches, if it had not been for the strain in the columns, which amounted to 2 inches. Observing the construction he noticed that a portion of the building was built and plastered, after which the additional weight of the tower was placed above. He would ask if any precautions were taken to keep the plaster from cracking down below. Did the plaster on the lower floor crack when the weight was put on the upper floors?

A. H. Harkness, M.E.I.C.

The author stated that the plaster on the lower floors did not crack as there was enough elastic deformation in the partitions to take compression without cracking.

[6] Chief Engineer, Dominion Bridge Company, Montreal.
[7] A. F. Byers Company, Ltd., Montreal.

In regard to compression of the steel columns in buildings, there is an interesting point in connection with the Empire State building. The steel was erected, and the mail chutes were put in alongside the elevator shafts, in their usual position. The columns were loaded afterwards by the construction of the concrete floor and compressed, there being no corresponding load and compression in the mail chutes. The angles and plates of the chutes buckled and became crooked. The contractors had to go over the mail chutes and ease them up so as to get clearance at the splices. There was a total of about 6½ inches compression at the Empire State building.

To get the level of the window sills a bench mark was taken at the centre of the building by which to fix the elevation. As the exterior walls were built the contractor noticed the tops of the window frames got closer and closer to the beam above. The engineer was asked what the matter was and he found that it was the load on the outside columns which was causing the trouble. The columns compressed and lowered the spandrel beams in relation to the interior of the building. That is, when the interior of the building was loaded with the concrete floors the outer bays sloped inwards a little, and after the wall was built it became level again.

Professor E. Brown, M.E.I.C.

Professor Brown observed that the amount of steel in the building was about the same as the Chrysler building. The cubic capacity of the building had just been quoted. What was the capacity of the Chrysler building?

A. H. Harkness, M.E.I.C.

The author replied that there was not much difference. The lower columns ran heavier in this building and there was some very heavy masonry that they had not on the Chrysler building, and the Chrysler walls were lighter. It would be noticed also, that there was a magnificient colonnade around the twenty-second floor, each pair of columns of which weighed about 300,000 pounds.

Discussion on "A Method of Laying out Warped Surfaces of Hydraulic Structures"

Paper by C. P. Dunn, M.E.I.C.[1]

James W. Rickey, M.E.I.C.[2]

Mr. Rickey stated that the paper was one of great interest and though as the author had said the method might be the ship builder's standard technique, he had no doubt it was as new to the majority of engineers as it was to him. It should prove very useful to hydraulic engineers in particular and he could think of many instances in his own practice when he would have greatly appreciated something of the sort.

The author had defined the ideal shape of the surface in terms of hydraulic efficiency and then proceeded to say that the elements of this ideal surface would consist of smooth easy curves and that the trace of a plane cutting it in any direction would also be a smooth easy curve. This premise was obviously correct.

Having determined hydraulically or by model (and the value of models in this connection was to be emphasized) the approximate ideal surface, this method of refining and obtaining the ideal surface would unquestionably result in the easiest form work. Of course, there might be circumstances where transitions could not be justified economically on the basis of hydraulic efficiency alone, but structural efficiency, i.e., resistance to erosion and avoidance of cracking must also be considered. In concrete it was elementary that cracks tend to form at any abrupt change of section.

He had seen the intake and bucket on the spillway section of the dam. Both were impressive. The latter in particular was a beautiful piece of work and its hydraulic performance fully bore out the theory back of the author's method. The combination of this method of design and construction without top forms had resulted: (1) in a structure ideally shaped; and (2) in a surface texture which should be far more resistant to erosion than that of the usual surface obtained by placing concrete against forms.

In his opinion, the paper was both excellent and timely and merited very close study by the hydraulic engineer.

[1] This paper was presented at the Annual General Meeting of The Institute, Montreal, Que., in February, 1931, and published in the January, 1931, Journal.
[2] Chief Hydraulic Engineer, Aluminum Company of America, Pittsburgh, Pa.

Frederick B. Brown, m.e.i.c.[3]

Mr. Brown stated that the paper was an example of one of the many problems which occurred in construction practice and which, unfortunately, were too seldom recorded. This type of paper was undoubtedly of great value to the field engineer, and particularly to those in junior positions who were likely to advance in their profession and who also had the ability to think for themselves.

It was undoubtedly true that the busy man in the field considered that he had no time to write about what he considered ordinary routine in the solving of field problems. It was also true that the busy man could always find time for additional activities if he considered them sufficiently important. Many a good field engineer and superintendent knew short cuts, stunts, kinks, gadgets or whatever one wished to call them, which could save his working brothers many an anxious hour and many personal energy units, if he only realized that the benefit of his experience would be valuable to himself and his juniors if he could present them in a form which could be readily understandable, and available.

Each item of valuable information such as given in the paper, added to the sum total of the knowledge of how and why to use the working tools of the art. In his experience, several men had taken the attitude that the knowledge gained by them in the exercise of their profession constituted a personal asset to be jealously guarded and used for their own direct benefit, but his opinion was that the dissemination of such knowledge was of more value to the man who discovered the particular item and to the profession at large than if he had kept it to himself.

The author was therefore to be congratulated for having set forth in such clear and concise language one of those items of information, and it should cause stimulation of thought and save time and money for others when they had to handle similar problems.

The technical aspects of the paper were sound and the exposition of methods was clear and concise. The use of models was of very great importance in checking paper calculations and Mr. Brown had found that in every case where a model had been recommended, the cost had been more than repaid in the results obtained.

F. W. Caldwell, m.e.i.c.[4]

Mr. Caldwell asked whether the energy function would not fit in with a case like this better than the velocity function. A change in energy should of course include all losses in a section, and there would not appear to be very much practical difference in a case such as that chosen. He wondered, however, if anyone had had any experience with this method of attack.

C. P. Dunn, m.e.i.c.[5]

The author replied that he had thought of this thing several times in terms of energy function, and in trying to get the mental picture of it the question which came to mind was: An attempt is to be made to set up a curve for the energy content of this water. Then came the question: The energy content of what water? How much water? Would the lineal foot be taken and the energy content computed and then the energy content be taken at another place where the conduit was small, or would the energy in one cubic foot of water be measured and followed through the transition?

The latter idea was carried out when the velocity head was used. That was the thing on which his mind was not settled. It was done this way and it seemed to work—but it might not be right, and it was not certain that this was the best way to do it.

J. J. Traill, m.e.i.c.[6]

Mr. Traill remarked that there was a minor point in the paper to which he took exception. It was not one perhaps of any particular importance in connection with transitions in which the velocity was increased as it was in the structures described in the paper. In Fig. 1 there was a curve showing the rate of increase in the velocity head in the transition. In the case of a transition in which the velocity was increased he did not think it mattered greatly at what rate the velocity was increased, whether it was increased as a direct function of the velocity with respect to distance, or the velocity-squared with respect to distance, or somewhat irregularly as was shown in the present case. When he considered the case of a transition in which the velocity was being reduced he found there were definite experimental data which indicated that the change should take place as a function of velocity-squared with respect to distance. A straight conical tube was the simplest expanding section that could be made. But that tube did not recover as much energy as one in which the change took place by a uniform rate of reduction in the square of the velocity. The change he suggested in the author's case was instead of using a curve to determine the rate of reduction of the velocity head a straight line should have been used. Experimental data indicated that such a type of transition, at any rate for an expanding section, was the most efficient.

C. P. Dunn, m.e.i.c.

The author, in reply, stated that in setting up the illustration referred to in the paper he had shaped a curve of velocity-head through the transition so that it would be a smooth curve, and believed this to be approximately right because he had used it successfully, although the experimental data available to him were not sufficient to convince him fully that the assumption was absolutely correct. It appeared reasonable to believe that a transition designed on the variation of velocity-head would be more nearly correct than a design based on simple area or velocity variation, because it would be more nearly a correct expression of the energy content of a given quantity of water. It seemed reasonable that the energy loss in a transition would be a minimum if the energy content in an assumed quantity of water, say one cubic foot, followed through the transition, were changed from one amount of energy to another with a minimum abruptness of variation in rate of change. A straight line variation of velocity-head, such as that suggested by Mr. Traill, would produce an abrupt variation of rate of change at the beginning and end of the transition.

(3) Consulting Engineer, Montreal.
(4) Consulting Engineer, Montreal.
(5) Chief Engineer, Alcoa Power Company, Arvida, Que.
(6) Engineer of Tests, Hydro-Electric Power Commission of Ontario, Toronto, Ont.

Discussion on "Automatic Block Signalling on the Canadian Pacific Railway"

Paper by A. J. Kidd[1]

W. M. Post[2]

Mr. Post observed that the paper on "Automatic Block Signalling on the Canadian Pacific Railway" covered the history and development of automatic block signals quite fully and the description would apply to most railroads which had used automatic block signals to any extent over a period of several years.

The author had stated that electro-pneumatic signals were not used to any great extent owing to the necessity of air supply for its operation. The Pennsylvania Railroad used electro-pneumatic automatic signals quite extensively east of Pittsburgh for twenty-five years prior to 1910. There was a 2-inch pipe line over the entire New York division between Philadelphia and Jersey City, 90 miles, conveying compressed air for the automatic signals and electro-pneumatic interlockings. There were altogether about 335 road miles, or 1,060 track miles equipped with electro-pneumatic automatic signals. These electro-pneumatic signals were very reliable in their operation and gave excellent service. They were of course rather expensive to instal and to maintain and the development of the top post motor signal, and later the position light signal, made it advisable to discontinue the installation of electro-pneumatic signals. As an illustration of the rapid changes in signalling which had taken place in the last twenty-five years, there were today only 29 road miles, or 76 track miles of electro-pneumatic automatic signals on the Pennsylvania system.

The impression was also given that lower quadrant signals had to be two-arm signals if the third or caution indication was displayed, the second arm being used to give this indication. It might be interesting to know that on the Pennsylvania lines west of Pittsburgh there were several hundred miles of automatic lower quadrant three-position signals in service prior to the development of the upper quadrant three-position signals.

The author had also stated that in other than searchlight signals, it was not possible to use a reflector of any kind owing to the danger of a phantom indication. A reflector was used in the position light signal for close-up indication, i.e., a reflector was so placed that the beam of light was reflected downward so that an engineman standing close to the signal will get the indication. The shape of the cover glass on the position light signal prevented the possibility of a phantom indication, as the rays from a headlight, or from sunlight, when the sun was near the horizon, were deflected in all directions except towards the engineman.

A. J. Kidd[3]

In connection with Mr. Post's remarks the author felt that perhaps he should admit that the title of his paper was somewhat of a misnomer and should perhaps have been called "An Historical Sketch of the Development of the Automatic Signalling Art in General and Latterly on the Canadian Pacific Railway in Particular." His remarks in connection with the use of electro-pneumatic signals were intended to note in passing a very interesting phase of the development of the art, and while he knew that the Pennsylvania Railroad and he thought the Central Railroad of New Jersey, had at one time installed a considerable mileage of this type of signal he did not have the exact mileage and he thanked Mr. Post for the information. The idea he meant to convey was that their use was not as general for instance as the use of the electric motor signal and that the use of the second arm on lower-quadrant signals became the general practice, although some roads were using a three-position lower-quadrant signal; the objection to this however was the difficulty of distinguishing the 90-degree position when given in the lower-quadrant.

When describing the use of a reflector in other than the searchlight type of colour-light signal the author had referred to the main light beam of signals and not to the "close-up-indication," and perhaps he had not been very explicit in this particular. The reflector Mr. Post mentioned was placed at an angle to the lamp in the top of the case and directed the light downwards, so that the engineman can obtain the signal indication when close up to, or more or less under the signal if mounted on a signal bridge.

F. O. Condon, M.E.I.C.[4]

Mr. Condon stated that the paper covered concisely the history of the signalling branch of railway work and described the different methods which have been tried from time to time as well as the changes and modifications made down to the present.

The different types and systems in use on the Canadian Pacific Railway were duplicated to a large extent on the Canadian National Railways; the only point of difference being the use of direct colour-light signals in the later installations in preference to the "searchlight" with moving roundels inside the lamp hood as used on the Canadian Pacific.

In place of the coloured, movable roundels to provide the colour indication, there were three separate lamps having coloured lenses which gave the required indication.

The lamp case was blackened at the rear of the lamp so that there was no possibility of a "phantom" indication, which seemed to be the principal reason for the "searchlight" type. In that type of signal there was no relay and all moving parts were done away with.

The centralized traffic control system had not yet been tried out on the eastern lines of the Canadian National as there were no locations where, with present traffic conditions, it would be justified.

The author had given a very comprehensive description of the signalling methods in use on the railways of North America and had handled his subject in a most creditable way.

A. J. Kidd

The author thanked Mr. Condon for his kind remarks in connection with his paper; he would like however to point out that the colour-light signals using three lights placed behind the necessary coloured lenses do use a relay, although the relay is housed somewhere else than in the signal head. It is felt that by placing this relay in the signal head and obtaining the ability of repeating this signal from the point where the indications are given to the engineman a very valuable feature is secured, especially in interlocking territory.

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[1] This paper was presented at the Annual Meeting of The Engineering Institute of Canada held in February, 1931, and appears in the January, 1931, issue of The Journal.

[2] Assistant Chief Signal Engineer, The Pennsylvania Railroad, Philadelphia, Pa.

[3] Assistant to Signal Engineer, Eastern Lines, Canadian Pacific Railway Company, Montreal.

[4] Principal Assistant Engineer, Canadian National Railways, Moncton, N.B.

Discussion on "Direct Method for Normal Thrust and Moment Influence Lines for Fixed Arches"

Paper by Alfred Gordon[1]

Alfred Gordon[2]

The author, in reply to Mr. Brett, observed that the method presented presumed that influence-lines were required. This having been granted, let a comparison be made between Fig. 2a of the paper and Fig. 72 of Hool and Kinne's "Reinforced Concrete and Masonry Structures," or the calculations in Section 9-21 of the same authors' "Movable and Long-Span Bridges": if this were done, there should be no doubt as to the simplification effected. Mr. Brett was, of course, quite correct in pointing out that the effect of the spandrel supports and deck framing, unless flexurally connected to the arch-rib, would render the method nugatory; but this was anticipated in the introductory paragraphs. The paper was, essentially, a "computer's," rather than a "designer's" paper. The art of computation, however, was not to be despised. In another type of structure, the continuous bridge, the simplification of this art, together with the correction of some erroneous views as to the quantitative effect of a settlement of the supports upon the stresses (this effect, measured as a percentage of the total stress, becoming almost negligible in long spans), had resulted in more and more of such spans being built. In this connection the possibilities of the fixed steel arch were not to be overlooked, although at present it was rare; but for such a structure the method would be quite valuable.

Replying to Mr. Pratley, the author said that there had been added to the paper a note which, it was hoped, would answer the question as to the object of introducing the "ellipse of elasticity." As there stated, its only use was to locate the line *M-M*, after which everything was as simple as Fig. 2a. With regard to "elastic weights" versus "method of least work," the former amounted to no more than finding the deflection of a beam through loading it with its M/EI diagram, hence the pictorial term "weight"; and it might be contended that this graphical way of evaluating an integral (i.e., in this case determining a deflection, since $\delta = \int Mm\, ds/I$), coupled with the generalization that every deflection-diagram was also an influence-line, was as "physical" and "tangible" as the "conservation of energy." As for the rigid bars, since to some they were evidently confusing, they might be set in yet another light. The one connecting the cut section to the elastic-centre simply corresponded to the analytical procedure of taking the centre of co-ordinates so that all terms containing $\int \frac{ds}{I} xy$ vanished. The other, connecting the skew-backs, converted the structure into a ring, cut at the panel-point considered. Because a force acting along the line *M-M* would produce a pure rotation or tangential displacement, as desired, the problem then became as simple as, say, that of a beam continuous over two supports, in which, as was well known, the deflection-curve due to a vertical load at the left-hand support (the support being removed) was itself the influence-line for the left-hand reaction due to vertical loads. It was unfortunate that the *proof* of the fact, that by means of the ellipse of elasticity the force which would deflect the end of the curved cantilever or cut ring in any desired direction could be located, was so tedious; but, the proof being accepted, the method for the curved rib, or ring, was just the same as for the continuous beam cited,—and it was to be remarked that, shorn of the simple, but tedious, mathematical proof, the whole method was set forth in four short paragraphs, commencing at the words "The explanation of these constructions is based on the well-known fact . . ." down to "The chain of argument will now be completed."

The only difference between the two cases was, that whereas in the continuous beam the vertical load at the support (the support being removed) deflected the beam vertically, a load applied to the end of the cantilever or cut ring deflected it, not in the direction of the force, but in a direction at right-angles to the axis conjugate to its direction. It was hoped that this argument by analogy would be to some more convincing than the mathematics.

[1] This paper was presented before the Montreal Branch of The Institute on February 19th, 1931, and appears on page 243 of the April, 1931, issue of The Journal.

[2] Canadian Pacific Railway Company, Montreal, Que.

Discussion on "The Design of the Chute a Caron Diversion Canal"

Paper by G. O. Vogan, A.M.E.I.C.[1]

J. B. Macphail, a.m.e.i.c.[2]

Mr. Macphail stated that the author's account of the results of operation of the sluice tubes was most welcome in its justification of the methods customarily used in the computation of such a case. Some calculations, necessarily rough because they were based only on the small scale drawings of the paper, showed that one could independently make a reasonable estimate of conditions which would actually occur. The model tests seemed to have had their greatest use in the removal of that doubt, which often occurred in the period between the design and the final operation of hydraulic works, as to the extent of the correlation between the physical facts and the assumptions on which calculations must be based. They must also have been useful as a reminder of the fact that the temporary deflecting wall in the tailrace east of unit No. 1 would be needed to remove an unsymmetrical channel condition which would be likely to cause unpredictable eddies in place of the jump desired.

It was perhaps a little ungrateful to wish that the author had ventured a little further into those regions which were at present beyond our mathematical reach, such as jump in abrupt channel enlargements of various proportions, and the jump in channels with sloping bottoms. Again there were cases of submerged sluices where the flow would be expected to be not in proportion to the square root of the net head if there was a possibility of a jump being formed: there was the case of the jump forming in the sluice tube itself; and there was the determination of the conditions just at the point when the proportionality of the square root of the net head begins or fails. Some information on all these points would have been very welcome, and it was to be hoped that others who might have had an opportunity of making some useful observations, either on models or on a full scale, would take the trouble which the author had in collecting and communicating his data.

[1] This paper was presented at the Annual General Meeting of The Institute, Montreal, Que., February, 1931, and published in the March, 1931, Journal.

[2] The Power Engineering Company, Ltd., Montreal.

Aerial Cameras and Photography

Flight Lieutenant J. R. Cairns,
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Presented on March 24th, 1931 ,before the Aeronautical Section of the Ottawa Branch of The Engineering Institute of Canada (Ottawa Section, Royal Aeronautical Society).

SUMMARY.—This paper outlines the development of aerial photography, first as a war-time development in Europe and later as applied for special purposes in Canada. The equipment and methods are considered for oblique and vertical aerial photography and in Part 2 descriptions are given of some of the early cameras used during and since the War and many of the latest developments in hand and multiple-lens cameras.

Application of Aerial Photography in the Great War

There is no authentic information as to where the first aerial photographs were actually taken; it is definitely known, however, that aerial photographs had, to a limited extent, been taken from balloons, dirigibles and kites previous to the great war, and were used for various purposes, but during the war aerial photography was greatly developed and its scope widened through the taking of photographs from airplanes.

Little information can be obtained as to how the aerial camera was first used for military and naval reconnaissance; the credit, however, for a great deal of the pioneering work in aerial photography is given to, at that time, Lieutenants Campbell and Moore Brabazon. During the early part of the war flights had been made and photographs taken with ordinary ground cameras, usually of the press type, and although the results obtained by these early cameras were anything but perfect, sufficient information was obtained from the photographs to warrant further experimental work being carried out to secure better results.

Hazy and vague negatives had to be improved upon and lack of contrast had not only to be eliminated but contrast if possible emphasized. Better results were eventually secured by the use of filters and proper developers, etc., and with such success that roads, trenches, paths, etc., showed up clearly on the photographs as white lines against a dark back-ground and guns camouflaged to deceive the human eye could not deceive the all-seeing eye of the camera.

By this time it was thoroughly appreciated by the authorities that a new field of operation of enormous value in warfare had been discovered, and steps were taken to secure a camera better suited for this type of work. This matter was put in the hands of Lieutenant Colonel Moore Brabazon who was later founder and chief of the Photographic section of the Royal Air Force. He was sent from France to London, where in conjunction with the Thornton Pickard Company, Ltd., he designed and produced the first practical aerial camera used by the Air Force.

The value of aerial photography during the war cannot be over-estimated. It completely changed the tactics of war, as the all-seeing eye of the camera revealed information which would otherwise have been hidden, and complete records and maps were made of enemy territory and kept up to date by frequent photographic flights over the line and comparison of photographs previously taken, and the work of interpreting these photographs and making them into mosaic maps became a highly specialized study, making this branch of the Service one of the most important and valuable in the war.

Application of Aerial Photography to Survey Work in Canada

After the world war was ended aerial photography still continued to make headway, although it is only within recent years that it has been applied to any great extent for commercial purposes. In Canada, however, it was felt by engineers and surveyors alike, that its application to topographical surveying and mapping could be used to great advantage and experiments in this work were carried out in 1918-19 when the Air Board was formed and wonderful progress was made yearly in the development of air survey by improvement of equipment and methods.

War-time aircraft and cameras were at first used, but these were gradually replaced by more up to date equipment until today the best types of aircraft and most up to date cameras and photographic equipment procurable are used for air survey work.

Canada with its vast tracts of unexplored territories was in need of accurate maps as these vast tracts of land were only known to Indians and a few white trappers, and any maps which might be available were inaccurate and unreliable.

As the natural resources of the country opened up, the demand for more accurate maps grew greater yearly, and the increase in the taking of air photographs developed accordingly. The percentage of this increase can best be judged by the following figures. In 1921-22 the total area covered by air photography in Canada was 280 square miles which involved the taking of 7,984 negatives; in 1925-26, five years later, 49,170 square miles were photographed and involved the taking of 24,248 negatives, and during 1929-30, 74,655 square miles were photographed, the number of negatives taken being 97,742.

This great work was first carried out by service and ex-service personnel under the Air Board, then by the Royal Canadian Air Force, and within the past three years by Royal Canadian Air Force officers and personnel under the Directorate of Civil Government Air Operations, each working in conjunction with the Topographical Survey of Canada.

Oblique Aerial Photography

There are two methods of photography used in these operations, vertical and oblique. The oblique photographs are taken from Vickers Vedette flying boats and the verticals from Fairchild cabin monoplanes and Bellancas which can be equipped with landing wheels, pontoons or skiis depending on conditions under which they may be operating. The photographic detachments which carry out the work consist of two aircraft with cameras and full camping equipment, etc., so that they can be operated away from a base. The personnel consists of two pilots and three other ranks who in addition to being qualified air engineers are trained as camera operators. When the detachment is operating away from civilization a cook is also included in the establishment. A suitable base is selected within or near the area to be photographed and the detachment remains there until the operation is completed.

For the purposes of mapping by aerial photography the country is divided into sheets covering 1 degree latitude and 2 degrees longitude, or approximately 70 by 90 miles. These sheets are marked and flown in strips 6 miles apart and photographed obliquely. For this purpose a Fairchild model fully automatic K.3 or F.3 type camera is mounted in the front cockpit of a Vedette flying boat and suspended in a special anti-vibration mount which can be tilted or depressed to any desired angle; it can also be rotated so that the horizontal axis of the camera can be kept parallel with the horizon.

The mount in turn is attached to a carriage which slides on a semi-circular track on the rim of the cockpit in order that the camera can be swung around to an angle of 45 degrees either side. The sight which can be readily attached to the top of the camera consists of a rectangular negative lens with a vertical and horizontal cross hair mounted in a moveable frame and supported by trunnions, to which is attached a quadrant marked in degrees; a foresight is also provided which is detachable. The camera is fully automatic and is operated electrically, current being supplied through a switch-board from an engine driven generator. From four to six camera magazines are carried, each of which hold a roll of film 75 feet in length and sufficient to take 112 exposures, the negatives being approximately 7 by 9 inches. The focal length of lens used in oblique photography for mapping is usually 8 inches with apertures of F6.8 or F4. Twelve-inch lenses are also carried for the taking of scenic photographs; the types of lenses used are Ross Xpres, Goertz Dagor and Zeiss Tessar.

Oblique photographs are taken from a height of 5,000 feet and it is essential for mapping purposes that the horizon line be clearly shown parallel to and 7/10ths of an inch from the top of each photograph. For this purpose the camera operator sets the camera sight to an angle of approximately 18 degrees on the quadrant, then by sighting on the horizon and having the cross hairs on the negative lens and foresight in alignment, the camera is given the correct angle of depression to show the horizon the correct distance from the top of each photograph. Bayonet type optical flat filters are used on the front of the camera lens to penetrate haze and give a clear horizon line. A set of three photographs are taken every mile and a half, one being taken directly on the line of flight and one on either side at an angle of 45 degrees from the centre of the first one taken; this ensures a side as well as a front overlap. Inside the cockpit and underneath the track on which the camera is mounted there is a scale marked in degrees and when the aircraft is crabbing or drifting the centre photograph is deflected through the drift angle and the others accordingly.

On completion of a photographic flight the exposed rolls of film are packed up and forwarded to the Photographic section, Ottawa, for developing and printing and enclosed with each roll of film is a report and record giving particulars of weather, light condition, exposure, altitude, temperature before taking off, and at height chosen for photography, altimeter readings at the commencement of and end of each photographic line and on landing. Copies of these reports are forwarded to the Topographical Surveys for their information, where they are used in plotting to determine the exact scale of each photograph.

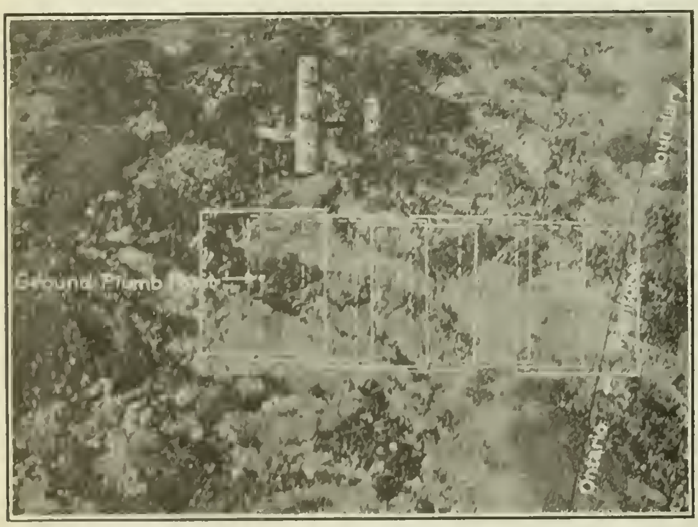

Fig. 1—Overlap of Vertical Pictures on a Strip.

Fig. 2—Installation of F.3 type Camera in Fairchild Cabin Monoplane for Vertical Photography.

Immediately the exposed films are received at the Photographic section, Ottawa, from photographic detachments on operations, they are developed and examined and a telegraphic report is sent back to the detachment giving them information regarding the quality of the film, overlap, crab, etc., and advising whether it is necessary to refly any line. After the films are dry, prints are made and forwarded to the Topographical Surveys where they are used in the making of the maps.

Prints which are required for mosaic purposes are corrected for scale and tilt and are also carefully matched to colour tone. Prints for filing are also supplied as a complete library and index is kept by the Topographical Survey department of all aerial photographs taken on government operations.

Vertical Aerial Photography

In the vertical operations carried out by the detachments of the Civil Government Air Operations the same type of cameras are used as in oblique photography, namely the Fairchild K.3 and F.3. As already mentioned, the camera platform used is a cabin type of plane, which can be fitted with either wheels, ski or floats. The camera is mounted vertically, that is, with the lens pointing vertically towards the earth's surface through a hole in the floor of the aircraft. The mount used is an adaption of the Fairchild gimbal mount which (in place of being suspended on rubber cushions to two cross bars placed above the hole in the floor of the aircraft through which the cone of the camera projects) fits into a circular metal container with sponge rubber to prevent vibration. This metal container fits around the edge of the hole, and is more or less a permanent fixture in the aircraft, being protected by a lid or cover which fits over the hole when the aircraft is not being used for aerial photography. The mount has a scale marked in degrees and the camera can easily be turned in either direction, through any angle of drift which may occur through crabbing of the aircraft.

The camera is electrically operated through a switch board as in oblique photography, but in addition an electrical timing device known as an intervalometer is used. This device automatically trips the camera shutter at predetermined intervals so as to ensure an overlap on each photograph, the interval being set by means of a dial on the intervalometer which is graduated in seconds. To obtain this interval accurately, which is most important in the taking of vertical photographs for mapping purposes, a special type of viewfinder is used which is really nothing more or less than a small camera having a ground glass on which a clear and distinct image of objects beneath the aeroplane are projected by means of a lens. Each viewfinder is provided with two or more ground glasses having lines engraved on them to correspond with the different focal lengths of lenses used on the camera. The viewfinder is operated on a ball and socket joint and has a scale marked in degrees to compensate for drift or crabbing of the aircraft.

In practice the finder is rotated on its ball and socket joint until an image of some object below the aircraft is travelling in a direction parallel to the lines which are ruled half an inch apart on the ground glass; these lines determine the true direction of flight and the amount of degrees the camera mount must be rotated to correct for crabbing. Two engraved lines at right angles to these drift lines are used to determine the exposure interval necessary for a 60 per cent overlap. The exposure interval is found by carefully noting the time this object (projected by the lens on the ground glass) takes to travel between the two engraved lines, this being the correct exposure interval for a 60 per cent overlap.

As already mentioned extra ground glasses are provided for different focal length lenses which must be changed to correspond with whatever lens is being used at the time. The sight is also provided with a level so that it can be kept on a vertical plane when timing the interval. Having determined the time interval, which is obtained by taking the mean of several trials, it is only necessary to set the dial on the intervalometer or electric timing device to the required number of seconds to operate the camera automatically.

In vertical photography the responsibility for keeping the machine on a level keel and flying straight lines rests entirely with the pilot. On reaching the height at which the photographs are to be taken, the camera operator levels his camera and determines the time interval through the sight so that the photographs will have the correct amount of overlap. The camera is then clamped and it is entirely up to the pilot to keep his machine flying level. The time interval is checked at various intervals throughout the flight and any variation is corrected on the intervalometer. A small light bulb on the pilot's dash board and one fixed near the camera operator flashes on a few seconds prior to each tripping of the camera shutter, and gives the pilot sufficient warning to keep his machine perfectly level during the period of exposure.

Fig. 3—Fairchild K.3 Camera Mounted in Vedette flying boat for Oblique Mapping Photography.

Eight, ten, twelve and twenty-inch cones are used in vertical photography depending on the nature of the operation being carried out, and optical flat filters are provided for the elimination of haze which is mainly caused by reflected light from water vapour, dust, smoke, etc.,

Fig. 4—Oblique Aerial Mapping View.

Fig. 5—K.3 Camera with 8-inch, 12-inch and 20-inch Cones.

suspended in the atmosphere, or by dry mollecules of the air itself; if filters are not used under these conditions this reflected light makes the first impression on the highly sensitive emulsion of the film and tends to reduce the necessary contrast in the negatives thereby producing flat indistinct photographs.

The same careful records are kept with reference to altitude and temperature readings, etc., as applies to oblique photographs.

In addition to this, where location of detachments permits such being done, prints of each roll taken by the detachment are returned to them for indexing and error tabulating. By means of special gauge cards made for this purpose the personnel of the detachments calculates the altitude percentage of overlap and degrees of crab and tilt of each photograph, and also keep an index map giving full particulars of each operation; this data is later sent to the Topographical Surveys department and is used by them in plotting the photographs.

During the operational season 1929-30, 26,130 square miles of vertical photographs were taken and 48,525 square miles of obliques. During the past summers operations 21,300 square miles of vertical photographs were taken and 32,800 square miles of obliques, or within the past two, a total area of 128,755 square miles have been covered by oblique and vertical photography.

Part II

A description of some of the early cameras used during and since the Great War and some of the latest developments in aerial photographic equipment.

C. Type

One of the first aerial cameras designed and used by the British during the war was the Model C. type. This camera, manufactured by the Thornton Pickard Company, was made entirely of wood and built to take plates not larger than 5 by 4 inches and lenses of not more than 12 inches in focal length. The plates were inserted in metal sheaths or septums and loaded one on top of another in magazines, each magazine holding from 12 to 18 plates. The shutter was of the simple focal plane type with a variable slit for different exposures and controlled by a spring with variable tensions. The lens, screwed into a flange in the cone of the camera, was of fixed focus and usually had an iris diaphram. The loaded magazine was locked on top of the camera and pulling out the sliding lid which was jointed and could be folded and locked on top of the magazine, allowed the plates to drop into position ready for exposure. By means of a sliding handle on top of the camera, the shutter was set and a sliding plate operated by gears pushed the exposed plate over into the other end of the camera where it dropped into an empty magazine. During the re-setting of the shutter curtain an opaque slide attached to the handle was drawn between the lens and the variable opening in the shutter blind and prevented the other plates becoming fogged; a tubular view finder with cross wires was attached to the side of the camera for sighting. This type of camera was adapted for vertical photography only, and was attached to the side of the aircraft by means of brackets; at a later period of the war it was used for training purposes in England, Canada and the United States.

E. Type

The E. type camera, an improvement on the C. type, was similar in many respects. It was made entirely of metal, however, and was less bulky owing to replacement of the opaque safety slide by a lens flap which worked automatically with the shutter. In place of the handle as used on the C. type camera, to change plates and re-set the shutter, provision was made for distance control by means of cords, and release of the shutter by means of a bowden wire.

L. Type

A further improvement in the last two types of cameras, which were non-automatic in their action, was the semi-automatic L. type. The same principle was used of carrying the unexposed plates in a magazine on top of the camera and pushing the exposed plate along on a horizontal plane until it dropped into an empty magazine. The principal difference was the addition of a mechanism whereby it could be connected up through a flexible cable to a wind driven propeller; provision was also made for attachment to an electric motor.

The focal plane shutter used in this camera was of the variable aperture type with a flap behind the lens to cap it during the setting of the shutter. The greatest fault in the cameras already mentioned was the frequent jams that occurred through bent plate sheaths or cracked and chipped plates, but despite these faults the L. type camera was used during the last two years of the war, and it was not until the closing months that an improved model, the L.B. type was constructed.

L.B. Type

The principal change from the L. type was the introduction of several interchangeable cones of different focal lengths. The focal plane shutter was also made removable and self-capping; the slit was variable from ¼ to 1½ inch to give various speeds. The changing of the plate and setting of the shutter could be done in a single movement by hand or by a wind-driven propeller; a bowden wire release of any length was also provided so that the operator could release the shutter at some distance from the camera. The gear driving mechanism, plate changer, and removable focal plane shutter was contained in the body of the camera; the lens was contained in the cones which as already stated were interchangeable and of various focal lengths, and were attached to the camera body by means of a bayonet type joint arrangement. A small wind-driven propeller, held by brackets in the slip-stream, and connected by a flexible drive to the camera, furnished the driving power. After an exposure the exposed plate was moved in a frame along the overhanging body extension to fall into the receiving magazine at the same time the shutter was re-set ready for the next exposure.

A. Type Hand Held Plate Camera

The types of cameras already described were used for vertical photography only and were not adaptable for oblique work. One of the earliest types of cameras used by the British during the war, and adapted for both oblique and vertical photography, was the A. type hand held plate camera, manufactured by the Thornton Pickard Company. It was made of wood and had a lens of 8-inch to 10-inch focal length and a focal plane shutter. It was adapted for 4 by 5 plates and was provided with a tubular view finder.

P. Type Hand Held Camera

Another type of hand held camera used during the war was the P. type which was made of metal with a fixed cone and lens of 8½ to 10½ focal length. It was provided with a variable slit focal plane shutter with fixed tension and was made for 4- by 5-inch plates; a handle and strap

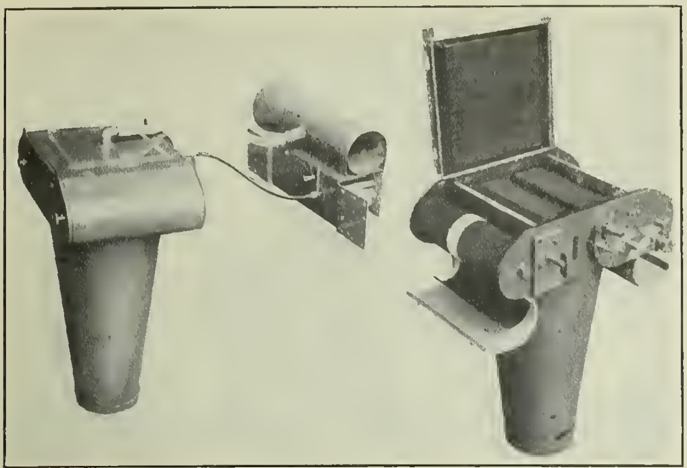

Fig. 6—Eastman K.1 Type Camera.

were provided to hold the camera, and a direct vision open sight was attached to the body and could be folded back when not in use.

THE GERMAN ICA HAND HELD CAMERA

This camera used during the war was fitted with a special type of removable shutter; four slits in the shutter provided four speeds varying from 1/90th of a second to 1/750th of a second. The shutter blind could be set at any slit to give the speed desired and an indicator was provided showing the speed markings. A capping device protected the plates when the shutter blind was being re-set. The magazines carried six plates 13 by 18 cm., the exposed plate being changed by withdrawing and pushing back the end of the magazine; handles were provided to hold the camera and an open vision view finder with fore-sight which could be folded back when not in use was also provided.

SOME LATER TYPES OF HAND HELD CAMERAS

EASTMAN A.1 TYPE FOR PLATES AND CUT FILM

This type of camera is made entirely of aluminum; it is fitted with a 10-inch Hawk Eye lens with an aperture of F4.5 and of fixed focus. The shutter is a focal plane type with a fixed slot and variable spring tension, and exposures can be made varying between 1/120th to 1/435th of a second. The camera body is adapted to take Graflex plate magazines, Graflex cut film magazines or Graflex roll film magazines of 4- by 5-inch size. The plate and cut film magazines have a light-proof leather bag attached into which the exposed plate or film is pulled by means of a metal slide; the bag is then gripped and the exposed plate or film is pushed back into the magazine behind the unexposed ones, this operation being carried out until all twelve exposures are made; an indicator on the side of the magazine records the number of exposures. The sight is of the tubular variety fitted with cross wires and is readily attached to the body of the camera. This type of camera was used in early operations carried out by the Air Board and a few of these cameras are still in use for scenic oblique work by the Civil Government Air Operations.

EASTMAN K.1 CAMERA

This type of camera, of metal construction, is made to take rolls of film 75 feet in length and sufficient for a hundred exposures of a size of approximately 7 by 9 inches. It is automatic in its action, the motive power being derived from a wind motor box which is attached by brackets to the side of the aircraft. A rotary paddle wheel is contained in the lower half of this box which is connected to a gear box on the camera by means of a flexible drive. The upper half of the box contains the venturi tube which is connected by rubber tubing to a suction head on top of the camera body. A graduated quadrant, with a lever to which a metal shutter is attached inside the box, controls the passage of air through the tunnel and acts as a damper control by which intervals between exposures may be governed. The body of the camera, which is also the film magazine, is equipped with a fixed aperture focal plane shutter with varying exposure from 1/90th to 1/310th of a second. Cones of varying focal lengths, and equipped with Hawk Eye lenses, with apertures of F4.5 can readily be attached to the camera body and are interchangeable with other cameras of this type. The film is held flat during exposure by means of a vacuum back which opens up on top of the camera body. The inside of this vacuum back has a perforated platen connected up by a suction head to the venturi tube in the wind motor box, the film being held flat against this platen by suction during exposure.

This type of camera was used in government surveying until 1923-4, when it was replaced by the Fairchild "between the lens shutter" camera.

THE WILLIAMSON PISTOL GRIP CAMERA

The camera body is made entirely of aluminum and is fitted with a Ross Xpres lens of 5-inch focus and an aperture of F4.5. The shutter is a sector type fitted between the lens combination and is adjustable for speed and aperture, the maximum speed being 1/100th of a second. The camera body is adapted to take plate holders, film pack adapters or roll film holders. A focusing screen with hood is also provided. The size of the picture taken is 2¼ by 3¼ inches. A brilliant view finder is built into the top of the camera which gives the correct view when the eye is approximately 6 inches from the back of the camera.

FAIRCHILD MODEL F.4 AERIAL CAMERA

This is a late type semi-automatic hand operated camera. It is equipped with a focal plane shutter of constant speed which tends to prevent distortion. The shutter speeds are adjustable and range from 1/75th to 1/225th of a second. A capping device for the lens works in conjunction with the shutter inside the cone. The lens is a 12-inch Zeiss Tessar F4.5 and is fitted with a diaphragm and focusing mount so that the camera can be used for taking ground pictures. The lens is provided with a locking device and can be locked at infinity when taking aerial views; lenses of various focal lengths can be interchanged with the standard cone of 12 inches supplied with the camera. Interchangeable magazines are provided for this camera which takes a roll of film 75 feet long suf-

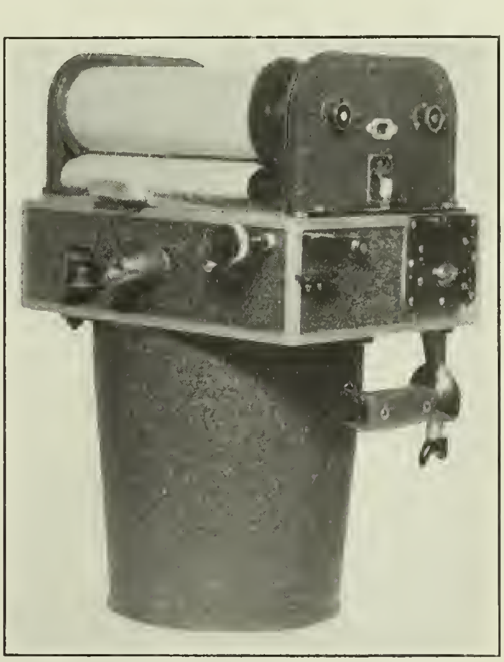

Fig. 7—Fairchild F.4 Type Camera with Magazine Cover Removed.

ficient for a hundred and twelve exposures, each exposure being 18 by 24 cm., or approximately 7 by 9 inches. The magazine is the standard Fairchild K.3 pattern with an automatic spacing unit which spaces the exposures equally throughout the entire roll, and an optical flat glass through which the pictures are taken; an automatic pressure plate holds the film securely and firmly against this glass during exposure and releases when the film is being wound for the next exposure. The camera is hand operated but is so constructed that it can be used for vertical as well as oblique photography. A negative lens sight is provided which can readily be attached to the body when used for oblique work.

French Aerial Camera Type Planiphote

This camera has been designed for the French Air Service and can be operated either automatically or semi-automatically. It is fitted with a Labrely shutter. The shutter consists of a number of very thin steel blades about 1 cm. wide. These blades operate like the slats in a Venetian blind, but only cut off a very small portion of light when they are stationary and parallel to the optical axis. There are eight blades pivoted on their longitudinal axis. All of the blades are connected together and operated by rods at each end. The rods in turn are operated by a cross shaft with a maltese cross shaped cam engaging with a second shaft, carrying a cam with two merging arms, which makes a three-quarter turn for each exposure During the three-quarter turn the shutter blades open, remain stationary, then close. The next exposure is precisely the same, but made in the opposite direction. This shutter is claimed to pass 80 per cent of the possible light; the exposure can be changed but is usually 1/150th of a second.

In the Planiphote magazine the film is stretched like a drum skin at the moment of exposure. This action is obtained by locking the winding reels and lowering a frame against the back of the film. This frame stretches the film and is claimed to give a plane surface as good as is obtained with plates. After exposure the frame is raised and the winding reels unlocked. The magazine is made for two hundred exposures on film 18 by 24 cm. A counter is provided for registering the exposures.

The cone of the camera carries a motor of 1/25 h.p. at 24 volts, driving gear, regulator for intervals varying from 5 to 60 seconds, shutter, lens focal length 30 cm. f.5.7., diaphragm, gear connecting shutter and magazine, suspension frame and a yellow screen.

French Military Type Camera by Demaria-Lapierre

This type of camera is used by the French Military Air Service. It uses a plate or film 18 by 24 cm., and a lens of 30 cm. focal length; magazines for 12 or 24 plates, or for a film of two hundred exposures are used. The shutter is of the focal plane type with ball bearings. The lens has an iris diaphragm and provision is made for a yellow screen. The body of the camera is entirely metallic in the form of a rectangular pyramid. A lens cover in the form of a metal flap open during exposure is used which can be fixed to remain open if desired. The shutter and lens cover are operated by a bowden control, and the speed of the exposure can be regulated. The plate magazine is of the sliding drawer type and the film magazine is of the same type as used on the Labrely camera.

Eagle Camera Type F.8 Mark II

This type of camera is used by the Royal Air Force and can be operated either manually or automatically by mechanical or electric controls which can be placed at a distance from the camera.

The camera is made entirely of metal and has interchangeable cones with lenses of various focal lengths. Interchangeable magazines are provided which take a roll of film sufficient for one hundred exposures, the size of each photograph measuring 7 by 8½ inches.

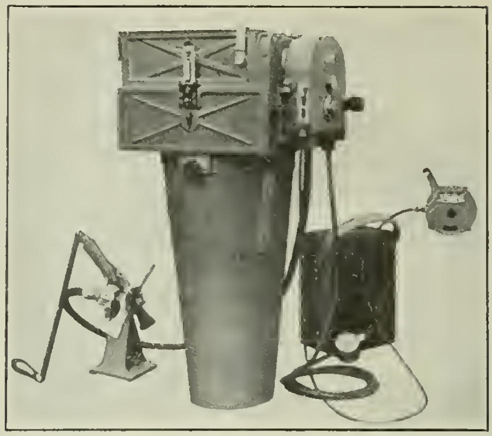

Fig. 8—Williamson Eagle Camera.

The body of the camera contains an optical flat glass through which the photographs are taken, the film being held flat against this glass by means of a pressure plate inside the magazine. The top surface of the casting surrounding this glass is in the plane of the focal register and therefore ensures the retention of the lens in correct focus. The shutter is of the focal plane type and operates close up to the focal plane glass in the camera body thereby providing greater efficiency than in the ordinary type of focal plane shutter. The shutter is also equipped with a braking device which ensures an even exposure over the whole photograph; it has a fixed speed of 1/90th of a second but interchangeable shutters can be provided with speeds varying from 1/40th to 1/120th of a second. All units of this camera are interchangeable and can readily be replaced if necessary. The camera can be operated by hand, electrically or by a wind-driven propeller and the timing between exposures can be controlled automatically by an electric control box which also shows the exact number of exposures taken; warning lights are also provided to enable the pilot to level his machine prior to an exposure being made.

Eagle Camera, Mark I

Another model of this camera, the Mark I, is identical in design but the body of the camera is constructed to take an instrument box containing a Veeder counter aneroid registering from 0 to 15,000 feet, two-way spirit level, a thirty-hour watch and an ivorine tablet on which useful data can be written; instruments are illuminated by small electric lamps and wide aperture lenses automatically records an image of these instruments on the side of every photograph taken by the camera.

Wilde Air Camera

This camera, manufactured by the Henry Wilde Surveying Instrument Supply Company, Switzerland, is built along precision lines for accurate aerial survey work. It is adapted for plates only and made entirely of metal, the body being a one-piece casting. The shutter is a between the lens type consisting of two blades only and one speed, a 1/100th of a second. The frame top of the camera body against which the plates are pressed during exposure has markers in the centre of each side and by intersecting lines through these markers the principal point can be obtained on each photograph. A stencil in one corner of this frame shows the camera number on each exposed plate while a set of small glass wheels in the lower left corner automatically register a reference number. The shutter is set by pushing down on this frame, the frame automatically springing back again into its former position after each exposure.

The magazines are of the drawer type and hold ten plates in metal sheaths of a size approximately 5 by 5 inches. To change a plate after exposure the drawer with all the unexposed plates is pulled out by a handle, the exposed plate remaining in place on the camera frame. When the drawer with the unexposed plates is pulled out far enough to clear, the exposed plate is snapped to the top of the magazine by two strong springs which come into play by the withdrawl of the drawer. A numbering device on the side of the magazine registers the number of plates exposed. When the magazine is in place, pushing it down on the camera body sets the shutter. A special locking device prevents the magazine drawer being pulled out after the tenth exposure thereby preventing exposing the plates twice over. Another device prevents the magazine being removed from the camera body before the magazine light slide is closed.

Special sights are provided on the camera and an elaborate camera mount with scales for drift, depression, etc., for accurate surveying work. Two rigid handles on the sides of the camera provide an excellent grip when the camera is being hand held for oblique pictures; a direct vision cross-wire sight, attached to the body, can be locked back when not in use.

Fairchild Model K.3 and F.3 Type Cameras

The K.3 and F.3 type of cameras are used on all photographic operations carried out by the directorate of Civil Government Air Operations. The principal difference, apart from minor changes in the two types, is the position of the focal plane glass plate. In the K.3 camera this plate is contained in the camera magazine, whereas in the F.3 type it is contained in the camera body, the latter type being considered the more accurate for topographical mapping.

The two types of cameras, which are fully automatic, consist of three principal parts: the magazine, the camera body or case, and the cone.

The magazine, which is built to take a roll of film 75 feet long capable of making 112 exposures, approximately 7 by 9 inches, contains the magazine drive, the pressure plate, the focal plane glass plate (in the K.3 type of camera), the light slide and a dial which shows the approximate amount of film exposed. The magazine drive spaces the film between exposures and automatically raises and lowers the pressure plate thus ensuring perfect contact of the film with the focal plane glass plate during exposure, and preventing movement or distortion.

The camera body or case contains a 12-volt motor, the main camera drive, exposure counter, levels, shutter speed adjusting dial, electrical connections, winding handle, trigger and magazine locking bar. The functions of the main drive mechanism, which is driven by the motor, is to control the motor circuit, re-wind the shutter after each exposure, and wind the magazine drive which is connected to the main drive when the magazine is locked in place on the camera body.

The cone, which is attached to the camera body by four screws, contains the adaptor for holding the shutter which is the Fairchild "between the lens" type consisting of five blades linked to a cam operating between the lens elements. A positive inertia retarding device provides three shutter speeds, 1/50th, 1/100th, and 1/150th of a second. This device comes into operation only when the shutter leaves are fully open, and disengages before they start to close, which gives the shutter a high efficiency. Attached to the sides of the cone are two trunnion arms for supporting the camera in the vertical mount.

Multiple Lens Cameras

Fairchild Model T3A 5-Lens Camera

This camera is one of the latest developments of the Fairchild Aerial Camera Corporation, New York. It consists of five separate chambers each with its own lens and magazine containing separate rolls of film. The camera is operated by hand, a turn of the handle winding

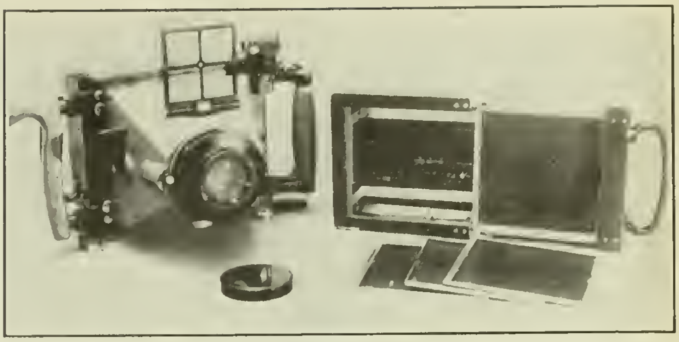

Fig. 9—"Wilde" Air Camera.

all five shutters simultaneously and bringing fresh film into place in the magazines ready for exposure. The centre lens is set vertically the other four being set at an angle so that the full coverage angle of view is approximately 86 degrees. The size of pictures taken by the centre lens is 5½ inches square; the side pictures are 5½ by 6½ inches. The lenses used are 6-inch Goertz Dagor F6.8, each lens being fitted with an Ilex shutter which is tripped simultaneously by a single tripping lever. The film is held flat in the magazine by means of a special vacuum back. A stop watch is built into the body of the camera for timing overlapping photographs; also a circular bubble level. In the camera mechanism a special spacing device spaces each film automatically and 190 exposures can be made at one loading. A special mount is provided for suspension of the camera in aircraft.

Automatic Interval Finder

Another recent development in aerial photographic apparatus is the Fairchild automatic interval finder. This instrument is a combination view finder and intervalometer and is somewhat similar in design to the Fairchild's vertical view finder previously described.

The timing mechanism operated by a small motor is contained on the side of the cone or body of the instrument which also contains the lens and ground glass screen and operates a wire which travels directly under and close to the ground glass screen. The speed of this wire is controlled by a rheostat so that it can be synchronized with some picked object on the ground, an image of which is thrown on the ground glass screen by the lens.

As soon as the speed of the wire coincides with this object, the camera is automatically tripped by means of an electrical control to ensure a 60 per cent overlap on every picture taken, the wire springing back to commence its travel over again after each exposure.

A dial on top of the instrument is engraved with different focal lengths of lenses and when set to whichever focal length lens is being used on the camera controls through the mechanism the length of travel of the wire.

Signal lights which flash on a few seconds prior to every exposure give warning to the pilot and camera operator to keep the camera on a level plane during exposure.

The ground glass screen on this instrument is engraved with drift lines half an inch apart; also a line at right angles to the drift lines marks the commencement of travel of the automatic wire. A wire on top of the ground glass is also provided and can be set to correspond with whatever focal length of lens is being used on the camera, the elapsed time as object takes to travel between the engraved line at right angle to the drift lines, and this wire can be taken by stop watch to insure an additional check of the time interval where necessary. The finder is operated on a ball and socket joint and is provided with a scale marked in degrees to compensate for drift; a circular level is also provided.

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The Engineer and Economic Problems

It is generally agreed that in the more civilized portions of the world, at any rate, the last half century has been remarkable for a general improvement in the physical well-being and standard of comfort of the average citizen, a development that has perhaps been more marked in North America than elsewhere but has also taken place in most of the European countries. Based originally on the work of the early inventors and the development of the steam engine, and carried forward with increasing speed as soon as the inventor joined hands with the man of science and the trained engineer, the movement has now enabled industry to furnish mankind with facilities for communication and transportation and with material comforts undreamed of fifty years ago. Better living conditions now exist; people are better housed and fed; control has been established over many diseases; education has advanced, and the distribution of wealth, with the material advantages it brings, has become more general.

For many of these changes the engineer is given credit, and rightly so, but if he leaves for a moment his preoccupation with the material requirements of mankind and begins to look round, he is struck with the fact that our industrial and scientific advance has not been accompanied by an equally satisfactory development of our economic organization. While it is true that the general standard of comfort has improved and that great changes have taken place for the better in working conditions in all lines of industry, it is evident that much still remains to be done. The factory or office worker still fears unemployment. The farmer has no assurance that he can sell his produce when he has harvested it, the investor feels insecure. At the present time there are people in need of food, while quantities of food-stuffs are available which cannot be sold for want of purchasers. Millions of men are anxious to work, capital and well-equipped factories are ready for them, but things do not move, and so they are not earning the money with which they could buy the products of the industry of others. Sooner or later, no doubt, our economic system will begin to function again with some approach to its former efficiency, but no one seems able to tell us when or why this will take place. Our social system has developed and improved, but apparently not along lines which are controllable.

Of late years there has been a tendency on the part of some to blame the engineer for such unsatisfactory happenings as business depression, unemployment and the like, presumably on the ground that as the industrial revolution and our mechanized civilization are largely the engineer's work, he should take the responsibility for their unpleasant as well as their pleasant results. It has even been suggested that the engineer, who has already accomplished so much, ought to organize the economic development of humanity and employ his analytical skill to plan all the readjustments necessary to make the future secure. But is this really his job? What about the statesmen, economists, sociologists, financiers, bankers and industrialists? It is true that in turn all of these experts have been struggling with the problem, have put forward many explanations and suggestions, and so far, while more or less unanimous in destructive criticism, have failed to agree on any constructive course of policy which will remedy our troubles. After all, should they not really take the lead as being best acquainted with the situation? They are in fact the persons most closely concerned in finding answers to these pressing questions and by training and experience should be best qualified to deal with them.

These reflections are suggested by the encouraging fact that leading engineering societies on both sides of the Atlantic are welcoming communications on economic topics. It is most desirable that engineers should apply themselves seriously to the consideration of economic problems as they affect industrial work. Two thoughtful addresses (*) on this subject delivered at a recent meeting of the American Society of Mechanical Engineers will repay careful study. One was by a prominent engineer, the other by an eminent economist. The former propounded some of the questions which suggest themselves to anyone concerned with the improvement of social conditions in connection with industry, and the latter explained the very serious difficulties standing in the way of providing answers to them. "How far are our present troubles due to speculation," asked the engineer. "Should people be thrifty or should they spend freely? What hinders industrial activity when everybody concerned is anxious to resume production?" Such problems as these will not settle themselves, and it is somewhat discouraging to find that the professional experts either cannot reply to such questions, or, if they do, show a hopeless diversity of opinion. But why should not a new profession arise, employing the engineer's methods of basic research and analysis and applying them in this new field? Its practitioners would deal with the action of economic forces on humanity rather than with the effects of physical forces upon materials, and as a result of their investigations, the problem of economic control would be attacked with extended knowledge and

*Mechanical Engineering, Feb. 1931, pp. 99-110.

from new viewpoints. If we accept this suggestion, it is evident that the engineer can help in this great task, and the question arises, how can he best do so.

The economist whose address followed that of the engineer naturally stressed the difficulties presented by economic problems, and while admitting the progress already made in social well-being, painted rather a discouraging picture of the complicated workings of the present economic machine. In his opinion the mystery is, not that our economic system now and then gets badly out of order, but rather that most of the time it actually runs after a fashion. Speaking for the economists, he admits that hitherto they have been critics rather than constructors, that they have not as yet sufficient knowledge of human behaviour to predict accurately the result of any given policy, and that up to the present, their theories have commanded very little support from people who are in a position to apply them. They can, in fact, "make headway with economic reforms only so fast as a large part of the public gets enlightened enough to sustain us or we get enlightened enough to carry a large part of the public with us."

Before an economist's proposal for a major change in economic method can even be tried in practice, it is necessary to persuade, not merely the management of a single business enterprise, but governments, politicians and millions of individuals.

For example, take the views expressed by a noted British economist, who states that the present industrial depression, unlike those which have preceded it, is principally due to the four years' cessation of production during the war. At that time, vast credits were established, on which the world has been living, and which are now exhausted, so that debtor countries are no longer able to finance their purchases. Tariff barriers almost everywhere prevent the debtors from making payment to the creditor countries otherwise than in gold, which they do not possess, and in consequence world commerce is paralysed. We are told that our only salvation is the universal abolition of these tariff barriers, thus providing all possible facilities to help the debtors to pay their debts. This is the considered recommendation of an economist, and the reception it is likely to get from the world at large may be judged from the fact that the tariff structure of which he complains has been built up everywhere in the face of the unanimous and continuous opposition of economists. Its demolition then would involve a complete change of heart on the part of almost all the leading countries of the world. Evidently we have not yet arrived at the point where economists alone can produce schemes which will meet with adoption in a reasonable time. For progress we must depend upon the co-operation of the economist with the financier, the business man and the industrialist.

The engineer can aid in this great task by convincing the public that it is physically possible to increase production, communication and transportation facilities to any extent required for the world's material welfare, and by pointing out that the difficulties which stand in the way of a world-wide rise in the level of material comfort for mankind are not technological, but depend on the peculiarities of human nature. Next, the engineer must aid the economists and other experts in the educational programme which is needed to give the average citizen, business man, or investor a better knowledge of the possibilities of industrial production, a more altruistic outlook, a greater readiness to study any proposals which appear to offer adequate solutions, and a more constructive attitude of mind.

Report of Committee on Classification and Remuneration of Engineers

Approved for Publication by Council at its Meeting held on March 24th, 1931.

The President and Council,—

Following instructions to prepare a revised edition of the 1922 report on classification, remuneration and tariff of fees of engineers, your committee issued a questionnaire to all corporate members and juniors requesting information regarding their education, engineering experience, and remuneration. There were 1,135 replies received to this questionnaire, representing 30 per cent of the number sent out, and your committee has made a complete analysis and study of all the information obtained in this manner, and the complete record of data and analysis is forwarded in the form of an appendix hereto.

The definite impression was obtained that the replies gave an excellent "cross-section" of conditions regarding remuneration in the engineering profession. They were uniformly distributed on the basis of years of experience from three years up to twenty-seven years. Beyond this point, say up to forty years' experience, there were still quite a large number of replies.

Of the total replies received it was found that 80 per cent came from college graduates and 20 per cent from non-graduates, and broadly speaking, the studies were made on the basis of keeping these two classes separate.

The conclusions of your committee are as follows:—

(*a*) That no useful purpose could be served by the preparation or repetition of a classification system. This conclusion was reached after careful study of the existing classification, but it was felt that in an organization representative of so many different branches of engineering endeavour it would be impossible to prepare a classification system without going into volumes of comparisons, definitions, and so forth, and that as soon as the classification became lengthy it would lose its value. As a basis of comparison therefore, years of experience were used throughout the analysis.

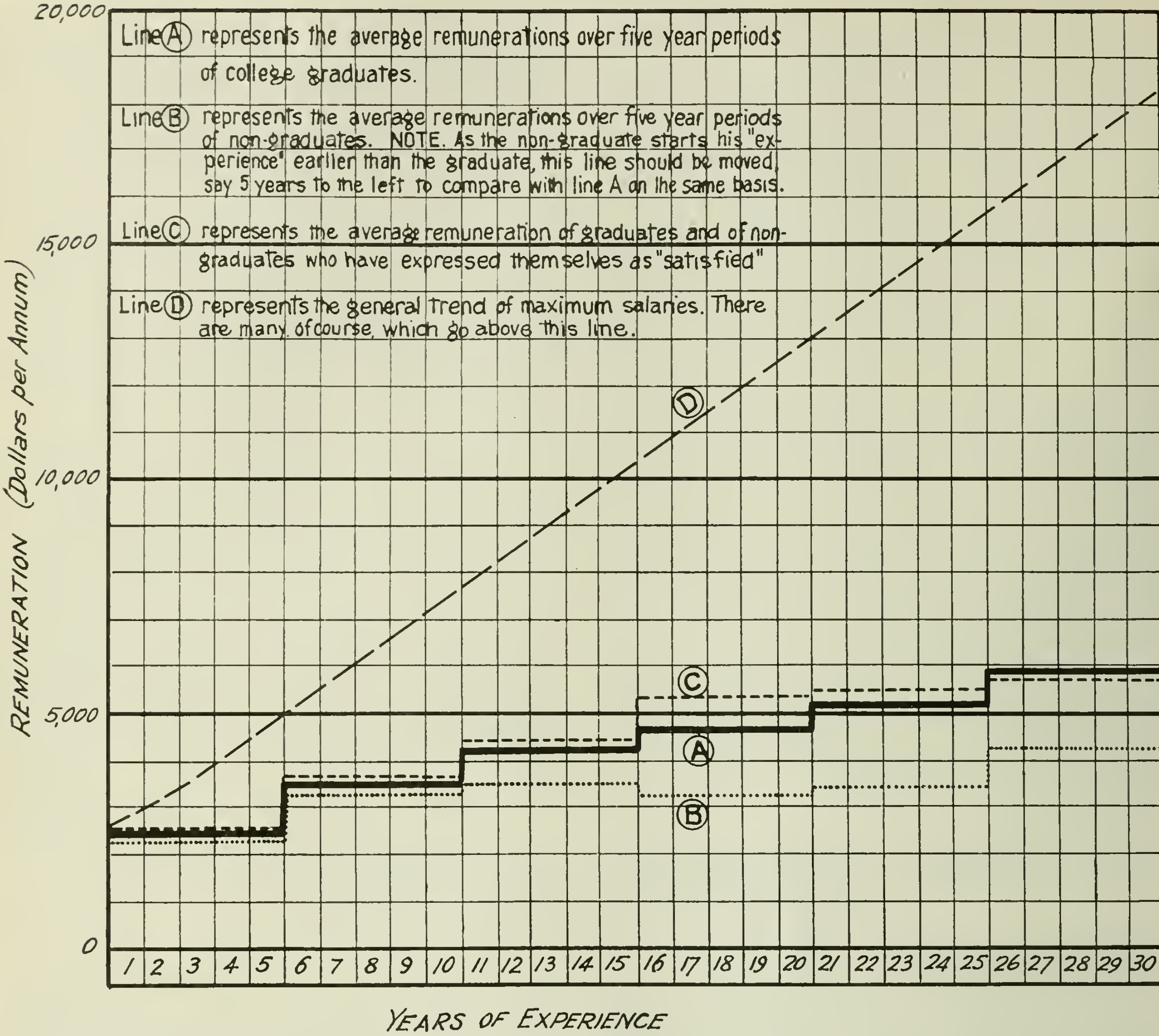
(*b*) That college graduates earn more than non-graduates.

(*c*) That the majority of college graduates express themselves as being satisfied with their remuneration, while in the case of non-graduates the opinion was equally divided between those who were satisfied and those who expressed the opinion that they were underpaid.

(*d*) That 5.4 per cent of the replies to the questionnaire reported remunerations exceeding $10,000 per annum, and the following table gives the nature of positions held by recipients thereof:—

Consulting Engineers	20
Executives	12
Chief Engineers	8
Contractors	5
Construction Engineers or Superintendents	5
Research Engineers	3
Not Stated	3
Sales Engineers	2
Plant Superintendents	2
College Professors and Consultants	1

It may be of interest to note that more than half of this group have had at least twenty-five years' experience since graduating.



(*e*) That graduates and non-graduates on the average earn the following remunerations:—

Years of Experience	Average Remuneration of Graduates	Average Remuneration of Non-Graduates	Average Remuneration of all Engineers who Expressed Themselves as Being Satisfied
1- 5	$2,462	$2,160	$2,587
6-10	3,410	3,151	3,486
11-15	4,138	3,415	4,341
16-20	4,674	3,113	5,343
21-25	5,094	3,344	5,496
26-30	5,963	4,132	5,740
31 and over	6,645	6,062	9,595

In explanation of the foregoing figures, it might be mentioned that in order to obtain representative figures, one extreme high and one extreme low remuneration in each year was eliminated before computing the average of the remainder. The average is really a weighted average in that it represents the summation of all salaries divided by the number reporting.

Attached hereto is a diagram on which is indicated in graphic form the average remunerations of graduates, non-graduates, and of those engineers who have expressed themselves as satisfied. In addition, a line in shown indicating the general trend of maximum salaries—this line, of course, is purely arbitrary, and there were a great many reports received of remunerations considerably above this line.

Attention is drawn to the fact that the foregoing figures are actually a fair application of the law of supply and demand; in other words, they definitely represent the ordinary market conditions as far as engineering services are concerned.

(*f*) That the order of the different branches of the profession from the best paid to the lowest paid is as follows:—contracting, industrial, electrical, mining, mechanical, civil.

(*g*) That the order by nature of employment from the best paying to the lowest paying is as follows:—consulting, sales, companies, teaching, municipal, government.

(*h*) That the majority of engineers do not reach the highest positions until they have had at least twenty-five years' experience.

(*i*) That the presentation of the facts regarding actual remunerations will be of greater value than any arbitrary recommended schedule of salaries.

Respectfully submitted,

Dec. 17th, 1930. J. L. Busfield, M.E.I.C., *Chairman.*

Meeting of Council

A meeting of Council was held at Headquarters on Tuesday, April 21st, 1931, at eight o'clock p.m., with Vice-President O. O. Lefebvre, M.E.I.C., in the chair and five other members of Council present.

On the suggestion of F. H. Peters, M.E.I.C., it was arranged that a copy of the report of The Institute's Committee on Remuneration should be forwarded for the confidential information of the Royal Commission which, under the chairmanship of Mr. E. W. Beatty, is investigating and reporting upon Civil Service matters.

Further discussion took place as to the date of the Plenary Meeting of Council, representations having been received from some members that the dates selected are not the most convenient. The Secretary was directed to communicate further with councillors regarding this matter. Discussion also took place regarding the best means of defraying the expense of this meeting.

Following the suggestion of Fraser S. Keith, M.E.I.C., chairman of The Institute's Committee on Engineering Education, the Secretary was directed to communicate with the various universities to ascertain whether they would take part in a conference on Engineering Education to be held in Toronto in February next at the time of the Annual General Meeting of The Institute.

The membership of the Leonard Medal Committee was approved as follows:

F. W. Gray, M.E.I.C., Chairman
F. D. Adams, Hon.M.E.I.C.
L. H. Cole, M.E.I.C.
S. C. Mifflen, M.E.I.C.
W. S. Wilson, A.M.E.I.C.

It was noted that K. L. Dawson, M.E.I.C., had accepted membership on the Papers Committee to represent the Maritime branches.

The examiners for the Students' and Juniors' Prizes, as submitted by the chairmen in the various zones, were approved as follows:

Zone A	Vice-President H. B. Muckleston, M.E.I.C.,	Chairman
H. N. Ruttan	Councillor R. W. Ross, A.M.E.I.C.,	Edmonton
Prize	Councillor N. M. Hall, M.E.I.C.,	Winnipeg
Zone B	Vice-President T. R. Loudon, M.E.I.C.,	Chairman
John Galbraith	Councillor D. M. Jemmett, A.M.E.I.C.,	Kingston
Prize	Councillor L. W. Wynne-Roberts, A.M.E.I.C.,	Toronto
Zone C (English)	Vice-President W. G. Mitchell, M.E.I.C.,	Chairman
Phelps Johnson	Councillor F. A. Combe, M.E.I.C.,	Montreal
Prize	Councillor J. A. McCrory, M.E.I.C.,	Montreal
Zone C (French)	Vice-President O. O. Lefebvre, M.E.I.C.,	Chairman
Ernest Marceau	Councillor Hector Cimon, M.E.I.C.,	Quebec
Prize	Councillor B. Grandmont, A.M.E.I.C.,	Three Rivers
Zone D	Vice-President F. R. Faulkner, M.E.I.C.,	Chairman
Martin Murphy	Councillor G. C. Torrens, A.M.E.I.C.,	Moncton
Prize	Councillor A. L. Hay, M.E.I.C.,	Glace Bay

J. A. McCrory, M.E.I.C., the chairman of the Publication Committee, presented that committee's report regarding the publication of a volume of Transactions. This report, which recommends the inclusion in this volume of twenty-six papers selected by the committee, was approved, and the Secretary was directed to prepare for the publication of the volume and to submit prices to the Finance Committee. The volume will be forwarded to the members free of charge, bound copies being available at cost of binding.

It was unanimously resolved that Messrs. W. McG. Gardner, A.M.E.I.C., H. Massue, A.M.E.I.C., and H. G. Thompson, A.M.E.I.C., be appointed scrutineers to canvass the ballot for the amendments to the By-laws, returnable on May 4th, 1931.

The Council noted with regret the death on March 30th, 1931, of R. W. E. Loucks, A.M.E.I.C., for many years secretary-treasurer of the Saskatchewan Branch of The Institute, and recently elected to represent that branch on Council. The following resolution was unanimously passed, the Secretary being directed to send a copy to the family:

"The Council of The Engineering Institute of Canada has learned with deep regret of the death of Roy William Egbert Loucks, so recently elected councillor by the Saskatchewan Branch. Always actively interested in Institute affairs, his valuable services for many years as Secretary-Treasurer of the Branch are gratefully recognized. The Council desires to record the loss sustained by The Institute and to express sympathy with his family on their bereavement."

In connection with the presentation of the first awards of The Engineering Institute of Canada Prizes the following were nominated to represent The Institute at the convocations of the various universities:

University of Alberta	R. W. Ross, A.M.E.I.C.
University of British Columbia	P. H. Buchan, A.M.E.I.C.
Ecole Polytechnique	O. O. Lefebvre, M.E.I.C.
University of Manitoba	J. G. Sullivan, M.E.I.C.
McGill University	D. C. Tennant, M.E.I.C.
University of New Brunswick	W. J. Johnston, A.M.E.I.C.
Nova Scotia Technical College	J. L. Allan, M.E.I.C.
Queen's University	Major L. F. Grant, M.E.I.C.
Royal Military College	D. M. Jemmett, A.M.E.I.C.
University of Saskatchewan	J. E. Underwood, A.M.E.I.C.

It was noted that at the University of Toronto no formal presentation of prizes is to be made.

The newly elected officers of the Toronto and Lethbridge Branches were noted.

Four resignations were accepted; two reinstatements were effected, and three 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	
Associate Members	5	Assoc. Member to Member	1
Juniors	3	Junior to Assoc. Member	4
Students admitted	5	Student to Assoc. Member	3
		Student to Junior	7

The Council rose at ten forty-five p.m.

OBITUARIES

Roy William Egbert Loucks, A.M.E.I.C.

It is with deep regret that the death is recorded of Roy William Egbert Loucks, A.M.E.I.C., which occurred at Regina, Sask., on March 30th, 1931.

Mr. Loucks was born at Meaford, Ont., on October 31st, 1884, and was educated at the public schools there, later teaching for two years prior to taking a course in civil engineering at the University of Toronto, graduating in 1908 with honours.

Mr. Loucks was a Dominion, Saskatchewan and Alberta land surveyor, and for some time in 1909-1910 he did mining prospecting in the north of Saskatchewan and also surveying work in the extreme north. In 1911 he was assistant to L. W. Brown on Saskatchewan land surveys and general engineering for municipalities. Later he organized the Northwest Construction Company at Saskatoon, and in 1913 established the engineering firm of Brown and Loucks in that city.

Mr. Loucks became a Student of the Canadian Society of Civil Engineers on June 12th, 1909, and transferred to Associate Membership on September 19th, 1916. He took an active interest in the affairs of The Institute and was for a number of years Secretary-Treasurer of the Saskatchewan Branch. Mr. Loucks was the representative of the Saskatchewan Branch on the Council of The Institute for the year 1931-1932.

Joseph William Hayward, M.E.I.C.

The death is recorded at Ste. Anne de Bellevue, Que., on April 14th, 1931, of Joseph William Hayward, M.E.I.C.

Mr. Hayward was born at Winchmore Hill, England, on January 24th, 1875, and was educated at Manchester University, graduating with the degree of B.Sc. with honours, in 1895, and securing the degree of M.Sc. in 1898.

During the years 1898-1902 he was engineering laboratory assistant at Armstrong College, Newcastle-on-Tyne, and in 1902-1906 he was chief engineering laboratory assistant at Central Technical College, South Kensington, London. Coming to Canada, Mr. Hayward was appointed assistant professor of mechanical engineering at McGill University, Montreal, and remained in that position during the years 1906-1908. In 1911-1912 he was engaged on a report on the harbour at Fanning island in the Pacific ocean for Mr. C. N. Armstrong, of Montreal, and in 1915-1916 he was chief assistant resident engineer for Sir Douglas Fox and Partners during the construction of the Royal Naval Cordite Factory, at Holton Heath, England. Returning to this country in 1916, he was engaged until 1918 as engineer of design and construction with British Acetones, Ltd., at Toronto, and later was designing engineer for the Canadian and American Electro Products Factories at Shawinigan Falls, Que. In 1921-1924 Mr. Hayward was instructor in machine design with the College of the City of New York, New York. In 1925 he collaborated with Professor Howard T. Barnes, M.E.I.C., in the preparation of a report upon the formation and movement of ice in the St. Lawrence river for the Hydro-Electric Power Commission of Ontario. For the past few years Mr. Hayward has been engaged in educational work.

He joined The Institute as an Associate Member on May 2nd, 1907, and transferred to full Membership on September 15th, 1925.

Mike Dmytro Olekshy, Jr.E.I.C.

Regret is expressed in recording the death at Wetaskiwin, Alta., on March 10th, of Mike Dmytro Olekshy, Jr.E.I.C.

Mr. Olekshy was born in the Western Ukraine, Europe, on September 12th, 1902, and, coming to this country in 1907, received his education at the Victoria High School, Edmonton, Edmonton Normal School, and the University of Alberta, graduating from the last-named institution in 1930 with the degree of B.Sc. In 1930 he was engaged as an instrumentman on Alberta Main Highways at Bassano, Alta., and in 1931 was with the Department of Public Works, Edmonton, Alta.

Mr. Olekshy joined The Institute as a Student on December 2nd, 1927, and transferred to the class of Junior on April 18th, 1930.

PERSONALS

Major R. D. Thexton, A.M.E.I.C., who has, for a number of years, been in Nigeria, B.W.A., is at present district engineer in charge of construction, Nigerian Railways, Kaduna Junction, Nigeria, B.W.A.

W. H. Hooper, Jr.E.I.C., is now connected with the Canada Wire and Cable Company, Ltd., at Leaside, Ont. Mr. Hooper, who graduated from McGill University in 1927 with the degree of B.Sc., was for a time with the Canadian General Electric Company at Peterborough, Ont., on a test course.

Dr. Charles Camsell, M.E.I.C., Receives Award.

Charles Camsell, B.A., LL.D., F.R.S.C., F.G.S.A., M.E.I.C., Deputy Minister of Mines, Department of Mines, Ottawa, has been awarded this year's gold medal by the British Institution of Mines and Metallurgy. Dr. Camsell has been selected for this honour "in recognition of his untiring zeal and great ability in promoting the development of the natural resources of the Dominion, and in furthering the general interests of the mining industry." The gold medal is the premier award of the Institution and was first presented in 1901. It is presented once each year "in recognition of eminent services rendered by the members of the Institution and others in the advancement of the technology of mining and metallurgy and for the improvement of various processes for the extraction of metals from their ores."

G. S. Clark, A.M.E.I.C., who was formerly with the Donnacona Paper Company, Ltd., Donnacona, Que., is now with Molsons Brewery, Ltd., Montreal.

H. T. Crosbie, M.E.I.C., is at present with the Department of Northern Development. Mr. Crosbie had been town engineer of Kenora, Ont., since 1927, and was for some years town engineer of Yorkton, Sask.

R. M. Doull, S.E.I.C., is now connected with Construction Equipment Company, Montreal. Mr. Doull, who is a graduate of McGill University of the year 1929, was formerly with the Dominion Engineering Works, Lachine, Que.

G. D. Durham, S.E.I.C., who has been located at Kenogami, Que., since January, 1930, is now with the Shawinigan Engineering Company, at Rapide Blanc, Que. Mr. Durham graduated from Queen's University in 1929, with the degree of B.Sc.

R. J. Fuller, A.M.E.I.C., has entered practice at Toronto, Ont., as a structural engineer. Mr. Fuller graduated from the University of Toronto with the degree of B.A.Sc. in 1912. In November, 1912, he entered the department of the city architect and superintendent of building, city of Toronto, where he remained until 1917, when he was appointed chief engineer of the John V. Gray Construction Company, Ltd. In 1927 he became connected with Mr. Roy. H. Bishop, architect, at Oshawa, Ont.

John E. Jackson, A.M.E.I.C., is at the present time employed with the Surveys department of the Department of Public Highways of Ontario, and is located at Riverside, Ont.

J. W. Lucas, S.E.I.C., has joined the staff of the Testing Laboratories of the Department of Public Works, Ottawa, Ont. Mr. Lucas, who was formerly with the Beauharnois Construction Company at Beauharnois, Que., is a graduate of the University of Alberta of the year 1930.

Major P. J. Jennings, M.E.I.C., who since 1928 has been Reclamation Engineer, Water Power and Reclamation Service, Department of the Interior, Calgary, has been appointed acting superintendent of Banff National Park. From 1911 to 1920 Major Jennings was connected with the Irrigation Branch, Reclamation Department of the Interior, with the exception of the period 1916 to August, 1919, when he was on active service, serving in British and German East Africa. Major Jennings takes a keen interest in Institute affairs, and is a charter member of the Calgary Branch. He represented that Branch on the Council of The Institute in 1928.

T. H. NICHOLSON, A.M.E.I.C.

T. H. Nicholson, A.M.E.I.C., is the head of a new company formed under Dominion charter at Montreal for the distribution through Canada, Newfoundland and the British West Indies of domestic electrical devices. Mr. Nicholson was formerly engaged as vice-president and general manager of the Compania Nacional de Electricidad, operating the principal electric light and power, telephone and tramway properties in Costa Rica. He was at one time consulting engineer with the Brazilian Telephone Company with headquarters at Rio de Janeiro, Brazil, and was for a number of years on the engineering staff of the Bell Telephone Company of Canada, Ltd., at Montreal.

T. S. Scott, M.E.I.C., who for the past year has been town engineer of Port Colborne, Ont., has received the appointment of Commissioner of Works for the township of York, Ont. Mr. Scott graduated from Queen's University with the degrees of B.A. and B.Sc., and was, for a time, professor of civil engineering at that university. In 1922 he became city engineer of Niagara Falls, Ont., and was later appointed city manager.

F. K. Beach, A.M.E.I.C., is now attached to the Petroleum and Natural Gas Division, Department of the Interior, Edmonton, Alta. Since 1927 Mr. Beach has been assistant engineer, office of the mining engineer, North West Territories and Yukon Branch of the Department of the Interior, located at Calgary, Alta.

F. C. Wightman, A.M.E.I.C., who has since 1927 been county engineer, Department of Highways, Truro, N.S., is now town manager of Kentville, N.S.

C. W. Justice, Jr.E.I.C., is electrical engineer with Noranda Mines, Ltd., Noranda, Que. Mr. Justice, who was formerly electrical demonstrator at the University of Manitoba, Winnipeg, Man., graduated from the university in 1926, with the degree of B.Sc., following which he took a test course with the Canadian General Electric Company at Peterborough, Ont.

BOOK REVIEWS

Airplane Structures

By Alfred S. Niles and Joseph S. Newell. Wiley & Sons, New York, 1929, cloth, 6 x 9 in., 413 pp., figs., charts, tables, $5.00.

In such a profession as aeronautical structural engineering, the necessity of designing structures as light as possible and yet adequate to withstand any probable load is essential; for upon this a large measure of the success of the aircraft depends. This book, which is for the most part intended to meet the needs of both student and practising engineer, deals with the more common problems encountered in this branch of aeronautical engineering. The problems at the end of each chapter are particularly useful to the student, and in fact could have been made more numerous with beneficial results. Being of American origin, the book is more particularly concerned with current American practice.

The book opens with a discussion of specification, a general description of loading conditions and the various forces applied to the aeroplane structure. Fundamentals in bending moments, shear, forces, etc., and methods of expressing them both in analytical and graphical form are reviewed.

The usual beam theory, the equations of three moments with various load distributions, and the effect of offset moments are discussed at some length. Detail design of simple beams with remarks on horizontal shear and allowable stresses are also dealt with. One chapter is devoted to torsion in various cross sections and allowable torsional stresses, with a description of how torsional stresses are combined with bending and axial stresses in practical design.

Then follows a dissertation on trusses and analytical methods of solution with examples included. The elementary principles of graphical truss analysis are explained fairly fully with the help of an illustrative problem.

The design of axial loaded members in both metal and wood with various tables, nomograms and charts appended, forms a very valuable part of this book. The effect of end fixity of columns is discussed at some length for the various materials in common use in aircraft work. Examples include various forms of joints used in aircraft construction with their relative merits and limitations and are commented upon with illustrative examples of design.

Considerable space is allotted to a treatise on members subjected to combined lateral and axial loads. The American methods adopted from British and German sources are discussed fully in general form and for several particular cases. The numerical examples given greatly facilitate the application to practical problems. Tables of the necessary functions are included. Mention is also made of special computation devices, approximate methods, secondary shear, special use of the precise formulae, and graphical solutions, with several numerical examples. This part of the book is probably the most valuable to the practical designing engineer.

Allowable stress grading for wood and metal according to the form of member involved, is explained quite fully. Useful charts are appended.

Deflections and various methods of obtaining them are fairly well discussed as applicable to both beams and trusses. Redundant structures and the method of least work applied to axial and bending conditions of loading together with many useful suggestions for practical use are explained.

Towards the end of the book, the writers return to the subject of weights and weight control with its many ramifications. Tabulated data directly useful to the designer are included with an attempt at detailed classification. A very useful bibliography and a good index complete this volume, which, without doubt, is one of the most useful books to those engaged in aeronautical engineering whether as students or as designers.

A. O. Adams, Flying Officer,
Civil Aviation Branch,
Department of National Defence, Canada,
Ottawa.

Automobile Steels

By A. Müller-Hauff and K. Stein. Translated from the German by H. Goldschmidt. Wiley & Sons, New York, 1930, cloth, 6 x 9 in., 219 pp., illus., figs., charts, tables, $3.50.

The book was written with the object of supplying a practical manual for designer, automobile plant manager, steel plant manager, business man and mechanic. With this purpose in view the authors have brought together a mass of widely scattered material to which they have added data and observations of their own.

The subject has been treated from many angles such as testing, metallography, manufacture, types of steel used, the selection of steel for various parts, and standards. A chapter on failures, consisting of photographs of broken parts, and one, consisting of thirteen tables showing the analysis and properties of steel used for the various parts by leading American and European manufacturers, were added in the translation. These may be considered by many to be the most valuable portion of the book.

Brevity is always desirable, but the reviewer feels that the authors have carried this too far. In chapter II the metallography of steel has been treated in about twelve pages. These contain some inaccurate statements which possibly result from the desire for brevity. In the effort to obtain brevity and simplicity the iron-carbon diagram is shown with a solidus curve but with no liquidus curve. The subsequent discussion of the changes which occur on cooling the alloys will probably leave an incorrect impression in the mind of the reader who is unfamiliar with this phase of the subject.

While the authors may not agree, the reviewer believes that the book would have been improved by the total omission of chapter II as it is too brief to be of any use to the technical man and will only add to the confusion of the non-technical reader.

Probably due to the attempt at a literal translation some of the terms are not used in their generally accepted sense. This is particularly true of the term "annealing."

The following typographical errors were noticed in chapter IV: 650° C. (840° F.) for 450° C. (840° F.), 7 per cent carbon for .7 per cent and Mi for Ni.

The comparison of German and American standards and practice will be found interesting, as well as the great mass of tabulated data on compositions and properties of the various steels. To those interested in automobile steels, the large amount of data contained in this book will make it of value as a reference.

O. A. Carson, Ph.D.,
Queen's University,
Kingston, Ont.

American Sewerage Practice

Volume 1 — Design of Sewers

By Leonard Metcalf and Harrison P. Eddy. McGraw-Hill, New York, 1928, cloth, 6 x 9 in., 759 pp., photos, figs., tables, $5.00.

It may truthfully be said that this volume, first published in 1914, constitutes an excellent work of reference. First editions are often subject to considerable revisions and additions and this book is no exception. The present edition represents the best thoughts devoted to the design of sewers, which design, however, is still regarded by not a few municipal authorities as an ordinary undertaking. Actually the function of the engineer is one of considerable importance when due regard is paid to his duty to his employers and to himself in the matter of reasonably economical designs.

Whilst the principles and theories appertaining to the hydraulics of sewers are dealt with fully, their application is described in such detail that the engineer is afforded ample opportunity of selecting the information which best suits the particular local conditions. In the chapter on precipitation the subject is dealt with in twenty-eight pages, and storm-water occupies another eighty-four. The term "rational method" of estimating the quantity of runoff does not seem to be logical: what is rational to one engineer may not be so to another. A term such as "synthetic method" seems to be more appropriate since it is a process of building up information, because the computations are started at the distant end of the sewer and each branch is added in orderly sequence. In other words the design is synthetically built up.

The numerous illustrated examples of masonry sewers will be of great value to engineers engaged on larger sewer schemes.

The section dealing with analysis of stress in sewer sections is a carefully prepared thesis on the subject.

The sections on junctions, siphons, bridges, flushing devices, and regulators, overflows, outlets, etc., are instructive and many examples are given of each.

The chapter on pumps of different kinds is interesting. Non-clogging impellers originated probably by Wood, of New Orleans, are described but no reference is made to the stereophagus pumps designed by Parsons.

Finally, the usefulness of a volume of this kind is greatly enhanced by a good comprehensive index, to which, in this volume, thirty-nine pages are devoted. This volume should be in the library of every municipal engineer.

R. O. Wynne-Roberts, m.e.i.c.,
Wynne-Roberts, Son & McLean.
Toronto, Ont.

City Noise

Report of the Noise Abatement Commission of the Department of Health, New York City. Edited by Messrs. Brown, Dennis, Henry and Pendray, 1930, paper, 6 x 9 in., 308 pp., photos, diagrs., tables.

In the foreword Dr. Shirley W. Wynne, Commissioner of Health, New York city, remarks in regard to the Noise Abatement Commission appointed in October, 1929:

> "Eight months ago I appointed a commission to study city noise and map out the means of abating it. This is the report of its work . . . " "This volume is the record of the generous contribution of time and talents by the members of the commission to their city. They have laboured with no hope of reward other than to make New York a peaceful, healthful place in which we can live."

In the list of commissioners appointed there are found several prominent physicians and professors of neurology, otology, etc., accoustical and other engineers, and executives of companies manufacturing sound deadening materials, as well as the Commissioner and Deputy Commissioner of Health for the City of New York.

Of especial interest to those who view city building and civic affairs in the light of the science and art of city planning is the fact that Lawson Purdy, LL.D., well known for his work in taxation and city planning is also a member of the commission.

A classification of the various city noises is made and their effect from the standpoint of health is analyzed. It is, of course, not within the scope of this review to go into details and the report is recommended to all readers who view community betterment as one of their main considerations, whether it be in New York where the first Noise Abatement Commission has been appointed, or in other less populous centres.

It seems to be quite clearly proved in the report that noise may destroy health and efficiency and cause economic loss.

There are many simple ways in which noise abatement may be carried out. As indicative, however, of some of the difficulties in the way and as to the attitude of the commissioners, the following extract in regard to radios may be quoted:

> "The commission has had cases called to its attention where these loudspeakers in residential neighbourhoods poured forth their intolerable clamour all day long and far into the night. Protests to the owners were useless; they refused to be reasonable or courteous, maintaining that every man has a right to operate his business and its advertising as he pleased—a specious argument which, if carried to its logical conclusion, would make the city uninhabitable!"

To those who see in the unlimited erection of skyscrapers an entire lack of scale between the height of such buildings and the open spaces around them there will be found another argument against the high building with the attendant noises after erection and the roar of the riveting machines during erection. Incidentally, the information is of value that the Pacific coast cities allow in their building codes for noiseless arc welding instead of riveting and some of the eastern United States cities may follow suit.

The appointment of such a commission and the publication of such a report is another indication of the regard that is being given to matters which in the past through lack of study and of thought were considered to be merely matters of individual whim and not of community concern. It is another illustration of our growing consciousness "that individual rights should cease when they become public wrongs."

Horace L. Seymour, m.e.i.c.,
Director of Town Planning,
Dept. of Municipal Affairs, Alberta,
Edmonton, Alta.

High Speed Steel

By Marcus A. Grossman and Edgar C. Bain. Wiley & Sons, New York, 1931, cloth, 6 x 9 in., 178 pp., illus., diagrs., charts, tables, $3.50.

The book is in two parts, the first dealing with melting, casting, working, annealing, hardening, tempering and inspection, the bearing of each step on the quality of the finished product being clearly discussed. The second part deals with the constitutional diagrams, the microstructures developed at various stages in the manufacture and heat treatment and their relation to the ultimate mechanical properties of the material.

High speed steel, an alloy of iron, tungsten, chromium, vanadium and carbon with or without some cobalt and molybdenum, has been considered an exceedingly complex alloy which bears little resemblance to ordinary carbon steel. However the authors have presented their work in a manner which shows clearly that the metallurgy of high speed steel is analogous to that of the simple carbon steels. By the assumptions that each per cent of Cr, V, and Mo may be considered as equivalent, respectively, to 0.5, 4.0 and 1.3 per cent of additional W, that the carbide exists as Fe_4W_2C and that cobalt may be treated as iron, a pseudo-binary diagram for the system $Fe - Fe_4W_2C$ is constructed and used to give a very satisfactory explanation of the heat treatment. The diagram bears a marked similarity to that for the $Fe - Fe_3C$ system, and any one with an understanding of the heat treatment of ordinary hypereutectoid carbon steels will readily follow and remember the heat treatment of high speed steel.

The book contains a considerable amount of valuable data and many micrographs. In the final chapter some excellent X-ray crystallograms (diffraction patterns) are reproduced. It is an excellent and authoritative technical treatise and will eliminate much of the existing confusion regarding high speed steel. The book has been written chiefly for the metallurgist, but the facts and principles have been expressed so clearly and simply that any one will find it easy to read and digest.

In the opinion of the reviewer the book will form, both as a text and a reference, a valuable addition to the libraries of all those who are at all interested in high speed steel.

O. A. Carson, Ph.D.,
Queen's University,
Kingston, Ont.

Modern Diesel Engine Practice

By Orville Adams. Henley Publishing Co., New York, 1931, cloth, 6 x 9 in., 656 pp., front., photos, figs., tables, $6.00.

This volume consists of 656 pages of material excellently printed and profusely illustrated and is intended to be a comprehensive treatise for the student and practical engineer, covering fully, theory, practical applications, operation, maintenance and repairs. It includes instructions suitable to the owner, operator, repairman, and engine salesman in addition to being valuable to students.

Within its covers there is a vast amount of general and detailed information regarding Diesel engines, their applications, operations, costs and so forth, dealing principally with American engines and practices. It might have been better, however, to have concentrated more on one phase of Diesel engineering rather than to attempt to include everything. For example, there is much in the book which the "practical Diesel engineer" will not read—and there is a great deal that the Diesel owner will not read. It is difficult to see the value of inserting into a book of this nature pages—nay, chapters, of material which can readily be obtained from the manufacturers' catalogues—in fact possibly more advantageously—as catalogues are kept up to date—whereas many manufacturers' practices described in this volume may be altered or obsolete in a very short time—Diesel practice is passing through many changes.

This very fact, however, gives merit to the publication, because it is at least an up-to-date review of the subject, of which there are not too many available.

The book has many illustrations, but it is very hard to see the purpose of some of these—unless merely to give a pictorial effect—and others have apparently been inserted without regard to the adjacent text.

These are, of course, minor criticisms and there is no doubt but that the volume would make a worth-while addition to the bookshelf of any engineer—even one with only a remote interest in Diesel engines or plants.

J. L. Busfield, M.E.I.C.,
Busfield, McLeod, Ltd., Montreal.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Presented by the Societies:
American Society of Mechanical Engineers: Record and Index Section of Transactions, 1930.
American Institute of Consulting Engineers, Inc.: Proceedings of the Annual Meeting, Held Jan. 19, 1931.
Constitution and By-Laws and List of Members, 1931.
The Institution of Civil Engineers: Selected Engineering Papers, Nos. 86-103, Session 1929-30.
The Institution of Water Engineers: Transactions, vol. 35, 1930.
American Institute of Electrical Engineers: Year Book, 1931.

Reports, etc.

Dept. of Labour, Canada:
Report for the Fiscal Year ending March 31, 1930.
Strikes and Lockouts in Canada and Other Countries, 1930.
Dept. of the Interior, Topographical Survey, Canada:
[Map of] Waterhen, Manitoba.
Dept. of the Interior, Forest Service, Canada:
Circular No. 29: Strength Tests of Creosoted Douglas Fir Railway Ties.
30: The Rate of Growth and Density of the Wood of White Spruce.
31: The Strength of Telephone Poles.
32: Changes in Moisture Content of Kiln-Dried Lumber When Shipped by Rail.
Geological Survey, Canada:
Summary Report, 1929, Part B.
Memoir 164: The Niagara Falls Survey of 1927.
Dept. of Mines, Canada:
Report for the Fiscal Year ending March 31, 1930.
Dominion Bureau of Statistics, Canada:
Trade of Canada, Fiscal Year ended March 31, 1930.
Dept. of Public Works, New Brunswick:
Official Government Map, Prov. of New Brunswick, Canada.
Dept. of Public Works, British Columbia:
Report of the Minister of Public Works for the Fiscal Year 1929-30.
The Lethbridge Northern Irrigation District:
Tenth Annual Report and Financial Statement, 1930.
Bureau of Standards, United States:
Miscellaneous Pub'n No. 114: Filters for the Reproduction of Sunlight and Daylight and the Determination of Color Temperature.
116: Report of the Twenty-Third National Conference on Weights and Measures.
Standards Year Book, 1931.
Geological Survey, United States:
Water Supply Paper 637-B: Preliminary Report on the Ground-Water Supply of Mimbres Valley, New Mexico.
Bulletin 821-C: Iron Ore on Canyon Creek, Fort Apache Indian Reservation, Arizona.
Public Health Service, United States:
Reprint 1434: Experimental Studies of Water Purification: Part 5: Prechlorination in Relation to the Efficiency of Water Filtration Processes.
University of Michigan, Dept. of Engineering Research:
Engineering Research Bulletin No 17: A Rapid Method for Predicting the Distribution of Daylight in Buildings.
National Electric Light Association:
Customers' Records Committee; Accounting National Section: Tabulating Machine Billing Plan.
Overhead Systems Committee, Engineering National Section: Design of 110 and 132 Kilovolt Steel Tower Transmission Lines.
Hydraulic Power Committee, Engineering National Section: Forecasting Water Supply.
Welding of Water Wheels.
Rate Research Committee: Report [1930].
Bethlehem Steel Corporation (New York City):
Twenty-sixth Annual Report, 1930.

Technical, Books, etc.

Presented by McGraw-Hill Book Company:
American Sewerage Practice, Vol. 1: Design of Sewers, by Metcalf and Eddy.
Presented by Northern Electric Co., Limited:
Bell Telephone System Monographs: B-522, B-524, B-529-B-533.
Aircraft Radio Development [27 pp.].
Presented by Henley Publishing Company:
Modern Diesel Engine Practice, by Orville Adams.
Presented by National Business Publications, Ltd.:
Canadian Mining Manual, 1931 edition.
Presented by Koninklijk Instituut Van Ingenieurs:
Alphabetische Naamlijst van Eereleden, Gewone- en Buitengewone Leden, 1 Maart, 1931.
Presented by Wiley & Sons:
American Civil Engineers' Handbook, 5th ed., 1930, edited by Merriman and Wiggin.
Purchased:
Great Britain, Imperial Institute: Tantalum and Niobium.

Catalogues

Dominion Oxygen Co. Limited:
Dominion Oxwelding Tips, Jan.-Feb., 1931 [16 pp.].
Ingersoll-Rand:
Modern Central Stations, Vol. 6. [1931].
The Falk Corporation (Milwaukee, Wisc.):
Bulletin No. 210: Falk Right Angle Speed Reducers [48 pp.].
Babcock & Wilcox Company:
Fusion Welding [17 pp.].
Rogers Brothers Corporation (Albion, Penna).
Rogers' Trailers [32 pp.].
Ferranti-Electric Limited:
Ferranti Power Transformers [6 pp.].
Link-Belt Company:
Link-Belt Heavy-Duty Apron Feeder [8 pp.].
Bailey Meter Company, Limited:
Dieform Compression Fittings [16 pp.].
The Herbert Morris Crane & Hoist Company, Ltd.:
Book 30 [252 pp.].

The Ferranti phase rotation indicator has met with considerable favour from various operating utilities, and the company announce that they are extending its range to 600 volts. This is being used primarily as a convenient means of checking phase rotation for synchronizing when connecting up new installations for the first time, or when a line or apparatus has been disconnected for repairs. It is more convenient than the familiar lamp and reactor connection. It is also used in checking meter and relay potential transformer connections.

Link-Belt Company, Chicago, Ill., announces a new design of heavy-duty manganese steel apron feeder. The new feeder is suitable for handling either abrasive or non-abrasive material, containing lumps of ¼-inch size, and smaller, up to 6-foot dimensions, being especially well adapted to the handling of extremely heavy, large, lumpy and abrasive materials. Full details, data and illustrations of this new apron feeder and its component parts, as well as installation views, are shown in Folder No. 1251, which is being distributed by Link-Belt Company, 300 West Pershing Road, Chicago, Ill.

ELECTIONS AND TRANSFERS

At the meeting of Council held on April 21st, 1931, the following elections and transfers were effected:

Associate Members

BALLARD, Guy Bristow, B.Sc., (Queen's Univ.), elec'l. engr. with National Research Council, Ottawa, Ont.

BARTEAUX, Ross M., B.Sc. (Elec. and Mech.), (N.S. Tech. Coll.), asst. to gen. supt., Nova Scotia Light & Power Co. Ltd., Halifax, N.S.

BIZIER, Joseph Lionel, B.A.Sc., C.E., (Ecole Polytech.), dredging engr., Quebec Harbour Commission, Quebec, Que.

GEROW, Carlyle, B.Sc., (Queen's Univ.), asst. gen. mgr. and technical advisor, coal sales dept., Dominion Coal Company, Limited, Montreal, Que.

POUNDER, Thomas James, B.Sc. (Eng.), (Univ. of Man.), asst. dist. engr., Dept. of Highways of Saskatchewan, Yorkton, Sask.

Juniors

GOODMAN, James Edward, (Queen's Univ.), research work for Dept. Public Highways of Ontario, Kingston, Ont.

GUDMUNDSON, August Evert, B.Sc. (Elec.), (Univ. of Alta.), Canadian Utilities Company, Calgary, Alta.

WRANGELL, Kjell Frederick, (Horten Tekniske Skole), mech. engr., E. B. Eddy Co. Ltd., Hull, Que.

Transferred from the class of Associate Member to that of Member

WHITTAKER, David, (Univ. of Liverpool), asst. hydraulic engr., Dominion Water Power & Hydrometric Bureau, Dept. of the Interior, Edmonton, Alta.

Transferred from the class of Junior to that of Associate Member

BURCHILL, George Herbert, B.Sc., (N.S. Tech. Coll.), acting professor of elect'l. engrg., Nova Scotia Technical College, Halifax, N.S.

HEATLEY, A. Harold, B.A.Sc., M.A., (Univ. of Toronto), chemist, John Walter & Sons Ltd., Kitchener, Ont.

KINGSMILL, Charles Grange, B.A.Sc., (Univ. of Toronto), res. engr. on portion of canal, Beauharnois Construction Company, Beauharnois, Que.

KIRKPATRICK, Harold Thompson, B.Sc., (McGill Univ.), Parrsboro, N.S.

Transferred from the class of Student to that of Associate Member

CAMPBELL, Wilfred John, B.A.Sc., (Univ. of Toronto), elect'l. engr., Detroit Edison Co., Detroit, Mich.

DILWORTH, Edwin L., B.Sc., (Queen's Univ.), heating and ventilating engr. in charge of Montreal sales office, Canadian Blower & Forge Co. Ltd., Montreal, Que.

THOMPSON, Harry Alexander, B.A., B.Sc. (C.E.), (Univ. of Sask.), constrn. engr., Morrow & Beatty, Fitzroy Harbour, Ont.

Transferred from the class of Student to that of Junior

ALLISON, Jesse Graham, B.Sc., (Univ. of So. California), estimator, H. C. Johnston Co. Ltd., Montreal, Que.

GRANT, Alex. James, Jr., B.Sc., (McGill Univ.), field engr., Dominion Bridge Company, Ltd., Montreal, Que.

GRANT, Wilfrid John, B.A.Sc., (Univ. of Toronto), teacher, dept. of physics, Central Technical School, Toronto, Ont.

MOOGK, Ernest George, B.A.Sc., (Univ. of Toronto), asst. in supt.'s office, University of Toronto, Toronto, Ont.

PATTERSON, Ian Stewart, B.Sc., (N.S. Tech. Coll.), industrial control specialist, Canadian General Electric Co. Ltd., Montreal, Que.

TAYLOR, Frank Denzil, B.Sc., (McGill Univ.), mill chemist, Brompton Pulp & Paper Co., East Angus, Que.

TIMLECK, Curtis James, B.A.Sc., (Univ. of B.C.), in charge of contract service dept., Canadian Ingersoll Rand Co. Ltd., Montreal, Que.

Students Admitted

BLAIR, James, (Univ. of Alta.), Hanna, Alta.

BROWN, William Boughton, (N.S. Tech. Coll.), Clark's Harbour, N.S.

CRAIG, Carleton, (McGill Univ.), 3433 Peel St., Montreal, Que.

FORSBERG, Clarence Rudeford, (Univ. of Sask.), Dunblane, Sask.

HEWSON, Edgar Wendell, (Mount Allison Univ.), Amherst, N.S.

Twelfth Annual Meeting of the Corporation of Professional Engineers of Quebec

A. R. Decary, D.Sc., M.E.I.C., Superintendent Engineer for the Province of Quebec, at the Department of Public Works of Canada, was re-elected for the twelfth time president of the Corporation of Professional Engineers of Quebec, on March 25th, at the headquarters of The Engineering Institute of Canada, Mansfield Street.

The following engineers attended the meeting: Messrs. Geo. E. Reakes, A.M.E.I.C., E. S. Holloway, M.E.I.C., Huet Massue, A.M.E.I.C., Charles Taschereau, J. A. McCrory, M.E.I.C., O. Graham, A. Leduc, E. Duval, Geo. K. McDougall, M.E.I.C., J. Chas. Legendre, Chs. A. Cousineau, M.E.I.C., Herbert Cantwell, A.M.E.I.C., N. L. Morgan, A.M.E.I.C., A. B. Normandin, A.M.E.I.C., C. E. Olive, J. M. Robertson, M.E.I.C., A. R. Decary, M.E.I.C., Frederick B. Brown, M.E.I.C., J. B. Macphail, A.M.E.I.C., J. A. Beauchemin, A.M.E.I.C., J. Raoul Julien, Gaston Labelle, Edmour Chauret, Emile Labay, Hector Cimon, A.M.E.I.C., R. J. Durley, M.E.I.C., J. M. Portugais, A.M.E.I.C., Ch. Godin, A.M.E.I.C., Walter Manning, S.E.I.C., Walter Clerk, Paul de Guise, P. E. Bourbonnais, A.M.E.I.C., J. B. O. Saint-Laurent, A.M.E.I.C., Y. Marchand, Adrien Genest, Réal Bélanger, S.E.I.C., Adrie Barrette, A.M.E.I.C., Martin Wolff, A.M.E.I.C., Wallace Dickson, M.E.I.C., M. A. Downes, A.M.E.I.C., J. C. Chagnon, C. A. Mathieu, H. Carignan, W. H. Benne, F. A. Combe, M.E.I.C., R. A. Vincent, A.M.E.I.C., J. N. E. Bélanger, K. B. Thornton, M.E.I.C., G. C. Bastien, M. Cailloux, H. Labrecque, A. Duperron, M.E.I.C., R. Langlois, A.M.E.I.C., Wm. McG. Gardner, A.M.E.I.C., N. Dozois, C. Valiquette, Jr.E.I.C., F. W. Caldwell, M.E.I.C., Teles. Toupin, J. P. Lalonde, S.E.I.C., Francis J. Hoar, S. F. Rutherford, A.M.E.I.C., A. Mailhiot, C. G. Porter, A.M.E.I.C., W. E. Lauriault, A.M.E.I.C., Jean M. Forget.

Mr. Frederick B. Brown, Secretary-Treasurer of the Corporation, read the reports from Council, from the Treasurer and from the Board of Examiners. All these reports show that the Corporation of Professional Engineers of Quebec is doing efficient work in the way of protecting its members, and that the law governing the engineering profession in the province of Quebec is helping greatly the members of the profession. Not less than forty-four cases of illegal practice and advertisement were reported settled during the past year.

The Treasurer's report shows a surplus for the year 1930.

Several questions of interest to the profession were discussed by the engineers present. Among these, the question of temporary licenses granted to engineers residing out of the province of Quebec was fully explained by the President of the Corporation, Dr. A. R. Decary. Several committees were nominated to study ways and means of improving the act governing the practice of the profession, and of giving more publicity to the work of the engineer for the welfare of the community.

The President read the report of the scrutineers, and the following members of Council were declared elected: For the district of Montreal: Dr. Olivier Lefebvre, M.E.I.C., and Messrs. Geo. K. McDougall and J. M. Robertson; for the district of Quebec: Mr. Hector Cimon.

At the close of the meeting, the Council met and elected officers as follows: President, Dr. A. R. Decary; Vice-President, Mr. J. M. Robertson; Secretary-Treasurer, Mr. Frederick B. Brown. The other members of Council are: Messrs. Olivier Lefebvre, C. N. Monsarrat, M.E.I.C., Geo. K. McDougall, A. B. Normandin and H. Cimon.

Mr. Adhémar Mailhiot was reappointed as Registrar of the Corporation.

The Garlock Packing Company have recently developed a new gasket material which is called "Button Hole Tape." On account of its unique construction and method of application it has many advantages for certain jobs. The Garlock button hole tape is made up of two parallel courses of high grade folded asbestos cloth joined together by a single ply of bonding fabric. As shipped from the factory it contains no holes. The insertion of a knife blade between the two parallel sections of the tape cuts the bonding fabric, forming a button hole which slips readily over the bolt or stud. With no tools, other than a knife, any workman can quickly make a perfect gasket which will remain in place, fit correctly, lie flat and form a positive seal around every bolt.

Jenkins Bros. Limited announce the election at the recently held annual meeting of the company of Mr. Herbert H. Gee as a director. Mr. Gee, who has been connected with the company for some twenty-three years, is Ontario manager.

The Herbert Morris Crane and Hoist Company, Ltd., Niagara Falls, Ont., have recently published Book 30, the company's latest general catalogue, which illustrates and describes in concise form the complete range of Morris material handling equipment.

BRANCH NEWS

Border Cities Branch

Harold J. A. Chambers, A.M.E.I.C., Secretary-Treasurer.

The regular monthly meeting of the Border Cities Branch was held on Friday, March 20th. The speaker of the evening was Mr. R. C. Manning, district engineer for the Canadian Institute of Steel Construction. The subject of Mr. Manning's address was steel; its growth as an industry, its importance, properties and uses in our modern civilization. Also, he outlined the work accomplished by the institute which he represented. At the close of his talk, motion pictures were shown illustrating the rolling of structural steel shapes in mills. An interesting film of the construction of the Empire State building, New York city, was also shown.

Steel

Iron, the speaker stated in opening his address, is one of the oldest and most useful of our known metals. Steel, however, which may be termed a refinement of iron, does not date far back, being discovered in England by Bessemer.

Trains, airplanes, automobiles, sky-scrapers and other features of our modern civilization, often termed the steel age, then only became possible. Since the discovery of steel, the growth of that industry has indeed been great. It has grown by leaps and bounds until now it is one of our leading industries and is widely used in building construction.

Structural steel is made by three important processes for commercial use, namely: the Bessemer, open hearth and the electric furnace. The open hearth is the most common process because it gives a better heat control. The electric furnace process is as yet very expensive. It yields a very pure product, but is not used to any great extent.

The physical and chemical properties of structural steel in process are under accurate scientific control and test. Great care in the selection of the flues and the furnace linings is necessary. Tests for phosphorus are taken for each melt. Consequently we are certain of a material of pre-determined analysis. The next step in the manufacture of structural steel shapes, rolling, is also carried out with great precision. Knowing the analysis of the steel, the ultimate strength and the cross section to be accurate, the designer can work intelligently and accurately. The detailer and fabricator also play their part, with the result that the completed structure is known to bear out the design. Material in building which takes up the least room is the material most desired. Steel insures strength and security. Steel bridges can be readily reinforced or altered to suit new conditions. They have a long life and the maintenance cost consists of painting every five or six years.

Steel can be erected in any weather and is self-supporting during erection. The erection is fast. Obsolete steel can be re-erected in a different location or it can be sold for scrap. Generally other building materials can not be sold or re-used. In steel, tension, compression and shear are all resisted to the same degree. The material is perfectly elastic and the deformation is proportional to the stress. The steel completely recovers its original volume and form if not stressed above the elastic limit. The yield point is never equalled by the working stress, a certain factor of safety always being used. Steel is not subject to fatigue. It fails slowly by bending and elongation. It is fabricated by standard methods. It is quickly erected and does not suffer damage from the weather. The above are some of the many advantages that steel has over other building materials.

Arc welding in steel structures is a comparatively new method of fabrication. As yet it is only used in secondary members. The first all-welded structure was erected by the Canadian Bridge Company, Ltd. during the summer of 1930. It was of the mill building type and was built for the Canadian General Electric Company at Peterboro, Ontario.

The purpose of the Institute of Steel Construction, the speaker stated, was to establish standard specifications and standard practice. In this direction, the first step was accomplished in 1923 by the American Institute of Steel Construction when they established a set of standard specifications. In 1924 a code of standard practice was drawn up. Later a handbook of standard sections was compiled, and following that specifications for fire proofing were established. This information was obtained from steel manufacturers, fabricators, architects and engineers.

At the conclusion of the address a hearty vote of thanks was conveyed to Mr. Manning by the chairman, R. J. Desmarais, A.M.E.I.C., on behalf of the members of the Branch.

Hamilton Branch

J. R. Dunbar, A.M.E.I.C., Secretary Treasurer.

J. A. M. Galilee, Affil.E.I.C., Branch News Editor.

Joint Meeting with A.S.M.E.

(*Reported by E. B. Scott*)

On April 2nd a joint meeting was held with the Ontario and Buffalo sections of the American Society of Mechanical Engineers and the Niagara Peninsular Branch of The Engineering Institute of Canada. At 1.00 p.m. approximately sixty members of the joint organizations met for luncheon at Cecil Roberts' restaurant, Hamilton.

Visits to Plants

Immediately after lunch this original party was supplemented by thirty additional members for visits to various factories in Hamilton. The members had their choice of going to the Canadian Westinghouse Company Ltd., the Firestone Tire and Rubber Company or the Steel Company of Canada, after which everyone went to the Dominion Glass Company. At the Canadian Westinghouse Company, motors, transformers, circuit breakers, generators, meters, relays, air brakes and all the more interesting electrical equipment were seen being made and tested. At the Firestone Tire and Rubber Company, the manufacture of tires and inner tubes was followed from the bulk gum rubber direct to the finished product. At the Steel Company of Canada the manufacture of steel in all its different stages was followed through systematically from the raw materials, mixing, heating, pouring, blooming, drawing and cutting, to the finished product. At 4 o'clock the different parties met at the Dominion Glass Company and were shown through the plant. The Glass Company were manufacturing bottles alone. The large furnaces and automatic blowers were the main points of interest.

Dinner

At 6 o'clock an enjoyable dinner was held in the ball room of the Royal Connaught hotel. Seated at the head table were Alex. J. Grant, M.E.I.C., St. Catharines, Past-President of The Institute, J. P. Wys, Toronto, E. H. Darling, M.E.I.C., Hamilton, W. F. McLaren, M.E.I.C., chairman, Hamilton Branch of The Institute, Prof. C. E. Harrington, Buffalo, Walter Jackson, M.E.I.C., St. Catharines, S. L. Fear, Toronto, Prof. E. A. Alcutt, M.E.I.C., Toronto, E. G. Cameron, A.M.E.I.C., St. Catharines, W. H. Taylor, Buffalo, and Dr. L. G. Hector, Buffalo.

After dinner Mr. McLaren introduced Alex. J. Grant, M.E.I.C., Past President of The Institute, who welcomed the visitors from the American Society of Mechanical Engineers. He spoke of the advisability of having as many joint meetings as possible between Canadian and American branches of engineering associations, because the development of the prosperity of our respective countries was principally in the hands of engineers and that we should advance together.

Mr. McLaren then introduced Professor Harrington from the University of Buffalo, who remarked upon the number of associations represented, Buffalo, Toronto, Galt and Hamilton, and the similarity between the Canadian and the American engineer.

Flow of Air Past Stationary and Rotating Aero Foils

Professor Harrington then asked Dr. Hector to say a few words explaining the photographs which were to follow. Dr. Hector explained that most of the motion pictures to follow were taken in Japan at the University of Tokyo and that the films dealt mostly with the flow of air past rotating and stationary aero foils. He said that Mr. Taylor would explain the aero foil and that he would deal with the construction of the camera. To obtain from 1,000 to 40,000 exposures per second a spiral film was wound on a fast moving drum. After the film has been taken, the film is cut along the spiral and made into a straight film which is enlarged to camera size. The photographs are taken in a dark room with light from an arc appearing from 1,000 to 40,000 times per second with total darkness in between. No shutter is needed. An entirely different scheme may also be used by the use of continuous illumination and make the object travel with the film. This is done by using 120 mirrors revolving as the film revolves with the mirrors reflecting the object. Perfect synchronism between speed of mirrors and speed of film must be obtained. Using 120 mirrors, 20,000 exposures per second were obtained. Later the number of mirrors was increased to 160 and 40,000 exposures per second was the result. In future it is hoped to obtain 80,000 exposures per second by still further increasing the number of mirrors.

Mr. Taylor then gave an explanation of the pictures. He asked the meeting if they had ever seen air and then asked if they had seen the air above a heated stove. That is how the action of air around air foils was studied. The foil was placed in a tunnel and heated air passed through. The use of smoke was also very common in studying the air disturbances around an aero foil.

The films were then projected on the screen. The first reel showed aero foils stationary and rotating and the disturbance of the smoke or air was very clearly seen. The foil was placed in all positions and rotated. At the end of the first reel a bullet was shown fired from a gun and entering a glass bulb (electric light bulb of ordinary size). The bullet seemed to enter one side and then bulge the opposite side before the glass shattered. This was very clearly seen and the bullet seemed to move very slowly.

The second reel showed aero foils of single motor aeroplanes and biplanes being rotated and their consequent air disturbance. Also in this reel were shown the disturbances caused by rotating spheres and semi-spheres.

The third reel dealt mostly with sound waves. A noise was created by an instantaneous arc inside a circle and the sound waves were seen to hit the circle and rebound, focusing in the centre, being sent out again and rebounding till the sound died away. The sound waves were also shown in a triangle and in an ellipse.

The pictures were very interesting and very amazing, but the steady advance of science and engineering was making many things possible.

Steam Storage

Mr. S. L. Fear, chairman of the Ontario Branch American Society Mechanical Engineers, then introduced the speaker of the evening, Mr. J. P. Wys, chief engineer of the Ruths Steam Storage (Canada) Limited, who gave a very interesting address on "Steam Storage."

Mr. Wys defined storage as "A method of putting something aside at a time when not needed in order to have it readily available at a time of want." This applies to steam as well as to any other product of manufacture.

In the average steam plant, such as dye, brewing, bleaching and evaporating plants, a large amount of steam is required to bring the process to a start, thus causing a heavy peak in the steam consumption which usually occurs at starting time in the morning. Following this peak period there is a period of low consumption which may continue through the day or there may be another peak before the process is finished. The power generation is in most cases entirely independent of the steam demand but the turbine or engine supplying steam cannot be regulated according to available steam. The steam has to be supplied at a rate corresponding to power requirements. It may easily be seen that the demand for steam in all plants varies greatly.

To flatten out the steam demand curves the first method is to distribute the peaks over the working hours, never allowing two peaks to occur at the same time. This method calls for rigid schedule which is not successful even at part time operated plants.

Steam storage is the next method. The first successful attempts to store steam were made in connection with mine hoisting and rolling mill machines. The exhaust from their engines at atmospheric pressure was put into constant volume accumulators and was then withdrawn for use in a turbine at a constant rate. This method was not so successful as steam could not be withdrawn unless the same amount of steam was entering.

Several methods of steam storage have since been invented but the one with the most general application at present is the Ruths system. The principle of this system is to supply the boilers with hot feed water during a peak load and to prepare such hot feed water during slack demand. If the boilers are fed with water at saturation temperature, the latent heat of the steam and the superheat has still to be supplied by heat transfer through the furnace. With the Ruths system feed water is supplied at a constant rate and high temperature and the steam production is therefore always equal to the maximum output. The feed pump must have a capacity of about six times the normal feed to supply sufficient water to condense all excess steam in case of heavy off peaks in steam demand.

Mr. Wys went on to explain the method of construction of the accumulators and the rigid tests they underwent. Illustrating with slides he showed a number of practical applications of the Ruths steam storage system in Canada and European countries.

Mr. Darling moved a vote of thanks to Mr. Wys for the very interesting lecture.

Professor Harrington thanked the Hamilton Branch on behalf of the Buffalo Branch for their hospitality and Mr. MacLaren then adjourned a most successful meeting.

The attendance at dinner was 100, and at the meeting following dinner, about 120.

London Branch

F. C. Ball, A.M.E.I.C., Secretary-Treasurer.
J. R. Rostron, A.M.E.I.C., Branch News Editor.

Fuel Burning Equipment for Modern Steam Plants

The regular monthly meeting of the Branch was held on March 17th in the County Council Chambers and W. R. Smith, A.M.E.I.C., Branch chairman, occupied the chair. The speaker was Mr. J. H. Schofield, of the Combustion Engineering Corporation Ltd., Toronto, Ont., and his subject was "Fuel Burning Equipment for Modern Steam Plants."

Mr. Smith first called upon Mr. Ball, the Secretary, to read to the meeting the pamphlet issued from Headquarters setting forth the aims and objects of The Engineering Institute of Canada and showing the reasons why membership in that body was desirable and even necessary from the viewpoint of engineering qualification.

D. M. Bright, A.M.E.I.C. who was called upon to introduce the speaker, said he had pleasure in stating that Mr. Schofield was an authority on all kinds of mechanical stokers from the smallest to the largest installations and he would show how to economize and yet obtain the highest amount of efficiency in the combustion of fuel with various boiler installations.

Mr. Schofield's talk was illustrated by means of lantern slides and he began by stating that the equipment in the first place must be designed to suit the particular kind of fuel it was proposed to use, whether bituminous coal, coke breeze or anthracite.

By means of illustrations he showed the variation in the size of lumps of coal and pointed out the desirability of having the lumps uniform in size in order to insure complete and efficient combustion. It was obvious that smaller pieces burnt through first and then hindered the combustion of the larger ones. Run of mine coal only gave an efficiency of from 40 to 50 per cent and this can be increased from 50 to 60 per cent. Again mechanical stokers increased the efficiency from 65 to 75 per cent and pulverized coal burnt in suspension still further increased the efficiency from 75 to 85 per cent according to the fineness of the pulverization.

Views were shown of several types of underfeed stokers, one designed for smaller boilers, others for boilers from 100 to 200 h.p., 125 to 650 h.p., and a multiple retort stoker designed to take care of boilers about 500 h.p. up to any required size, most of these being of the ram feed type. Chain grate stokers were then shown and described by the speaker. These included the Green chain grate stoker—natural draft and forced draft, and were followed by the Coxe travelling grate stoker—forced draft. The working of these units was fully explained by Mr. Schofield with particular attention to the action of the draft and the advantage of each type under certain conditions.

The speaker next turned his attention to the powdered coal applications and illustrated his remarks by views and diagrams of the Raymond roller mill, the Raymond hammer type mill and mention was made of a ball type mill. These mills can be regulated to give the desired degree of fineness and are situated directly in front of the boilers. The speaker pointed out that when these mills were in full operation the process of grinding the coal into dust was noiseless.

The moisture content of coal should not exceed 8 per cent before entering the furnace.

This was followed by a description of the designs of several air preheaters, water walls and water screens.

Mr. Schofield's talk was much appreciated by those present and followed with lively interest, as was evidenced by the number of questions asked and by the discusssion which followed.

One question was "When does pulverized coal become economical?" The answer was—In plants requiring from 600 to 700 h.p. or over and when the operation is continuous day and night.

Another question was "What is the principal cause of explosion with pulverized coal?"

Answer—Poor operation or control. If the gases are allowed to escape before ignition at the burner there is no danger.

In answer to another question it was stated that 30,000 B.t.u.'s can be obtained from a cubic foot of coal and about 25,000 B.t.u.'s from a cubic foot of pulverized coal.

A hearty vote of thanks to the speaker was proposed by H. B. R. Craig, M.E.I.C., and seconded by John R. Rostrom, A.M.E.I.C.

About thirty-five members and other persons interested were present.

Moncton Branch

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

Sackville Visit

On March 17th a joint meeting of Moncton Branch and the Engineering Society of Mount Allison was held in the Science building of the University at Sackville. George Campbell, President of the Engineering Society, occupied the chair. The speaker of the evening was J. D. McBeath, B.A.I., chief engineer of the city of Moncton, who gave an address on Municipal Engineering. Mr. McBeath described in detail the various engineering services of Moncton and also referred to the local air-port, the design for which he is responsible. The address was illustrated with maps and plans. At the close of his remarks a hearty vote of thanks was tendered Mr. McBeath by the presiding chairman.

Recent Research Developments in Building Materials

(Reported by G. E. Smith, A.M.E.I.C.)

A very pleasant gathering composed of the engineers and friends in the building fraternity gathered at the Y.M.C.A. building for the regular monthly meeting of the Moncton Branch on March 18th.

This took the regular form of dinner and lecture combined, and after musical numbers by local artists, the speaker of the evening, James Govan, M.R.A.I.C., of Toronto, was introduced. Mr. Govan took for his subject "Recent Research Developments in Building Materials."

The speaker dealt with his subject from the view point of fire, fire resistance, insulation, acoustics, building materials and orientation of buildings.

In speaking from the fire point of view the speaker showed that in adapting Fire Underwriter codes and Building codes a very careful study should be made to note their adaptability to Canadian conditions.

During the lecture lantern slides and moving pictures were shown. The first group of pictures showed the construction of a fire test building, the building constructed with frame work of wood covered inside and outside with Gyproc, and spaces between joists, studs, and rafters filled with insulex. An additional layer of Gyproc board was applied to the inside of the building and combustible material placed and ignited. Recording thermometers showed that in twenty minutes time the inside temperature had risen to 1,930 degrees, while the outside temperature of the wall remained below 80 degrees. At no time during the test did the exterior of walls become too hot to place the hand thereon.

In dealing with insulation of buildings various tables were shown indicating the time required for passage through walls of a fixed amount of heat. Tests had been conducted whereby the amount of radiation had been reduced by 55 per cent and the desired inside temperature steadily maintained. These tests showed that the present standard practice of figuring radiation was in error, in that the temperature difference used was too high and not sufficient allowance given for insulation.

In the acoustic field the speaker stated that Canadian research indicated that some of the data presented by the authorities in other countries is not in accord with results obtained in actual practice. Very careful deliberation was now being given to the matter with a view of obtaining more reliable data as to the acoustic properties of various building materials.

One slide showing the results of tests made in Norway with various forms of wood wall construction showed a wall filled with shavings and heat resistance qualities very high. This was particularly interesting in that this has been the type of wall used for ice house construction for many years and is still in practice. The test showed that the breaking up of the air spaces and consequent reduction in air motion was the chief agent in providing high insulating qualities.

In speaking of the placing of buildings with regard to the sun's rays, Mr. Govan said that this is causing not only a needless waste of fuel but also discomfort in Canadian buildings. These conditions he said could easily be remedied by a greater attention to the principle of orientation of buildings.

C. S. G. Rogers, A.M.E.I.C., brought up the question of the corrosive action of gypsum composition on steel and the speaker showed that if the material was allowed to dry and was kept from further moisture there was no danger of the action being carried beyond the initial stages similar to that obtaining with concrete.

H. J. Crudge, A.M.E.I.C., brought up the question of vibration in buildings with light steel framing and thin partition walls, etc. He felt that this was a question which was causing some very serious thought in some structures now in place. Mr. Govan said he realized this very much and mentioned work where such disturbances had been foreseen, but the methods adopted to overcome same had not proved satisfactory.

The chairman tendered Mr. Govan a very hearty vote of thanks on motion of H. J. Crudge, A.M.E.I.C., seconded by C. S. G. Rogers, A.M.E.I.C.

Montreal Branch

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

The New Viau Bridge

On February 12th, L. J. Leroux, M.E.I.C., engineer of bridges and tunnels for the city of Montreal, delivered a paper before the Montreal Branch on the new Viau bridge across the Back river at Ahuntsic.

At first it was undecided whether the bridge should be constructed of steel or concrete but the latter was the final choice of those responsible for the work. The main section of the bridge was 1,050 feet in length divided into five unequal spans and in addition there were the approaches on each side, 150 feet and 250 feet in length respectively. The old bridge constructed in 1885 was only 16 feet wide and had no sidewalks while the new one is 54 feet wide with two 6-foot sidewalks and provision for street car tracks if same should ever be needed.

Steel caissons were used for piers and these had to be sunk to depths of from 22 to 32 feet to reach solid rock. At the water line the piers were protected with granite blocks. As the piers were completed, a very substantial trestle was erected to carry the formwork for the concrete. The bed of the river was cleared of obstructions and irregularities and the trestle supported on the bottom. B.C. fir to the value of over $100,000 was used in the construction of the trestle work.

The bridge was hinged at three points, namely on each of the central piers, and amongst the many interesting slides which were shown were several illustrating very clearly the detail of these hinges. In all some 176,000 bags of concrete were used in the bridge and the work which started in May, 1929, was completed in October, 1930.

Dr. O. Lefebvre, M.E.I.C., occupied the chair.

The Art of Telegraphy

Mr. J. C. Burkholder, chief engineer of the Canadian National Telegraphs, addressed the Montreal Branch on February 26th on "The Art of Telegraphy and other forms of Railway Communication."

The earlier forms of communication were first described, commencing with the semaphore system built by the Chappe brothers in France followed later by the Morse telegraph, the telephone invented by Alexander Graham Bell, the printer telegraph, and finally the carrier system in use at the present time.

The carrier current principles were discovered in 1886 by Elisha Gray and later, with the development of the telephone, it was found possible to combine telephone and telegraph circuits. This led, Mr. Burkholder said, to the production by the Canadian National Telegraphs of the "Jitney Carrier telegraph system."

Amongst the many applications of communication used by the Canadian National Railways at the present time are the use of both telephone and telegraph for train dispatching; two way telephone service from moving trains; radio broadcasting network with 41 broadcast control stations and 78 individual amplifiers. By means of carrier currents it is possible to transmit telegraph and telephone messages over 24 current channels on one pair of wires, and Mr. Burkholder indicated that its maximum possibilities had not yet been reached.

J. L. Clarke, A.M.E.I.C., presided.

Ottawa Branch

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

Island Falls Power Development

N. J. Kayser, M.E.I.C., a director and assistant to the first vice-president of the Fraser-Brace Engineering Company, was the speaker at the noon luncheon held at the Chateau Laurier on February 26th. G. J. Desbarats, C.M.G., M.E.I.C., chairman of the local branch, presided at the meeting. At the head table in addition to the chairman and the speaker there were the following guests: Honourable T. G. Murphy; Honourable Charles Stewart; R. A. Gibson; J. T. Johnston, M.E.I.C.; V. Meek, M.E.I.C.; N. Marr, M.E.I.C.; J. Murphy, M.E.I.C.; K. M. Cameron, M.E.I.C.; Colonel A. E. Dubuc, M.E.I.C.; Noulan Cauchon, A.M.E.I.C.; O. B. Lefebvre, M.E.I.C., chief engineer of the Quebec Streams Commission; F. S. Small, M.E.I.C., resident engineer on construction at Island Falls; and Dr. G. Malcolm, resident physician on construction at Island Falls.

Mr. Kayser in his address, supplemented by the use of lantern slides, outlined the steps taken in the construction of the Island Falls power development from virgin wilderness to its present state whereby it is producing power for the Flin Flon and Sherritt-Gordon mines.

Island Falls is located about 15 miles west of the Manitoba boundary in latitude 55°32′. It is the first hydro-electric development to be built in Saskatchewan and the most northerly one of its size in Canada.

Power for the operation of the construction machinery for the main plant itself was obtained from a temporary hydro-electric plant located about 13 miles northeast of Island Falls at the outlet of a chain of lakes having an area of about 100 square miles. This temporary plant had a 38-foot head and consisted of a crib dam 30 feet long with a maximum height of 20 feet with two wood stave penstocks 8 feet in diameter and 90 feet long to convey the water to two 1,250 h.p. vertical shaft turbines which were direct connected to 1,000 kv.a. generators.

The development at Island Falls itself consists of a main dam with power house and intake works located in the main channel, a spillway dam containing 46 stop log sluices located in an old channel of the river, and seven earth-fill cut-off dams. These dams completed the structures necessary to confine the water in the head pond which is 56 feet above the original river.

The present installation consists of three 14,000 h.p. units and the two smaller units previously mentioned. Provision is allowed for the building, when required, of an additional three large units. The current is generated at 6,600 volts and is stepped up to 110,000 volts and transmitted to Flin Flon over a double-circuit steel tower transmission line. Power was delivered to Flin Flon on June 12, 1930, a few days less than a year from the time the first concrete was placed in the power house foundations.

The main power plant being 68 miles by winter road and 72 miles by summer route from Flin Flon, the nearest railway station, the matter of transportation was, of course, a very serious one.

Both routes followed the same chain of lakes, the summer route occupying the higher ground on the portages (of which there were six totalling 17½ miles), while the winter road followed the muskeg. Due to the flat nature of the country the winter road had a maximum grade of only 4 per cent against the north bound traffic and very little grading was necessary.

For summer freight, barges of 15 tons capacity were built at each lake. Each barge was fitted with two 15 h.p. outboard Johnson motors and a third was kept aboard as a reserve. When loaded they travelled about 6 miles an hour. However, only a very small proportion of the total freighting was done by this method, some 1,500 tons being taken in during the summer out of a total of 35,000 tons transported altogether.

The main winter's hauling was done by eleven 100 h.p. Lynn tractors carrying a 6-ton load as ballast and pulling from three to five sleighs and a caboose. The crews worked in eight-hour shifts, the spare crews living in the caboose, and the tractors worked continuously. The switching at each end was done by Holt-60 tractors, two at the railway head and one at Island Falls.

The average load for the first winter was 67 tons, and this varied with the thickness of the ice. In February the maximum was 112 tons with 32 tons on one sleigh. The speed of the tractor trains loaded varied from 2½ to 5 miles an hour and when empty 7 miles an hour.

Tank sleighs were used to ice the portages and each Lynn tractor carried a snow plow. Crossing some of the wind swept lakes where the snow drifted badly, as many as four parallel roads were plowed—the outer ones acting as snow fences and intercepting the drift.

An interesting feature of the construction programme was the manner of arranging for the transportation of food stuffs for the eight hundred men who were employed on the construction. Practically all the food was hauled in during the winter, this item amounting to 1,380 tons, of which 250 tons were meat. Fresh vegetables, canned goods and eggs were placed in heated vans. The meat was allowed to freeze and upon its arrival was put in a frozen storage room. A 10-ton ice machine maintained the meat storage room at a temperature of 10 degrees above zero. A cold storage room with a temperature of slightly above freezing was also operated by the ice machine.

STRUCTURAL ENGINEERING IN LARGE BUILDINGS

At The Engineering Institute luncheon which was held at the Chateau Laurier on March 27th, 1931, A. H. Harkness, B.A.Sc., M.E.I.C., president of the Association of Professional Engineers of Ontario, spoke on the interesting technical details of the new Canadian Bank of Commerce building in Toronto. Among those at the head table with the chairman, G. J. Desbarats, C.M.G., M.E.I.C., and Mr. Harkness were L. L. Bolton, M.E.I.C., John McLeish, M.E.I.C., A. W. Mattice and F. H. Peters, M.E.I.C.

CANADIAN BANK OF COMMERCE BUILDING, TORONTO, ONT.

This building, the tallest in the British Empire, rises 35 storeys or $472\frac{1}{2}$ feet above the street level. The depth of the foundation is 62 feet and embodies 4 separate basements while some of the columns in the building support a weight of 4,400,000 pounds.

Mr. Harkness said that while there are other lines of engineering work in which development has been equally great, and perhaps, in some respects even greater, there is no development in modern civilization quite so spectacular as tall buildings. Dwelling for a few minutes on the importance of each specialized engineer's work to the whole, he pointed out that while structural engineers might build sky scrapers, the latter would not be of much use unless the electrical engineers and mechanical engineers installed elevators, lights, bells, heat and so forth, thus stressing the interdependance of these professions.

A short description was given of the various operations after the architect had submitted his plans—how "loads" were calculated, the different steps in making plans, from pencil sketches to the actual working blue prints. While the Canadian Bank of Commerce building did not present any features different from those met from time to time in equally tall or taller buildings some of the column loads reached magnitudes that have not very often been exceeded, on account of the heavy masonry walls and pilasters. The loads standing on the plate girders were also placed in this category.

Mr. Harkness illustrated his points with lantern slides of the building itself showing various features of interest from the excavation to the completed job; technical details, coal-bins, banking-rooms, walls, frame-work, spacing, tower and graphs of calculations.

CORROSION OF METALS

Dr. A. Stansfield, M.E.I.C., professor of Metallurgy at McGill University, Montreal, was the guest speaker at the noon luncheon held at the Chateau Laurier on April 9, his address being upon "The Corrosion of Metals." Dr. Stansfield was introduced by the chairman, G. J. Desbarats, C.M.G., M.E.I.C. In addition, the following were at the head table: R. F. Howard, M.E.I.C.; W. B. Timm; Colonel Mulock; Dr. R. W. Boyle, M.E.I.C.; R. J. Durley, M.E.I.C., General Secretary of The Engineering Institute; Dr. Chas. Camsell, M.E.I.C.; F. H. Peters, M.E.I.C.; F. E. Lathe; John McLeish, M.E.I.C.; R. Meldrum Stewart, M.E.I.C.; J. L. Rannie, M.E.I.C.; and B. Stuart McKenzie, M.E.I.C.

Dr. Stansfield remarked that while prehistoric articles of copper or bronze have come down to us with comparatively little corrosion, there are very few relics to-day of the iron age, iron being acted upon more rapidly than bronze when exposed to moisture. The question of the corrosion of metals had thus been one of considerable importance from early days. Such corrosion was due to the combination of a metal with oxygen or some other non-metallic element, and the corrodibility of metals could be measured by their tendency to combine with oxygen. The action of water or corrosive agents upon metals was greatly affected by the purity or otherwise of the metal, and as a rule material which was shown on microscopic examination to consist of a mixture of a number of different compounds, as in the case of cast iron or steel, showed more tendency to rust than pure electrolytic iron. By means of X-ray spectra it was now possible to study the atom arrangement in metals, and this had thrown much light upon the causes of corrosion.

Metals or alloys which were comparatively free from corrosion were those in which the various elements existed as a solid solution, as, for example, in copper-steel, where the atoms of copper were distributed throughout the mass of iron and did not cause electrolysis.

Discussing the action of various liquids, Dr. Stansfield pointed out that in the case of water corrosive action on a single piece of metal might be produced if the amount of oxygen dissolved were different in different parts of the solution. Thus, for example, the action of moisture upon iron was largely due to the difference in oxygen content of the water at different places where it was in contact with the iron.

When corrosion had occurred, the resulting film of oxide or other product of corrosion might or might not protect the metal beneath it. In aluminum the oxide film prevented further corrosion, while with iron this was not the case.

Dr. Stansfield's address was illustrated by slides and was listened to with the greatest of interest by his audience. Toward the conclusion of the meeting the chairman took the opportunity to extend congratulations to Dr. Charles Camsell for being awarded the medal presented by the Institute of Mining and Metallurgy of Great Britain for achievement of outstanding importance in connection with the sciences of mining and metallurgy. The award went to Dr. Camsell this year for his work in connection with promoting development of the mineral resources of the Dominion. Dr. Camsell responded briefly and stated that the award, in his opinion, was not so much a personal one as a recognition of the work being done in Canada by Canadians.

Peterborough Branch

S. O. Shields, Jr.E.I.C., Secretary.
B. Ottewell, A.M.E.I.C., Branch News Editor.

AUTOMOBILE BODY DESIGN

At the meeting of the Peterborough Branch of The Institute held on March 26th, 1931, the speakers, Messrs. J. E. V. Shortt and Charles Smith, both of the General Motors Company of Canada, were introduced by the chairman, W. E. Ross, A.M.E.I.C.

The numerous tests to which automobiles are subject to ensure the utmost of performance was explained and illustrated by films, which proved most informative and unfolded facts unknown to the average automobile owner.

For instance, the General Motors Corporation maintain an immense proving ground some 1,245 acres in extent a short distance north west of Detroit, wherein are built roads of every type and description and where a scientifically banked speed loop, one of the finest on the American continent, is constructed, and where General Motors products are run against those of their competitors without prejudice or favour.

In this proving ground are roads constructed of gravel and concrete, dust roads, rutty roads, water-logged roads and miry roads; there are also service stations run and operated by almost every car manufacturer on the continent, living quarters for resident and visiting engineers and a lecture auditorium.

Before going out on test the cars are each measured and every specification duly noted by competent engineers—nothing is left to chance or taken for granted. The automobiles are then started out on a 2,000 mile running-in test, during which they are held at specified speeds. At 2,000 miles the cars are tuned-up for the more gruelling engineering tests, after which they are subjected to over 100 different scientific and mechanical examinations covering speed, safety, riding comfort, performance and durability.

A detailed record is kept of the performance of each car, so that comparisons can easily be made at any time between two automobiles of different makes, while any part of the mechanism which gives way under the strain which is imposed upon it, is sent to the laboratories for scientific investigation as to the underlying cause for that breakdown.

Mr. Smith traced the growth of the bodies from the time when they first take shape in full size chalk drawings, which after approval by the designers and artists, takes more concrete shape in the form of clay models, from which wooden patterns are made. He went on to describe the construction of the steel panels of the body which are made from the wood patterns, and how each part is carefully woven together. Tests are conducted on the finished body to prove its roadibility, freedom from vibration, its comfort and ability to withstand the weather, etc.

He averred that the present trend in automobile body design is for speed, and consequently lighter bodies, in other words a decrease of weight and increased strength.

Both speakers were accorded a hearty vote of thanks.

Quebec Branch

P. Methé, A.M.E.I.C., Secretary-Treasurer.

HISTORIC BUILDINGS AND EARLY INDUSTRY IN QUEBEC

On April 9th, 1931, the Quebec Branch held a well attended meeting in a seventeenth century setting, the vaults of the old Boswell brewery, which formerly were part of the Intendant's palace. The building was originally constructed in 1668 as the Brasserie du Roi by Jean Talon, the first Intendant of New France, and later, after the return of Talon to France about 1675, was purchased from Talon by the government and became an official residence and the meeting place of the SovereignCouncil.

The Intendant Bégon had hardly taken up his residence there when in 1713 the building was destroyed by fire, a fate which overtook it again in 1726. In 1775, the building, then abandoned as a seat of government, was occupied by the Americans, and was greatly damaged by the bombardment it received from the Garrison of Quebec. Later its ruins formed the basis on which the present Boswell brewery was established, the original vaults being incorporated in the more modern building, and reverting to their original purposes.

At the meeting, Hector Cimon, M.E.I.C., gave an interesting historical résumé of the development of early industry in Quebec, of which the following is an abridgment.

AUX CAVES DE TALON

Les voûtes hospitalières qui nous abritent ce soir, furent construites au XVIIe siècle, par Jean Talon, premier Intendant de la Nouvelle-France, un homme d'une grande valeur qui fit des sept années de son séjour au Canada (1665-72) une des périodes les plus intéressantes de l'histoire de ce pays.

La plaque de bronze que l'on voit sur la façade de l'édifice actuel, rue St-Nicolas, rappelle aux passants qu'ici fut érigée en 1668, il y a 263 ans, la première brasserie, la Brasserie du Roi et qu'elle fut transformée après quelques années en "palais de l'Intendant."

En 1665 s'ouvrit une ère nouvelle pour le Canada. La France alors prospère et glorieuse après une série de victoires, suivie des traités avec l'Allemagne et l'Espagne et d'une période de paix et de prépondérance dans les affaires de l'Europe, était à l'aurore du grand règne de Louis XIV qui affirmait sa volonté de gouverneur lui-même dès l'âge de 23 ans. Les requêtes des pionniers de la Colonie auprès du trône de France allaient enfin trouver une oreille bienveillante et les secours depuis si longtemps attendus allaient être effectivement donnés à sa jeune France d'outre-mer.

Le développement du pays avait jusqu'ici été laissé aux soins de Compagnies plus intéressées dans la traite des fourrures que dans la colonisation et la mise en valeur des autres ressources naturelles. Aussi, depuis bientôt 60 ans que la nation Canadienne était née, le jour de la fondation de Québec, en 1608, et qu'il y avait eu résidence en permanence sur les bords du St-Laurent, la population s'était-elle accrue bien lentement au faible chiffre total d'environ 3,000 âmes.

En 1668, Talon avait fait passer par le conseil une ordonnance très importante concernant l'importation des boissons alcooliques et l'établissement des brasseries.

Talon voulait en même temps créer un marché pour le surplus des grains et ainsi engager les gens à se livrer à la culture.

Prêchant d'exemple, il construisit lui-même la première brasserie—où nous sommes réunis.

Commencée en 1668, elle était en opération 2 ans plus tard et en 71, Talon écrivait dans un mémoire: "Elle peut fournir 2,000 barriques de bière pour les Antilles, si elles en peuvent consommer autant, et en travailler autre 2,000 pour l'usage du Canada, ce qui donnera lieu à la consommation de plus de 12,000 minots de grain par chaque année."

Quoiqu'elle fut connue dans le temps par les habitants comme la Brasserie du Roi, cette première brasserie appartenait à l'Intendant personnellement et elle figurait dans la liste de ses biens, d'après son estimation personnelle, à 43,192 livres ($9,000, environ).

Après son retour en France, Talon négocia pour la vente de ses propriétés du Canada. Mais, le roi, satisfait des services de Talon, priait le gouverneur de s'intéresser aux propriétés de l'ex-Intendant, spécialement à la brasserie dont on projetait l'acquisition pour des fins publiques et, finalement, le marché se conclut pour une somme de 30,000 livres ($6,000), en 1685.

Le palais de l'Intendance, qui servirait de résidence à l'Intendant, aussi bien que de lieu de réunion pour les séances du Conseil Souverain, de prison et de magasins de l'état, allait succéder à la première brasserie du Canada.

Un incendie désastreux ravagea une première fois le Palais, le 5 janvier 1713. L'intendant Bégon s'y était installé l'automne précédent avec un mobilier et un équipage des plus magnifiques. Le palais fut immédiatement reconstruit aux frais du Roi et Bégon vit à ce qu'il fût bien plus somptueux qu'auparavant. En 1726, le feu visita de nouveau le Palais qui fut restauré l'année suivante.

Le fameux Bigot fut le dernier Intendant qui présida, et, pendant les 11 années de son séjour, le palais fut témoin d'une force et d'une splendeur sans précédents.

Vint la Conquête (1759) et sous le régime anglais le Palais fut négligé comme résidence officielle. Enfin, au cours de l'invasion Américaine, 1775, un détachement de l'armée d'Arnold s'étant retranché dans ses murs, le Palais fut soumis au bombardement de la garnison de Québec et détruit en grande partie.

En fin de compte, les extrêmes se touchent parfois puisque des ruines de la Brasserie du Roi surgit la Brasserie Boswell dont nous apprécions la bonne et hospitalière courtoisie en ce moment.

Une tannerie fut aussi établie près de Québec, et l'Intendant sut développer diverses industries domestiques et autres, les plus nécessaires à la colonie, si bien qu'il écrivait dans un mémoire en 1671: "J'ai fait faire, cette année, de la laine, qu'ont portée les brebis que Sa Majesté a fait passer ici, du droquet, du bourocan, de l'étamine, de la serge de seigneur; on travaille des cuirs du pays près du tiers de la chaussure et, présentement, j'ai des productions du Canada de quoi me vêtir du pied à la tête.

D'autres industries ayant pour vus de venir en aide à la colonisation furent celles de la fabrication de la potasse et du goudron.

La potasse canadienne devait être employée soit pour lessiver le linge, soit convertie en savons mous, pour nettoyer les soies et dégraisser les draps et devait affranchir la Mère-Patrie du tribut qu'elle avait à payer à la Moscovie pour ses potasses et à l'Espagne pour ses soudes. Par ailleurs, cette industrie favorisait le défrichement des terres canadiennes en fournissant un moyen de rétribuer ce travail. L'entreprise fort avantageuse pour les habitants ne devait cependant pas survivre bien longtemps après le départ de Talon.

Le goudron devait aussi être tiré de nos arbres par distillation et servir tant aux chantiers maritimes du Canada qu'à ceux de France. Talon avait fait venir des experts pour organiser cette industrie et enseigner aux habitants la méthode de la faire. Il en fut fabriqué de très bon, paraît-il, mais le sort de cette initiative devait être la même que celui des potasseries.

Il convient aussi de noter que la construction des navires à Québec, industrie qui fut si active ici pendant de nombreuses années est due à la sagacité de Talon dont le but était d'obtenir des moyens d'échange commerciaux et des débouchés pour les produits du Canada. Il fournit ainsi des vaisseaux de tous tonnages pour les communications fluviales de la colonie, la pêche et surtout en circuit canadien de navigation d'ici aux Indes Occidentales et en France. Prenant toujours l'avant et réalisant par ses actes ce qu'il prêchait aux autres, on le vit s'associer à un marchand local pour expédier aux Antilles sur des vaisseaux Canadiens, une des premières cargaisons de produits canadiens consistant en saumon, anguille, morue sèche et salée, pois, huile de poisson, douves, madriers et petits mâts.

La prospective des mines reçut aussi une attention particulière. En 1666 un ingénieur, M. de la Tesserie, rapportait qu'une mine de fer très abondante gisait à la Baie St-Paul et qu'il espérait y trouver aussi du cuivre et peut-être de l'argent. Un autre ingénieur, Sieur de la Potardière, vint de France l'année suivante pour examiner cette mine et celle des environs des Trois-Rivières que l'on venait de découvrir et déclara qu'il n'était pas possible de trouver du meilleur fer et en plus grande abondance.

Saskatchewan Branch

Stewart Young, A.M.E.I.C., Secretary.

Annual Meeting

The annual meeting of the Saskatchewan Branch of The Engineering Institute of Canada was held in the Kitchener hotel at 6.30 p.m. on Friday, March 27th, the meeting being preceded by a banquet at which there were forty-nine guests present.

The meeting was presided over by the branch chairman, Professor W. G. Worcester, M.E.I.C., of the University of Saskatchewan. After the toast to the King, the minutes of the previous annual meeting together with the minutes of the last regular meeting were read by the acting secretary, S. Young, A.M.E.I.C. There being no objection to the minutes these were duly confirmed.

There then followed an explanation of the necessity for a substitute to take the Secretary's place, and on motion of Messrs. MacKenzie and D. A. McCannell, M.E.I.C., the acting Secretary was instructed to convey the sincere regrets of the meeting to Mrs. Loucks at the inability of R. W. E. Loucks to be present, also best wishes for his speedy recovery.

The acting Secretary then read letters of good wishes for a successful meeting from W. T. Thompson, M.E.I.C., Cranberry Portage, Man., M. Sinclair, A.M.E.I.C., Yorkton, and J. W. Hamilton, Dauphin, Man.

On behalf of the legislative committee, P. C. Perry, A.M.E.I.C., reported that the committee had no report to submit, there being no activity in legislation this year.

J. W. D. Farrell, A.M.E.I.C., reported on behalf of the Papers and Library committee. This report, on motion of Messrs. Farrell and Ritchie, was adopted.

The report of the Executive committee was then read by the acting Secretary, and on motion of Messrs. McCannell and MacKenzie was adopted.

Messrs. Kirkpatrick, Laird, Sergeant Day and Corporal Leatham, R.C.M.P., entertained the guests during the banquet.

The Financing of Canadian Engineering Projects

The chairman then called on Mr. W. L. Gilliland for his address on "The Financing of Canadian Engineering Projects." Mr. Gilliland, the manager of the local branch of the Imperial Bank of Canada, and an authority on the subject, defined engineering and traced the development of engineering science from very early times to its present high standards. He stated that to-day engineering is one of the outstanding professions. The profession had advanced until at the present time marvellous feats such as the Suez, Panama and Welland canals have been carried out. The transcontinental railways were another marvel, and from these examples, he stated, it was obvious that the activities of the engineer are among the greatest factors in modern life.

All these projects cost money and it therefore is the duty of the engineer to see that they are successfully put across. Mr. Gilliland divided engineering projects roughly into two classes according to authority: (*a*) Government, (*b*) Private capital.

Under the heading of government activities he cited canals, power plants, highways, public buildings, stating that for these projects it was the custom to issue bonds which become a general charge on the public domain. With respect to private capital he divided the activities into two groups according to the nature of the investment: (1) highly speculative, (2) more nearly a project of safe investment such as a government bond.

In the first group he stated that mining claim development would be a fair example. A group of men would at first finance the project, later selling stock to the public, which is willing to speculate, thus the capital for development is obtained. In the second group as an example he cited a power development. A few men would organize a company, subscribe an amount to start, then an engineer would make an investigation. On the strength of his report if favourable, the group would go to a banker, who in turn would retain an engineer. If his report is favourable, the financier would put out a bond issue. A trust company would take a mortgage to cover the assets and thus the bond holders were protected, interest being payable at stated periods for definite amounts. In the event of failure to meet the interest charges the trust company could take charge of the plant for the bond holders. Usually the company was obliged to create a sinking fund to retire the bonds. In an organization of this nature there must also be a capital structure;

this is termed usually the common stock. These are the controlling owners. Finally the bond holders must be paid off and often this is done through common stock. The initial expenditures also often take common stock and are thus reimbursed.

Mr. Gilliland's address was productive of considerable discussion, a number of questions being asked and answered.

On motion of J. D. Peters, A.M.E.I.C., and A. C. Garner, M.E.I.C., a hearty vote of thanks was tendered to Mr. Gilliland and to the entertainers.

The scrutineers then reported for the ensuing year reporting a tie between Messrs. W. H. Hastings, A.M.E.I.C., and S. R. Muirhead, A.M.E.I.C., as members of council. On the tossing of a coin Mr. Hastings won the toss.

The officers for the ensuing year were then declared by the Chairman to be D. A. R. McCannell, Chairman; J. D. Peters, Vice-Chairman; S. Young, G. M. Williams, A.M.E.I.C., W. H. Hastings, Executive committee.

The nominating committee for the ensuing year is A. P. Linton, A.M.E.I.C., A. R. Greig, M.E.I.C., E. H. Phillips, A.M.E.I.C., M. B. Weekes, M.E.I.C., J. R. C. Macredie, M.E.I.C.

On motion of Messrs. Peters and Houston the meeting adjourned at 10.30 p.m.

Saint John Branch

A. A. Turnbull, A.M.E.I.C., Secretary-Treasurer.

A meeting of the Branch was held in the Saint John Board of Trade rooms on Thursday, March 19, 1931, at 8 p.m., with the chairman, W. J. Johnston, A.M.E.I.C., presiding.

Experiences of an Oil Geologist in India

The speaker of the evening was Dr. W. J. Wright, provincial geologist, of the Department of Lands and Mines, Fredericton, N.B. Dr. Wright is also professor of mineralogy at the University of New Brunswick. Dr. Wright gave a very interesting address on the "Experiences of an Oil Geologist in India" and "The Great Vale of Kashmir," illustrating the address with many excellent lantern slides depicting the country and the inhabitants.

Following the illustrated address on India, Dr. Wright spoke of the geological conditions in the Province of New Brunswick. He deplored the fact that New Brunswick people were not "prospecting minded" enough and stated that in his opinion the future of the mineral wealth of the province depended upon non-metallic minerals such as coal, gypsum, salt and building stone. Providing the minerals are there, the geological formations would indicate that there is no reason why New Brunswick should not have as great mineral development as Ontario. He urged that all prospects be fully investigated before extensive operations were undertaken. If there was a decent showing there would be no trouble in obtaining money for testing. He spoke of the fine new laboratory which the Department of Lands and Mines had fitted up in Fredericton for the purpose of helping mining in the province and of conducting researches into mining prospects. Prospecting in New Brunswick, he claimed, was difficult because of the "drift" that in many parts was overlaying the stratified or other rock formations.

Sault Ste. Marie Branch

A. A. Rose, A.M.E.I.C., Secretary-Treasurer.

The regular monthly meeting of the Sault Ste. Marie Branch was held in the Y.M.C.A., on Friday, March 27th, following a dinner.

Atlantic Outports of Canada

The speaker of the evening was H. F. Bennett, A.M.E.I.C., district engineer, Department of Public Works. He had taken as his subject "Atlantic Outports of Canada," and as Mr. Bennett has but recently come to Sault Ste. Marie from Halifax, where he was assistant engineer for the department, and as he was also for a number of years at Saint John, he had a first-hand knowledge of his subject.

Introducing his subject Mr. Bennett mentioned a few of the almost innumerable harbours of Nova Scotia and New Brunswick. In general these harbours may be classed as fishing harbours, harbours of safety and national harbours.

Of the hundreds of fishery harbours, the speaker described in some detail two, Cove Harbour on Grand Manan island and Lunenburg, famous as the home of the "Bluenose" and those other boats that fish "The Banks."

The two most important harbours of safety are Sydney and Louisburg in Cape Breton. Sydney is very large and well protected and easy of approach. Louisburg, the winter port of Sydney, is open the year round.

The national ports of Saint John and Halifax were described in considerable detail. Saint John, the mouth of a river, has its own peculiar problems due to its being situated on a soft soil instead of rock and to the tides, there being a range of 28 feet at the spring tide. Saint John is open the year round, is the winter harbour of the Canadian Pacific Railway of whose main line it is the eastern terminal. It gives freight service to almost any port in the world, and in the speaker's opinion its freight service is due for a large development.

Halifax harbour is the great naval base of the north Atlantic and an extremely well protected harbour. In contrast to Saint John it is situated on rock, is not a river mouth and has a tide range of about 4½ feet. It is a "port of call," being near the lane from New York to Liverpool and is specially equipped for passenger service, in which line it is likely to increase.

The address was appropriately illustrated by maps, lantern slides and photographs.

Following an interesting discussion, a vote of thanks was tendered Mr. Bennett for his most interesting and instructive address on motion of Messrs. C. H. E. Rounthwaite, A.M.E.I.C., and R. S. McCormick, M.E.I.C.

Toronto Branch

W. S. Wilson, A.M.E.I.C., Secretary-Treasurer.

The Civil Government Activities of the Royal Air Force

On the evening of March 5th the Toronto Branch was privileged to hear an address on "The Civil Government Activities of the Royal Air Force" by Wing-Commander G. O. Johnson, A.M.E.I.C., officer in charge of Flying Operations Branch, Department of National Defence. Commander Johnson's paper was very interesting to all present. In introducing his subject the speaker told how the application of aircraft to civil government work, in an experimental way, was originated by the Air Board in 1920. By 1923 when the Air Board was merged with the Department of Militia and Naval Service in the Department of National Defence, civil government air operations were deemed essential by the various departments concerned and the work was continued by the Royal Canadian Air Force. By 1927, 48 officers and 206 airmen of the Royal Canadian Air Force were employed on civil government work. The foundation of the civil government organization was a forest protection service in Manitoba, Saskatchewan and Alberta which expanded from year to year until it reached a peak in 1927. Gradually, however, other classes of work were developed and extended until they have become more extensive than the forest protection service.

The methods employed in the forest protection service vary with the nature of the country. The east slopes of the Rockies have been patrolled since 1920 but as the areas are mountainous and devoid of places to land the service is primarily a detection service corresponding to a city fire alarm system. On the other hand, the forest areas of Manitoba and Saskatchewan include numerous lakes and rivers on which seaplanes can alight. In these areas the air service not only locates fires in their early stages but also transports men and fire-fighting equipment to nearby lakes and rivers. By placing crews on fires promptly, most of the fires are prevented from spreading to any serious extent.

A large part of the civil government activity is photography, the type of photograph varying with the purpose for which it is to be used. The late Dr. Deville, former Surveyor General of Canada, devised a method of mapping with a reasonable degree of accuracy from photographs taken obliquely at an altitude of 5,000 feet with the horizon showing in each exposure, the method being applicable only to areas in which the variation of ground elevation is relatively slight. Weather permitting, one aeroplane can take photographs in a 4-hour flight to map more than 1,000 square miles.

Another activity is that of reconnaissance flights over large areas to determine hill tops suitable for observation posts, for the forest service to investigate timber resources and for the geological survey to locate rock and outcroppings and geological formations. Transportation of survey and investigation parties proceeding to northern points is another activity, thus increasing the working time of these parties. Some years ago the Department of Agriculture called upon the Air Force to assist in developing methods of combating insect and fungus pests. Experimental work is still being carried on to perfect a dusting apparatus from an aeroplane to combat the spruce bud worm and the hemlock luper which completely destroy an area of timber in which they get established. It has also been proven that wheat rust can be combated by dusting a crop two or three times at intervals of one week during the first three weeks in July, provided that the dust is not washed off by rain, but at the present price of wheat the process is not economically worth while.

The organization of the directorate of the civil government air operations is centred at Ottawa, Winnipeg, High River and Vancouver, and the work is carried out from these bases. The speaker then described the activities of the service in 1930 showing the great amount of work that is being done. In conclusion Wing-Commander Johnson stated that the function of the Civil Government Air Operations is in applying aircraft to assist in the administration and development of Canada's resources in such a manner as to expedite development and effect economy. The lecture was illustrated by slides and on conclusion a hearty vote of thanks was tendered the speaker for coming from Ottawa to address the Toronto Branch.

Structural Engineering in Some Recent Buildings

The speaker at the meeting of the Toronto Branch on March 19th was Mr. A. H. Harkness, M.E.I.C., of the firm of Harkness and Hertzberg, consulting engineers, who presented a paper on "Structural Engineering in Some Recent Buildings." Mr. Harkness gave a very interesting and instructive talk on structural engineering as applied to the modern tall building and dwelt particularly on the Canadian Bank of Commerce Building in Toronto and the Sun Life Building in Montreal. In opening his remarks the speaker mentioned the importance of the work and how spectacular is the construction of this type of building, possibly because of its conspicuous position. In describing the evolution of the skyscraper Mr. Harkness stated that the first work done towards its construction falls to the architect who will probably spend months preparing sketch plans and in consultations with the owner, keeping in mind the engineering possibilities. Following this the general plans are submitted to the engineer who prepares a preliminary lay-out of the steel framing to see that no unreasonable or unsurmountable difficulties are met with. After the plans including elevations have been fully decided on the engineer proceeds with his design. Different firms have different methods and Mr. Harkness described the one used by his firm which is as follows: Pencil plans of all floors are made locating the columns, beams and girders, arranged with regard to floor construction, elevators, stairs, etc. A preliminary investigation is made of wind pressures and the best method of providing for it is decided on. The direction in which the columns will stand is then determined having respect to beam connections and resistance to bending from wind stresses. Next all loads are carefully calculated for live and dead loads, for beams and fire-proofing of same, piers, column fire-proofing, elevator machinery, water tanks, and these are noted on the floors on which they occur. The column loads are individually tabulated on column sheets and the total loads are transferred to another sheet from which the columns are designed, additional areas due to bending on account of eccentric loading and wind being added as required. The columns so designed are then tabulated on the column drawings. After the beams have all been designed the floor plans are traced off and special drawings made of girders, trusses and special details.

The new Bank of Commerce which at the present time is the tallest building in the British Empire, did not present any features different from those met with from time to time in equally tall and taller buildings in the United States. However on account of the heavy masonry walls and pilasters and the off-set columns, some of the columns reached magnitudes that have not often been exceeded and neither have the loads standing on plate girders.

Mr. Harkness then showed a considerable number of slides describing the Bank of Commerce building. This structure has 35 storeys with 4 basements, and has a height of 472 feet 6 inches. The first storey is 33 feet, the second and third are 18 feet, the fourth and fifth are 15 feet, the sixth is 14 feet and the balance are generally 12 feet, thus making the building equivalent to a 39-storey building having 12 feet storey heights. The exterior is of Indiana limestone backed with brick, the walls being 14 inches in thickness. The floors are of long span ribbed slab reinforced concrete. The banking room at the south side has a width of 85 feet with a ceiling about 60 feet high. The general excavation for the building was carried 47 feet below street level and for the boiler room 63 feet.

The slides shown covered the building in detail and they were fully explained by Mr. Harkness. A feature was the extremely heavy column sections and girders that were required. The wind pressure was figured for a load of 30 pounds per square foot with 25 per cent overstress allowed. This took care of the stresses down to the 26th floor while below the 26th floor they were carried in the outer wall columns.

Following Mr. Harkness's address a moving picture was shown of the construction of the Empire State building in New York, the tallest building in the world. This film was shown by courtesy of the Canadian Institute of Steel Construction. A general discussion followed and it was easily seen that the lecture had been well received by the members of the Toronto Branch.

Annual Meeting

The Annual Branch Meeting of the Toronto Branch was held on Thursday evening, April 2nd, 1931. During the evening the reports of the various committee chairmen were received and R. J. Durley, M.E.I.C., who was present, spoke on Institute affairs. Following the counting of the ballots the scrutineers reported the election of the following officers.

Chairman	C. S. L. Hertzberg, M.E.I.C.
Vice-Chairman	J. Roy Cockburn, M.E.I.C.
Secretary-Treasurer	W. S. Wilson, A.M.E.I.C.
Committee	G. H. Davis, M.E.I.C.
	W. W. Gunn, A.M.E.I.C.
	R. E. Smythe, A.M.E.I.C.

The scrutineers also reported that the change in the Branch by-laws which allows a continuity of service for the secretary-treasurer had passed. Following this Mr. Hertzberg was conducted to the chair and after speaking briefly declared the meeting closed.

Winnipeg Branch

E. W. M. James, A.M.E.I.C., Secretary-Treasurer.

Annual Meeting

The annual meeting of the Winnipeg Branch of The Institute was held in the Engineering building of the University of Manitoba on February 19th.

Colour

On this occasion the speaker of the evening was the Right Reverend Monsignor Morton, who delivered an extremely interesting address under the title of "Colour," which was defined as a sensation produced on the retina by means of energy impulses which occur with varying frequencies up to 763 grand billion per second. Monsignor Morton's address was illustrated by lantern slides and experiments which the speaker performed with great dexterity. An interesting fact was brought out, viz. that perception of red and green is very poor in an astonishing number of persons (from 1 in 80, to 1 in 20), and that perception of orange and blue is almost universally good. This provides a strong argument in favour of substituting orange and blue for the conventional red and green in traffic signals.

Retiring chairman J. W. Porter, M.E.I.C., read the report of the Executive committee, and remarked that apparently there is a tendency for small attendance, when meetings are held monthly, as compared to that when meetings are held fortnightly; and as the Branch has decided in favour of continuing fortnightly meetings, it is hoped that the desired effect upon attendance will be produced.

The report of the committee on Students' Prizes was read by Dean E. P. Fetherstonhaugh, M.E.I.C. The prizes were awarded as follows:

- 1st prize Civil Engineering, $25 to L. E. Jones, S.E.I.C., for a paper entitled "Track Realignment."
- 2nd prize Civil Engineering, $15 to W. E. Morden, for a paper entitled "Open Pitwork at Flin Flon."
- 1st prize Electrical Engineering, $25 to G. M. Bell, S.E.I.C., for a paper entitled "Arc Welding, its Principles, Control and Application."
- 2nd prize Electrical Engineering, $15 to H. A. Park, for a paper entitled "Preparing High Tension Transmission Line Foundations."

The report of the scrutineers was presented, showing the election of the following:

Chairman—Charles T. Barnes, A.M.E.I.C.

To the Executive Committee—W. E. Hobbs, A.M.E.I.C., J. M. Morton, A.M.E.I.C.

Chairman, Nomination Committee—F. H. Martin, M.E.I.C.

Auditors—R. H. Andrews, A.M.E.I.C., D. N. Sharpe, M.E.I.C.

Chairman, Library and Publication Committee—J. F. Cunningham, Affil.E.I.C.

Chairman, Legislation and Public Affairs Committee—D. L. McLean, A.M.E.I.C.

Chairman, Advisory Committee—E. P. Fetherstonhaugh, M.E.I.C.

" Remuneration Committee—C. H. Fox, M.E.I.C.

" Students' Prize Committee—E. V. Caton, M.E.I.C.

" Programme Committee—A. E. MacDonald, Jr.E.I.C.

" Research and Investigation Committee—C. A. Clendening, A.M.E.I.C..

Nominees for Councillors—J. N. Finlayson, M.E.I.C., J. W. Porter, M.E.I.C.

Secretary-Treasurer—E. W. M. James, A.M.E.I.C.

Preliminary Notice

of Applications for Admission and for Transfer

April 18th, 1931.

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, 1931.

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

ALEXANDER—DAVID TASKER, of Sandwich, Ont., Born at Dundee, Scotland, Jan. 14th, 1885; Educ., 1901-04, Dundee Technical College. I.C.S. Struct'l. Engrg. and Bldg. Constrn. courses; 1909 to date, with the Canadian Bridge Co. Ltd., Walkerville, Ont., as follows: 1909-14, detail drawings of bldgs. and bridges; 1914-16, checking bridge drawings; 1916-19, asst. supt. of munitions plant; 1919-22, squad foreman in charge of dfting-room work on bridges; 1922-23, design of bridges; 1923 to date, chief dftsman. in charge of all dfting-room operations.

References: P. B. Motley, W. A. Duff, M. B. Atkinson, J. C. Keith, F. H. Kester, S. E. McGorman.

BEMAN—EDWIN ARTHUR, of Regina, Sask., Born at Saltoun, Sask., Nov. 14th, 1902; Educ., B.E., Univ. of Sask., 1928; Season 1924, rodman and recorder, and season 1927, instr'man., plane table surveys, Geol. Survey of Canada; 1928-30, res. engr. on constrn. of municipal water supply system, also gen. surveying, Underwood & McLellan, Saskatoon; 1930 to date, res. engr. on road constrn. and prelim. surveys, Dept. of Highways, Prov. of Sask., Regina, Sask.

References: C. J. Mackenzie, J. E. Underwood, R. A. McLellan, H. R. MacKenzie, W. W. Perrie.

BREAKEY—JAMES, of 227 Garden Ave., Toronto, Ont., Born at Sheffield, England, Sept. 19th, 1901; Educ., Associate in Engrg., Sheffield Univ., 1921; 2nd Engr's. British B.O.T. Cert. (Marine), 1929; 1922 (July-Dec.), student in erection shops, Brightside Foundry & Engrg. Co., Sheffield; 1923-25, college ap'tice, Metropolitan-Vickers Electrical Co. Ltd., Manchester, England; with same company as follows: 1925 (Jan.-Oct.), engr. on erection of mech'l. and elect'l. apparatus, and in particular erection of a complete power plant (two 2,500 kv.a. turbo generator sets and auxiliaries); Oct. 1925 to Feb. 1926, inspection of various turbo generator sets in power plants and reporting on condition of same; Feb. 1926 to Jan. 1927, design of power plants; 1927-29, sea-going engr., with P. Holt & Co. Liverpool, on two of their 10,000 ton liners; 1929 (June-Sept.), dftsman., industrial drawing office, Canadian Vickers Ltd., Montreal, on design of "Kidwell" boilers; Oct. 1929 to date, associate editor, technical publications of The MacLean Publishing Company (Power House, Canadian Machinery and Manufacturing News, and Canadian Foundryman).

References: C. B. Hamilton, Jr., R. E. Smythe, A. C. Malloch, R. Ramsay, G. Agar.

FOSS—WALLACE LELAND, of 1036 College Drive, Saskatoon, Sask., Born at Velva, North Dakota, Aug. 26th, 1901; Educ., B.Sc. (C.E.), Univ. of Sask., 1930; 1928 (summer), instr'man. for C. J. Mackenzie, M.E.I.C.; 1929 (summer), and May 1930 to date, field engr., City of Saskatoon, road and street constrn. and estimates—street rly. and other municipal projects.

References: H. M. Weir, A. R. Greig, C. J. Mackenzie, W. G. Worcester, R. A. Spencer.

GUMLEY—FRANC STEWART, of 740-8th St. East, North Vancouver, B.C., Born at Edinburgh, Scotland, Oct. 8th, 1898; Educ., 1914-18, Heriot-Watt Technical College. Member, Assn. Prof. Engrs. B.C. by Exam.; 1914-18, ap'ticeship, North British Railway Co., Scotland. Junior in new works dept., surveying, location, assting. in major schemes, carrying out minor ones; 1920-23, with Bain & Brown Ltd., reinforced concrete engrg. and contractors, Edinburgh. 3 mos. dftsman., 1 year designer, 1½ years field engr.; 1923-24, with Butterfield & Swire, Hong Kong, asst., works dept., on inspection of works; 1924-28, with same company, formed contracting dept., and assumed control of constrn. in China, including warehouses, wharf properties and wharves, dwellings and office blocks; 1929 to date, designer in drawing office, Western Bridge Company, North Vancouver, B.C.

References: J. A. McFarlane, E. C. Thrupp, E. A. Wheatley, J. P. Mackenzie.

HEWSON—JOSEPH SELDEN, of 28 Martin Ave., Dorval, Que., Born at Amherst, N.S., Feb. 8th, 1898; Educ., B.Sc. (Civil), Nova Scotia Tech. Coll., 1924; 1922-23 (summers), instr'man. on road constrn., N.S. Prov. Highways Board; 1924-31, with Turner Construction Co., New York, as follows: 1924-26, timekeeper, accountant, cost accountant; 1926-28, line and grade engr. and asst. supt. on constrn.; 1928-31, supt. in charge of constrn. of bldgs., this work involved organizing jobs, some purchasing and general executive work.

References: H. R. Little, F. R. Faulkner, H. Donkin, H. W. McKiel, F. L. West.

LEACH—JOHN WILLIAM, of 1325 Dorchester St. West, Montreal, Que., Born at Broxburn, Scotland, Sept. 28th, 1902; Educ., B.Sc. (Mech.), Univ. of Sask., 1927; 1927 (2 mos.), ap'tice course, Canadian Westinghouse Company, Hamilton, Ont.; 1926 (4 mos.), asst. with Regina Creosoted Products; 1927 to date, maintainer of Diesel-Electric cars, C.N.R., Montreal, Que.

References: C. J. Mackenzie, J. J. White, R. G. Gage, A. R. Greig, I. M. Fraser.

MORTON—PHILIP S. A., of 441 Water St., Peterborough, Ont., Born at Barrie, Ont., Oct. 4th, 1903; Educ., B.A.Sc., Univ. of Toronto, 1928; 1928 to date, with Canadian General Electric Co., Peterborough, as follows: 1928-29, test course; 1929-30, asst. foreman, test dept.; Apr. 1930 to date, junior engr., engrg. dept.

References: L. DeW. Magie, V. S. Foster, A. B. Gates, W. E. Ross, W. M. Cruthers.

RENSAA—EGIL MIKKELSEN, of Winnipeg, Man., Born at Ibestad, Norway, Mar. 19th, 1896; Educ., 1919-23, Bergen Technical Prepar'y. School, with high school graduation; 1923-25 (21 mos.), Bergens Tekniske Skole, Norway. Civil Engr., June 1925; 1917-19, highway constrn., foundation and sea canal constrn., Norway; 1920-22, chainman and rodman, Norwegian Govt. Rlys.; 1925 (July-Dec.), dftsman., Harstad Iron Works, Norway; 1927 (June-Dec.), chainman, 1928-29, dftsman., April 1929 to date, designer, C.N.R., Winnipeg.

References: T. C. Main, J. W. Porter, W. Burns, G. M. Pearston, J. L. Charles.

RIDOUT—GEOFFREY SWABEY, of Montreal, Que., Born at Toronto, Ont., July 9th, 1895; Educ., B.A.Sc., Univ. of Toronto, 1922. R.M.C. 1912-14; 1920-22 (summers), Canadian Westinghouse Co.; 1922-24, Evans & Howard Fire Brick Co., St. Louis, Mo.; 1915-20, Commissioned Officer, Royal Engrs., Overseas; 1924 to date, with Bell Telephone Company of Canada as follows: 1924-27, engrg. asst. (equipment), 1927-29; divn. equipment engr., Montreal, and 1930 to date, divn. plant engr., Montreal.

References: R. V. Macauley, H. E. McCrudden, A. M. Mackenzie, A. B. McEwen, H. W. B. Swabey.

SCRYMGEOUR—CHARLES, of Dartmouth, N.S., Born at Liverpool, England, Feb. 17th, 1894; Educ., 1907-10, Bootle Engineering College; 1910-13, Liverpool Engineering College (evening classes); 1910-15, engrg. ap'tice, Jas. Buchanan & Sons, Ltd., Engineers, Liverpool, England, including one year (1914-15), as asst. foreman on constrn. of Acadia Sugar Refinery at Woodside, N.S., under contract for this company; 1915-16, foreman, munitions dept., of above company; 1917-19, asst.

supt., munitions dept., (5,000 employees), Austin Motor Co., Longbridge works, Birmingham, England; 1919-21, dftsman., Acadia Sugar Refining Co. Ltd., Woodside, N.S.; 1921 to date, with Imperial Oil Refineries, Ltd., as follows: 1921-27, engr. and dftsman., Dartmouth, N.S.; 1926-29, asst. refinery engr., and 1929 to date, refinery engr., Dartmouth, N.S. (Regd. Mech. Engr., Assn. of Prof. Engrs., N.S.)

References: R. L. Dunsmore, J. S. Misener, A. G. Pedder, J. L. Allan, A. F. Dyer, F. W. Townsend, E. L. Baillie.

TODD—WILLIAM L., of Toronto, Ont., Born at Indianapolis, Ind., Apr. 19th, 1891; Educ., One year Purdue Univ.; 1919-21, estimator, American Well Works; 1921-24, manager, Aurora Pump & Mfg. Co.; 1924-29, manager of subsidiaries, Layne & Bowler, Inc.; 1929 to date, President and Manager, Layne Canadian Water Supply Co. Ltd., Toronto, Ont.

References: E. V. Buchanan, D. H. Fleming, W. B. Redfern, T. C. Main, A. W. Connor.

WIGHT—CECIL DOUGLAS, of 137 Fentiman Ave., Ottawa, Ont., Born at Ottawa, Aug. 29th, 1903; Educ., B.Sc., Queen's Univ., 1928; O.L.S. 1927; 1922-24, chainman and rodman, and 1925-26 (summers), instr'man., Messrs. Lewis & MacRostie; 1927 (Apr.-Oct.), chief of party making traverse and triangulation survey of Gananoque Lake and part of Gananoque River, for Dept. of Lands and Forests Ontario; 1928-30, principal asst. to M. B. MacRostie, A.M.E.I.C., consltg. engr. and surveyor, Ottawa. Surveying, land valuation, arbitration proceedings, supervision and inspection of constrn. works, etc.; Jan. 1931 to date, partner in firm of MacRostie & Wight, 193 Sparks St., Ottawa, Ont. (successors to M. B. MacRostie).

References: M. B. MacRostie, D. S. Ellis, W. P. Wilgar, B. H. Segre, F. C. Askwith, J. H. Ramsay, J. A. Stiles, J. E. N. Cauchon.

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

DuCANE—CHARLES GEORGE, of Rickmansworth, Herts., England, Born at Willingale, Essex, England, Mar. 20th, 1879; Educ., B.A. (Mech. Sci. Tripos), Cambridge Univ., 1900; 1900-01, pupil in Crompton & Co.'s works, Chelmsford, England; 1901-02, pupil to Sir John Wolfe Barry and Partners, acting as junior asst. in London office, and until 1910 with same firm as follows: 1902-05, asst. to res. engr., and 1906, res. engr., Middlesborough Dock Extension; 1907, asst. on general work in London office; 1908-10, mainly occupied as chief asst. in connection with design and contracts for the Kowloon Canton Railway (British Section) for constrn. plant, bridges, permanent way, repair shops, equipment, etc.; 1911-12, chief engr. for Western Canada for Norton Griffiths & Co. (Canada) Ltd.; 1912-14, partner in firm, DuCane, Dutcher & Co., consltg. engrs., Vancouver, B.C.; 1914-19, on active service with Royal Engineers, in Russia and France. Lieut.-Col., O.B.E.; 1919, in India as representative of Sir John Wolfe Barry, Lyster and Partners, in connection with report on Madras minor ports; 1920, in charge, for A. J. Barry and Partners, of Kent Portland Cement Works (Dartford), also parliamentary and general work; 1921-22, partner in firm A. J. Barry and Partners; 1922 to date, partner in firm, Sir John Wolfe Barry and Partners, Consltg. Engrs., London, England. (*A.M. 1912.*)

References: G. E. W. Cruttwell, H. B. Fergusson, Sir Henry Japp, H. K. Dutcher, N. M. Hall.

FOR TRANSFER FROM THE CLASS OF JUNIOR TO A HIGHER CLASS

DUNCAN—JAMES EDGAR, of 215-6th Ave. West, Calgary, Alta., Born at Vankleek Hill, Ont., Apr. 7th, 1897; Educ., B.Sc. (E.E.), Univ. of Man., 1923; 1916-18, army signal work, C.E.F.; 1923-24, equipment engrg. (machine switching telephone work), and 1924-25, magnetic materials research, Western Electric Co., Hawthorne, Ill.; 1925-26, field work on development of apparatus for picking up seismic waves and transmission of radio time signals, and 1926-27, development of seismic reflection waves and charge of seismic crew using refraction method, for Geophysical Research Corporation, 65 Broadway, New York; 1929 to date, geophysical prospecting using magnetic variometers and electrical apparatus in Alberta for possible gas structures, for Canadian Western Natural Gas, Light, Heat & Power Co. Ltd., Calgary, Alta. (*S. 1922, Jr. 1925.*)

References: R. W. Boyle, C. A. Robb, E. P. Fetherstonhaugh, C. J. Yorath, J. Garrett.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

ABBOTT—ARTHUR CALDWELL, of 435 des Forges St., Three Rivers, Que., Born at Senneville, Que., Jan. 27th, 1904; Educ., B.Sc. (Mech.), 1925, B.Sc. (E.E.), 1926, McGill Univ.; 1926-28, ap'tice course with Shawinigan Water & Power Company; 1928-29, asst. supt., and 1929-30, supt., Beauharnois Electric Co. Ltd., in charge of operation and mtce., responsible for plant and equipment, ordering of all material, formation of power contracts, etc.; at present, distribution engr., Commercial and Dist. Dept., Shawinigan Water & Power Company, Three Rivers, Que. (*S. 1925.*)

References: C. V. Christie, E. Brown, G. A. Wallace, P. S. Gregory, R. H. Mather.

ANGUS—FREDERIC WILLIAM, of 3450 Drummond St., Montreal, Que., Born at Montreal, Feb. 19th, 1904; Educ., B.Sc., McGill Univ., 1929; 1927, Montreal Armature works; 1929, toll estimating, 1929 to date, dial engr., dial division and equipment engrg. dept., Bell Telephone Company of Canada, Montreal. (*S. 1929.*)

References: G. A. Wallace, C. V. Christie, C. M. McKergow, W. F. Angus.

CLANCY—JOHN, of Montreal, Que., Born at Mulgrave, N.S., Oct. 5th, 1903; Educ., B.Sc. (Elec.), Nova Scotia Tech. Coll., 1928; 1928 (May-Nov.), inspection engrg. dept., and from 1928 to date, telephone systems equipment, engrg. dept., Northern Electric Co. Ltd., Montreal, Que. (*S. 1928.*)

References: A. J. Lawrence, N. L. Dann, N. L. Morgan, W. B. Cartmel, B. B. Shier.

DURLEY—THOMAS, RICHARD, of Westmount, Que., Born at Montreal, Aug. 7th, 1905; Educ., B.Sc. (E.E.), McGill Univ., 1928; 1925-26 (summers), installn. dept., Northern Electric Co.; 1927 (summer), dftsman., Dominion Bridge Co.; 1928-29, test dept,. General Electric Co., Schenectady and Philadelphia; 1929 (6 mos.), switchboard engrg. dept., Can. Gen. Elec. Co.; 1930, in charge elect'l. installn. Plant No. 1, and from Feb. 1931 to date, asst. supt., Plant No. 1, Montreal East, Canada Cement Company. (*S. 1926.*)

References: F. B. Kilbourn, S. Barr, W. G. H. Cam, A. B. Gates, C. V. Christie, W. M. Cruthers, L. DeW. Magie.

FOY—ALBERT JOSEPH BERNARD, of 71 Clandeboye Ave., Westmount, Que., Born at Fort Covington, N.Y., Feb. 12th, 1903; Educ., B.Sc., McGill Univ., 1924; 1925-26, engr., gas distribution dept., Montreal Light, Heat & Power Cons.; 1926 to date, inspr., sprinklered risk dept., Canadian Fire Underwriters Association, Montreal, Que. (*S. 1925.*)

References: A. R. Roberts, C. M. McKergow, H. R. Little, F. S. Lawrence.

GATHERCOLE—JOHN WILLIAM, of 3411 Northcliffe Ave., Montreal, Que., Born at Hamilton, Ont., Mar. 10th, 1903; Educ., B.Sc., Queen's Univ., 1927; 1927-28, sales-service engr., Bailey Meter Co., Cleveland, Ohio; 1928-29, steam control and meter engr., Brompton Pulp & Paper Co., East Angus, Que.; 1929 to date, steam control and meter engr., Canada Sugar Refining Co. Ltd , Montreal. (*S. 1927.*)

References: E. P. Wilson, K. G. Cameron, F. J. DiBenga.

KYLE—WILLARD HUGH, of 5239 Byron Ave., Montreal, Que., Born at Montreal, May 10th, 1903; Educ., B.Sc. (C.E.), McGill Univ., 1926; 1923 (summer), Hollinger Gold Mine; 1924-25 (summers), rly. mtce., C.N.R.; 1926-28, instr'man. and concrete inspr., 1928-29, asst. to divn. engr., Montreal Terminals; 1929 to date, asst. engr., Montreal District, C.N.R. (*S. 1926.*)

References: R. A. C. Henry, F. L. C. Bond, W. Walker, E. Brown, A. C. Oxley.

PIGOT—CHARLES HUGH, of Beauharnois, Que., Born at Quebec, Que., Aug. 29th, 1903; Educ., B.Sc. (C.E.), McGill Univ., 1926; Summers: 1922-23, bond tester, Quebec Rly. Light & Power Co.; 1924, rodman on power house constrn., Isle Maligne, and 1925, rodman and topogr. on Arvida survey, Quebec Development Co.; 1926-27, in charge of sounding party on Lake St. John survey for Quebec Development Co. and Duke Price Power Co.; 1927 (July-Oct.), instr'man. on Mistassini River power development survey for Lake St. John Power & Paper Co., at Dolheau, Que.; 1927-28, in Montreal office of above company on prelim. studies for power development; 1928 (May-Sept.), instr'man. and plane table topgr. on Beauharnois Canal survey for Marquette Investment Corporation; 1928-29, with Frederick B. Brown, M.E.I.C., consltg. engr., Montreal, on estimates and studies in connection with Beauharnois Canal project—field engr. on Gleneagles Apartment House foundation excavation—in charge of field party completing topographic survey at Beauharnois; July 1929 to date, with Beauharnois Construction Co., as asst. engr. in railway dept., on field locations and estimates; plant yard and camp layouts; engr. on constrn. foundations for crusher, mixer and cement storage plants; engr. on constrn. Howard Smith Paper Mill water line. (*S. 1924.*)

References: C. J. Pigot, F. H. Cothran, D. F. Noyes, M. V. Sauer, F. M. Wood, J. Stadler, F. B. Brown.

ROSS—WILLIAM THOMAS DYGNUM, of Montreal, Que., Born at Portage la Prairie, Man., July 25th, 1903; Educ., B.Sc. (Chem.), McGill Univ., 1926; 1923-24 (summer and winter), highway constrn. and location survey; 1924 (summer), inspecting concrete; 1925 (spring), instructor, McGill Survey School; 1925 (summer), with Jackson & Moreland, Boston; 1927 to date, chemical engr., with Canadian Industries Limited, in explosives division, as follows: 1 year, laboratory, Nobel, Ont., 1 year, plant, Nobel, Ont., and 2 years, operating dept., Montreal. (*S. 1921.*)

References: H. W. McKiel, F. L. West, L. deB. McCrady, I. R. Tait, A. B. McEwen.

ROWE—GORDON WILLIAM, of Lethbridge, Alta., Born at Leeds, Yorks., England, Jan. 20th, 1904; Educ., B.Sc. (C.E.), Univ. of Man., 1927; 1927-28, asst. to res. engr. on hydro-electric constr., and from Apr. to Dec. 1928, designer and detailer on constrn. of 300 ton newsprint mill, with Backus Brooks Co.; 1928-30, designing, detailing and checking plans in connection with constrn. of reinforced concrete grain elevators, and from Apr. 1930 to date, field engr. on inspection of reinforced concrete grain elevators, with C. D. Howe & Co. of Port Arthur, Ont. (*S. 1926.*)

References: C. D. Howe, J. N. Finlayson, F. M. Corneil, R. B. Chandler, J. Haimes, W. M. Reynolds.

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CIVIL ENGINEER, university graduate 1926, desires employment as junior engineer or instrumentman on construction work. Experience, resident engineer on railway construction, miscellaneous surveys. References. Available any time. Apply to Box No. 149-W.

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CIVIL ENGINEER, A.M.E.I.C., Canadian, R.P.E., Nova Scotia, 21 years engineering experience, both field and office, in railway, highways, foundations, concrete structures, water power and conservation, electric transmission lines, etc., experience comprising both surveys and construction, desires employment. Single. Will go anywhere. Working knowledge of French and Spanish. Available immediately. Apply to Box No. 327-W.

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CIVIL ENGINEER; age 48; married; A.M.E.I.C., R.P.E., Ontario and New Brunswick; 32 years experience in municipal engineering, on roadways, sewers, waterworks and buildings, desires position with either municipality or as engineer superintendent with contractor. Ten years with City of Toronto, construction engineer on roadway work; four years consulting engineer; three years engineer in charge of construction work; one year resident engineer, Dept. of Public Highways. Available immediately. Maritimes or, Ontario preferred. Apply to Box No. 336-W.

CIVIL ENGINEER, S.E.I.C., graduate '29, desires engineering position with possibilities of advancement. Past experience consists chiefly of survey work and municipal construction. Location in western provinces preferred. Apply to Box No. 338-W.

CIVIL ENGINEER, graduate, age 32, A.M.E.I.C. Ten years experience; seven years on design, construction, erection work and maintenance of paper mill and mine buildings and machinery. Three years on hydro-electric work in charge of surveys and field investigations; associate hydro-electric engineer, U.S. Engineers, on office investigation, design and estimates; desires permanent position in Canada. Apply to Box No. 362-W.

SCOTS ENGINEER, 28 years old, desires situation as junior executive or some similar situation. Wide experience in mechanical, civil and hydraulic fields and four years as junior executive; A.M.I.C.E. exam., Jr.E.I.C. Will go anywhere. Apply to Box No. 381-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate of Nova Scotia Tech. with experience as plane table topographer, instrumentman and draughtsman and particularly interested in hydro-electric power development and reinforced concrete design, desires position. Willing to go to foreign fields. Available at a few weeks notice. Apply to Box No. 431-W.

CIVIL ENGINEER, B.A.Sc., A.M.E.I.C., Jr.A.S.C.E., age 29, married. Experience over the past eight years upon hydro-electric developments in construction, design and reports. Also some experience in railway construction. Permanent work preferred. Location immaterial. Available at once. Apply to Box No. 447-W.

Situations Wanted

CIVIL ENGINEER, experienced in road construction, mine surveying, transmission line survey and construction; paper mill construction; age 27. Apply to Box No. 468-W.

CIVIL ENGINEER, A.M.E.I.C., age 39, with wide experience on design and construction of reinforced concrete structures, desires position. Apply to Box No. 475-W.

CIVIL ENGINEER, B.Sc., six years experience in paper mill and hydro-electric work, desires position with paper or power company. Paper mill experience covers design, layout, some estimating, and construction. Hydro experience covers preliminary and flowage surveys, transmission line location, design, and six months as resident engineer on construction. Available at once. Apply to Box No. 482-W.

STRUCTURAL ENGINEER, technical graduate, age 40, married, seeks position with architect or contractor. Fully experienced in design and supervision of all types of office and industrial buildings, structural steel or reinforced concrete. Available on short notice. Apply to Box No. 501-W.

ELECTRICAL ENGINEER, B.Sc., McGill University, Jr.E.I.C., age 32. Five years practical experience before graduating. Since graduation two years course with International Paper Co., including six months as electrical foreman, engineer in charge of installation of electrical equipment for two 28,000-h.p. units. Also electrical equipment for large coal-fired boiler house, designing some of the features. Apply to Box No. 506-W.

MECHANICAL ENGINEER, Jr.E.I.C., B.Sc., '26. Ten months experience in pulp and paper steam control. Four years experience in detail and design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

CIVIL ENGINEER, B.A.Sc., '29, with experience in supervision of construction and general office engineering, desires permanent position with contractor or engineer. Available at once. Apply to Box No. 524-W.

CIVIL ENGINEER, A.M.E.I.C., with twelve years experience embracing survey and construction, railway, hydro-electric and highways, foundations, pile driving, municipal engineering, water power surveys, road location, inspection and estimating, is open for engagement as resident engineer on construction or other responsible position. Experience comprises both office and outside work. Available immediately. Apply to Box No. 527-W.

ELECTRICAL ENGINEER, S.E.I.C., about to graduate (1931), desires to become associated after graduation with some branch of electrical engineering offering good opportunity for advancement. Sixteen months experience in draughting of electrical apparatus with large manufacturing concern; including layout work, and making of detail working drawings. Bulk of experience with industrial control apparatus. Apply to Box No. 532-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C., age 32. Seven years general experience in hydro-electric power investigations and construction. Has been in charge of high power transmission lines location, also in charge extension surveys. Experience in office and field. Thorough knowledge of French. Best of references from former employers. Apply to Box No. 537-W.

Situations Wanted

CIVIL ENGINEER, McGill '20, A.M.E.I.C., P.E.O., age 31, single. Experience includes general engineering, especially reinforced concrete work, and eight years of pulp and paper mill construction and layout. Best of references. Available on short notice. Apply to Box No. 547-W.

UNDERGRADUATE ENGINEER, S.E.I.C., junior year standing (Sask.), desires work to complete course. Electrical or mechanical work preferred. Apply to Box No. 553-W.

ELECTRICAL ENGINEER, S.E.I.C., graduating 1931, desires employment in electrical engineering. Sixteen months draughting experience on electrical machines with a large manufacturing company. Work included making of layouts and detail working drawings. Available immediately. Location immaterial. Apply to Box No. 555-W.

A.M.E.I.C., graduate of University of Toronto, 1915. Building engineer and superintendent, with considerable experience as installation, sales and promotion engineer. Present connection, four years in responsible position with large utility corporation. Open for immediate connection where he can use his past experience. Location immaterial. Apply to Box No. 560-W.

CIVIL ENGINEER, S.E.I.C., graduating this year. Experience in railway maintenance, and instrumentman on location and construction. Desires to enter any branch of civil engineering or industrial work affording technical experience and an opportunity for increasing responsibility. Will go anywhere. Apply to Box No. 567-W.

CIVIL ENGINEER, A.M.E.I.C., ten years experience as mining engineer of a colliery, six years railway construction, including location, construction, bridge construction, and maintenance. Also one year on hydro transmission lines; one year government land surveys. Would consider position in any branch of construction, as resident engineer or instrumentman. Apply to Box No. 569-W.

CIVIL ENGINEER, B.Sc. McGill Univ., Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

CIVIL ENGINEER, Jr.E.I.C., B.A.Sc. (Toronto), 1928, age 25, married. Experience in field and office of surveying, general structural design, hydro-electric structures. Present location Montreal. Apply to Box No. 576-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., (Univ. of B.C. '30), Undergraduate experience in pulp mill. One year's experience, Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

ELECTRICAL ENGINEER. College graduate with about seven years designing experience with large manufacturer of electrical apparatus; would consider junior partnership with electrical contractor or electrical repair firm. Could invest several thousand dollars. Correspondence invited. Apply to Box No. 579-W.

TEMPORARY EMPLOYMENT FOR SUMMER MONTHS wanted by an engineer with wide experience in the design and operation of steam power plants and heating systems. Apply to Box No. 584-W.

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Power Development at Island Falls, Churchill River,

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Paper presented before the Calgary Branch of The Engineering Institute of Canada, January 29th, 1931

SUMMARY.—The hydro-electric power plant at Island Falls on the Churchill river is the first development of this nature in Saskatchewan. The 44,000 h.p. developed will be used for mining purposes at the Flin Flon and Sherritt-Gordon mines.

The paper describes the Churchill river basin and storage conditions. The construction of the plant presented considerable difficulty as a transportation system had to be provided. Forty-three miles of road had to be built and scow transportation arranged for on the lakes. In winter the material was handled by trains of sleighs hauled by 100 h.p. tractors, and carrying about 77 tons per train. The total freight dealt with during construction was 35,000 tons. Power during construction was supplied by a temporary hydro-electric plant developed at a site 14 miles from the job.

Three main turbine units are installed, each giving 14,000 h.p. under a 56-foot head at 163.6 r.p.m. The three vertical generators are rated at 12,000 kv.a., 3-phase, 60-cycle, and generate at 6,600 volts, the voltage being stepped up to 110,000 kv. for transmission over the 58 miles to Flin Flon and the 45-mile branch line to Sherritt-Gordon.

The power dam spans the river channel and has three ice chutes, four under sluices, and a spillway section with thirteen openings. There is a separate concrete spillway dam and a number of earth dams along the margin of the headpond to prevent overflow.

The total construction period was some two years, but power was supplied twelve months after first breaking ground.

The completion of the Island Falls power plant on the Churchill river marks the entrance of the province of Saskatchewan into the field of hydro-electric development, as this is the first plant of that nature to be placed in operation in that province.

The plant has been constructed mainly for industrial purposes by the Churchill River Power Company Ltd., and will not be used for the distribution of electrical energy for municipal purposes, as there is no market at present available for sale of the power, other than the mines in the vicinity of the plant. The power being developed, which amounts to 44,000 h.p., is used by the Flin Flon mine of the Hudson Bay Mining and Smelting Company, Ltd., and by the Sherritt-Gordon Mine at Cold lake in Manitoba.

Before proceeding with a description of the construction of the plant, it may be of interest to give some particulars of the source from which this hydro-electric energy is produced.

Churchill River

The Churchill river basin lies in the central and northern parts of the provinces of Manitoba and Saskatchewan and extends into the province of Alberta. The greater part of the area is included in the Pre-Cambrian peneplain of northern Canada and has a gently rolling surface characterized by rounded outlines that have resulted from long continued and profound erosion. The river is peculiar in that it is composed of chains of lakes connected by falls, rapids and stretches of swift water which makes it difficult to navigate and numerous portages are necessary to pass these points. In earlier days the river was used to a considerable extent by the fur traders, but traffic has practically ceased since the advent of railway transportation.

The river rises in Churchill lake in western Saskatchewan, but some of the tributary head waters are in Alberta, and the total length from Churchill lake to Churchill, where it enters Hudson bay, is approximately 1,325 miles. In this distance there is a fall of over 1,300 feet which is well concentrated in the numerous falls and rapids along its course, making it a very valuable stream for power purposes, particularly so as the large lakes in the drainage basin and extensive areas of swamp and muskeg afford means of natural regulation. The total drainage area is about 114,500 square miles of which possibly 80,000 square miles is above the power site. There are excellent facilities for storage as the drainage basin contains several large lakes of which Reindeer lake, Lac la Ronge and Ile à la Crosse lake may be mentioned, and it would be a comparatively simple matter to dam the outlets of these lakes and impound large quantities of water.

In the drainage basin above the power site the rock formations consist mainly of granite or gneisses which are exposed along the river channel. In the areas away from the river the rocks are covered with glacial drift, sometimes to considerable depths, and these consist of till, clay and sandy formations; where suitable cover exists the country is covered with thick growths of poplar, spruce, birch and jack-pine. Some good stands of merchantable timber are to be found in the valley bottoms, but most of the timber is too small for commercial use.

At present little information has been obtained as to the flow of the stream, but a minimum of 10,000 c.f.s. and a maximum of 35,000 c.f.s. was recorded during the years 1928-1930, and there is reason to believe that a much higher maximum flow has been attained at some time in the past, which may have amounted to as much as 100,000 c.f.s., judging from old high water marks.

Preliminary Investigations

The Flin Flon mine was first discovered in 1915 and some efforts were made to develop the property, but little

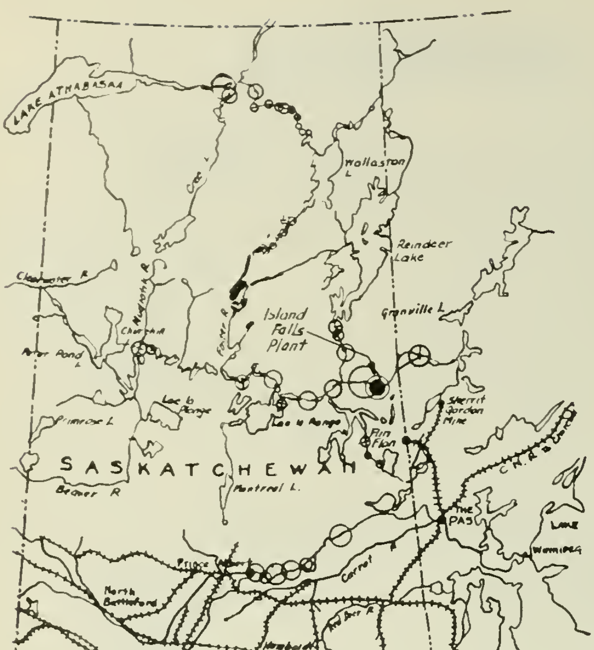

Fig. 1—Location of Island Falls Plant.

success attended these efforts owing to lack of transportation facilities and a successful method of treatment of the ore. Sufficient work was, however, done to reveal the presence of a large body of copper-sulphide ore and an option on the property was secured by the Whitney interests in 1925. Experimental work was carried on during the years 1926-1927 and the results were sufficiently encouraging to warrant the purchase of the property. Arrangements were immediately concluded for the construction of a railway from The Pas to Flin Flon and investigations of possible water power sites were started. A considerable amount of study was given to the power possibilities of both the Churchill and Nelson rivers and the site at Island falls was finally selected as the one most suitable to the needs of the company.

Preliminary Construction

The location of the power site was in a region remote from the point where power was to be used and the only means of access was by canoes with frequent portages between lakes. No roads existed in this area and the distance from the mine to the power site was about 70 miles.

It was therefore obvious that a transportation system would have to be built to connect the job with railhead, which would be capable of handling the large amount of material and supplies needed by the construction crews, during both the summer and winter seasons, and this work was started during the summer of 1928 and completed the following winter. During this period a total of 43 miles of forest road had been cleared and graded. Camps were established along the route, docks built at the end of each lake, and several large scows of 20 to 30 tons capacity had been constructed. A bush telephone line connected the camps and terminal points.

Winter transportation was handled by trains of sleighs hauled by tractors of 100 h.p. Each train was made up of about six sleighs, tractor and heated caboose, and operations were carried out on a definite running schedule, the time for the round trip varying from thirty-six to forty hours. The average load per train was 77 tons, but loads up to 120 tons were hauled.

The total amount of freight handled during the construction period was 35,000 tons, 70 per cent of which was handled during the first winter.

The work of erecting the construction camp was started during the winter. Operations were also commenced in connection with the location and clearing of the transmission line.

The permanent camp buildings were erected during the winter of 1928-1929, and the two sawmills were busily engaged in preparing lumber for building and construction purposes.

Power for construction purposes was first supplied by portable engines, but a small power site had been located at Spruce falls, about 14 miles from the job, and a temporary power plant was constructed at this point, with a transmission line to Island falls. Power was transmitted at 26,000 volts and stepped down at a substation to motor and lighting voltages.

This small plant was in operation for over a year and supplied 4,700,000 kw.h. of electrical energy. The dams and power-house were of timber construction and the plant consisted of two 1,250 h.p. units coupled to 1,000 kv.a. vertical type generators, 600-volt, 3-phase, 60-cycle, speed 400 r.p.m. 40-foot head. The transformers were located apart from the building and consisted of a bank of three 667 kv.a. units 600 to 6,600/26,400 volts with lightning arresters for protection purposes.

Construction and Design

The design of the plant was based upon the use of local material as far as was possible, in order to save transportation of structural material, and the layout of the plant was so arranged that space was also economized so as to keep the cost of construction within reasonable limits.

The general layout may be briefly described as follows:—

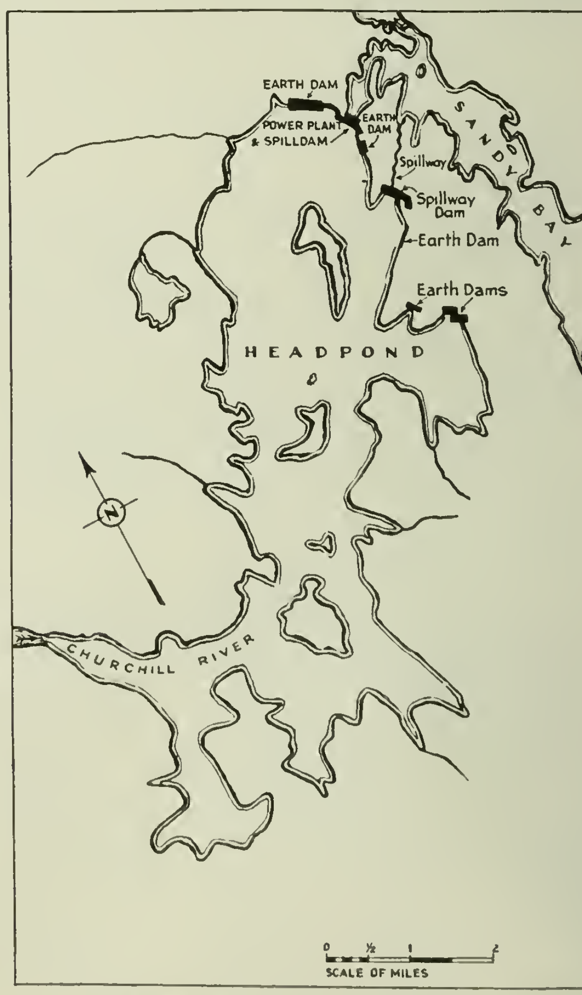

Fig. 2—Plan of Power Development.

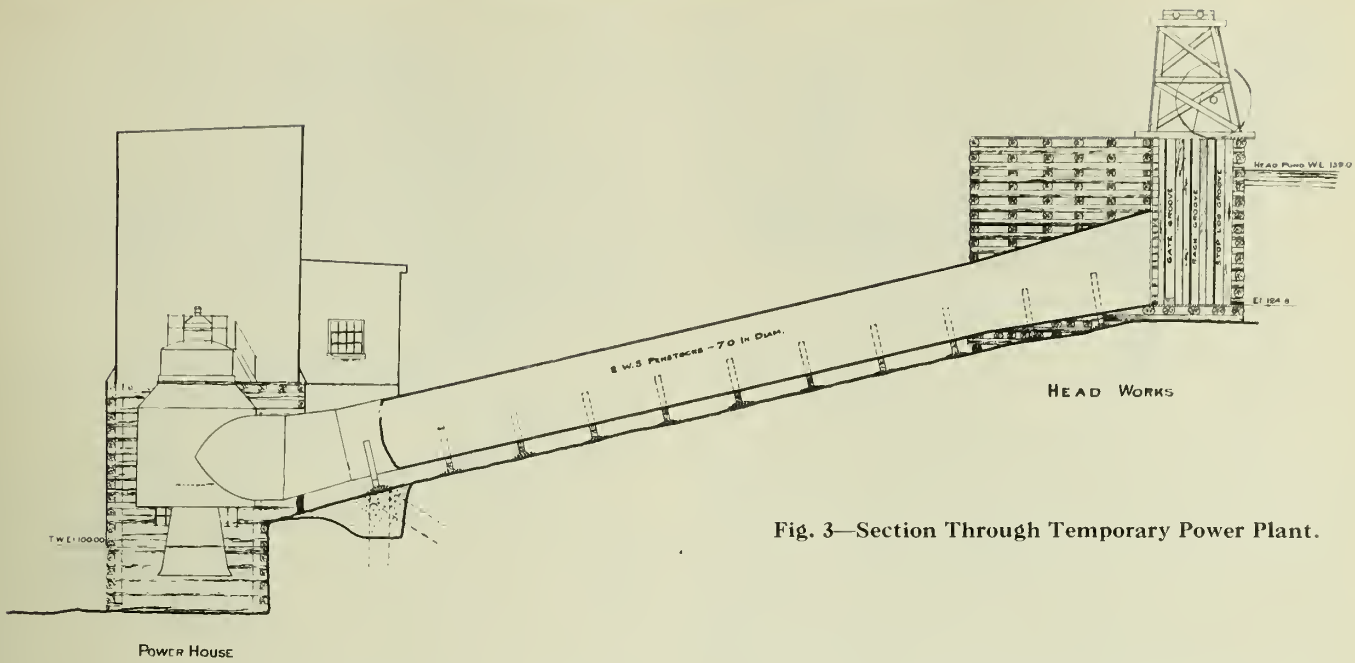

Fig. 3—Section Through Temporary Power Plant.

1. A power-house of concrete block construction supported by a mass concrete substructure.
2. A main power dam spanning the river channel with provision for ice chutes, undersluices and spilldam section—maximum height 90 feet.
3. An extension of the power-house headworks to provide for additional units in the future.
4. Bulwark dams forming shore connections to the north and south banks.
5. A main spillway dam of concrete construction situated one mile south of the power dam—maximum height 44 feet.
6. A number of earth dams or levees along the margin of the head pond to prevent overflow.

Cofferdams

To unwater the sites of the main dam and tailrace it was necessary to construct six cofferdams; these were of crib construction filled with rock and sheet-piled on the water face. The south channel closure was first made, building out from the river bank and a small island in midstream, the dam being closed by a key section. A side dam was built on the island and the downstream end closed by another dam, when the water was pumped out by two 12-inch centrifugal pumps. The tailrace was enclosed by one dam following the line of the south bank, and the north channel by two dams from the island to the north shore.

The cribs were constructed of rough lumber, squared on the connecting face and were built on the shore or existing cofferdam, and then launched and floated into position, being held by cables until ready to sink. Soundings were taken from projecting timbers and the bottom crib was then shaped to fit the river bottom. The sheet-piling in face of the dams was set by divers, three crews being employed, and upon the completion of the dams a banquette of clay was deposited on the water face, which made them practically water-tight.

Power-House

The power-house is of concrete block construction with overall dimensions of 203 feet by 112 feet and has a maximum height of 125 feet. The initial development provides for three main units and two auxiliary units which are contained within the present building. A temporary wall is placed at the south end with a view to further extension to provide for three additional units. The superstructure is supported by a mass concrete substructure,

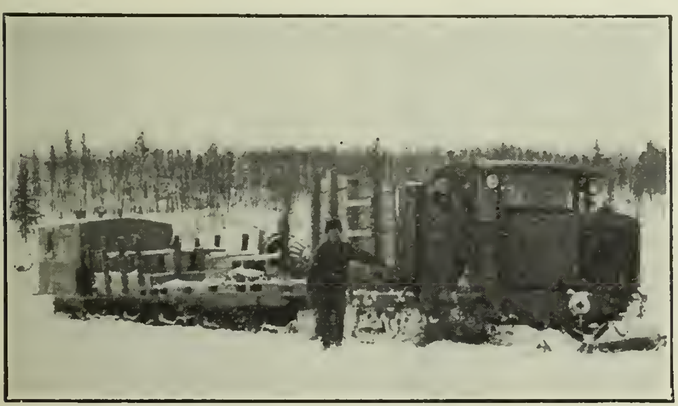

Fig. 4—Small Tractor Train—Winter Transportation.

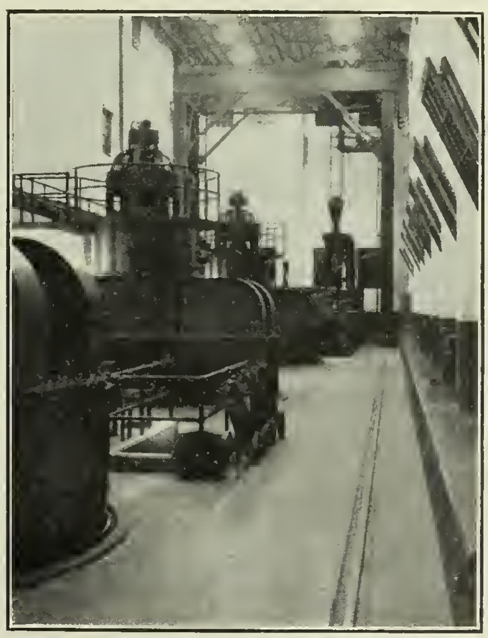

Fig. 5—Generator Room.

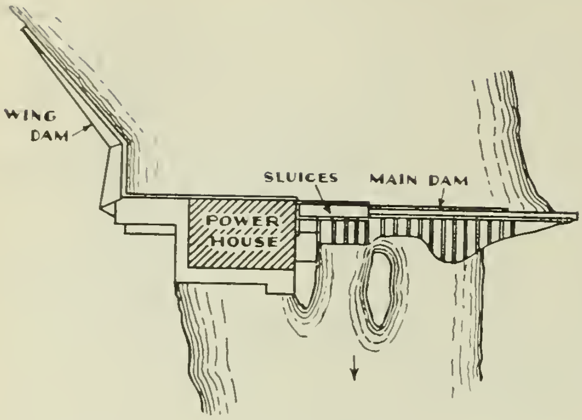

Fig. 6—Plan of Island Falls Power Dam.

which contains the turbine intakes, wheel pits and draft tubes for the units at present installed.

There are two gate openings for each of the main units, with areas of 293 square feet, and these are separated by piers six feet in width, the piers between the intakes being one foot wider. The gates are of the fixed roller type operated by electric hoists placed below the floor of the gate-house, wire rope being used for hoisting. Trash racks and emergency gates are provided in front of each inlet and are handled by a 40-ton gantry crane. The gates are equipped with a water seal, and seat on steel sills let flush into the floor of the intake; steel guides are placed in all gate openings and checks for stop-logs, to facilitate operation.

The auxiliary units have only one opening, and are equipped with gates similar to the main units.

The fixed roller type of gate has given no trouble in operation and seems to give better results than the type with the loose roller train when working under fairly high heads. The gates were loaded with concrete to overcome the pressure head. All the gate operating mechanism of the power-house is enclosed within the gate-house.

Initial Installation

The initial installation consists of three main units and two auxiliary units as previously stated. The hydraulic equipment includes the turbines, governors and pressure tanks, and a pumping plant for water supply and fire protection purposes is provided. The electrical installation includes generators, transformer banks and the necessary switching equipment for delivering power at 110 kv.a. to the transmission line.

The turbines which are of the single runner, vertical shaft, propeller type are capable of developing 14,000 h.p. when operating under a head of 56 feet and running at a speed of 163.6 r.p.m. The maximum expected efficiency of the turbines is 92 per cent.

These machines are direct-connected to conventional vertical shaft two-bearing generators with thrust bearing of the Kingsbury type located above the stator. The casing is formed in the concrete and is of the spiral type. Separate casing stay-vanes are set around the outside of the movable guide-vanes, and these carry the supporting ring to which the turbine head cover and pit lining are secured. These stay-vanes are designed to withstand the bursting pressure of the water in the casing and transmit the superimposed loads of concrete and machinery to the sub-structure.

The draft tube is of the Moody spreading type, formed in the concrete, with symmetrical collection chamber and a hydracone extending up to the runner, which is set to clear it. The upper parts of the draft tube and cone are protected with cast steel plates and semi-steel supporting vanes set around the draft tube carry the superimposed weights of concrete and machinery.

The runners are of cast steel of the diagonal flow propeller type, with six vanes, the shaft being fitted with cast steel sleeves where it passes through the guide-bearing

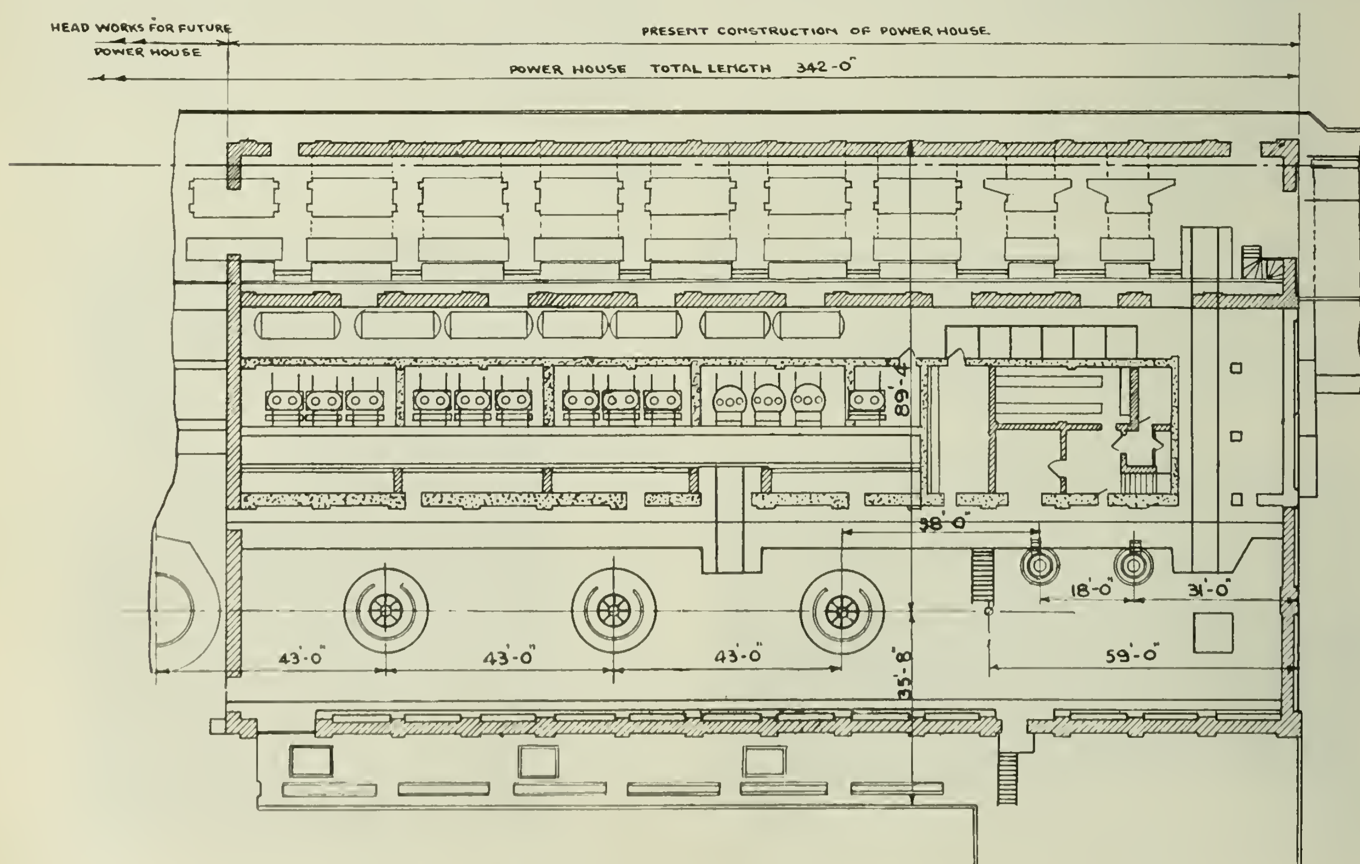

Fig. 7—Layout of Power House.

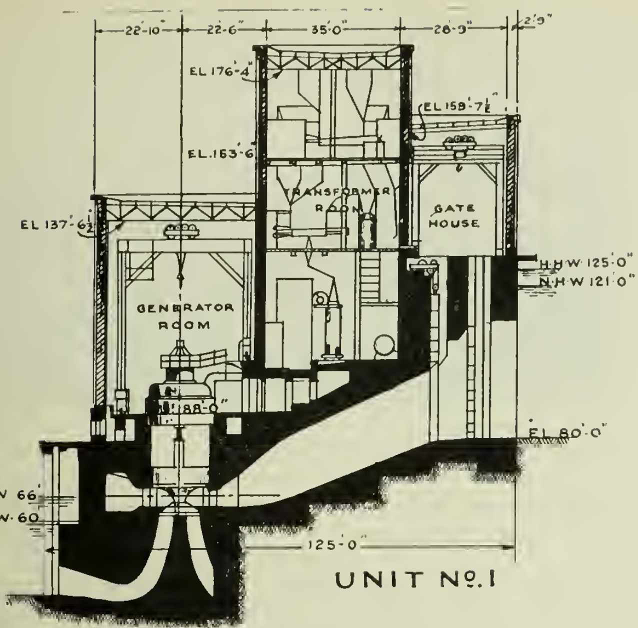

Fig. 8—Cross Section of Power House.

and stuffing box. The guide-bearing is lined with strips of lignum vitae and is water lubricated.

The operating mechanism consists of two cast iron servo-motors which are connected to the operating ring and supported by the pit liner. A governor actuator of the Woodward type is set alongside the generator and is arranged to use oil as the pressure medium and equipped with electrical motor-driven mechanism. Each unit is equipped with a pressure system which includes oil pumps, accumulator tank, sump tank and compressor plant, and the systems for each unit are interconnected.

The generators are of the revolving field vertical shaft type rated at 12,000 kv.a., 3-phase, 60-cycle, speed 163.6 r.p.m., power factor 90 per cent. Current is generated at 6,600 volts. Excitation is provided by a 100 kw. 250-volt main exciter and a 2½ kw. pilot exciter both direct connected, and a 100 kw.-250-volt station exciter is also installed. Each generator is connected directly to the low tension side of the transformer bank.

The two small auxiliary units are of the vertical water wheel type rated at 1,250 h.p. each and are direct connected to 1,000 kv.a., 600-volt, 3-phase, 60-cycle generators which supply current for station services.

Three banks of main transformers and one spare are provided, also one bank of transformers for the auxiliary units. The main transformers are of the oil-filled, water-cooled type rated 4,000 kv.a., single-phase, 60-cycle, 6,600/110,000 v., D/Y with grounded neutral. Taps for 112,750/107,250/104,500/101,750 volts, full capacity. The auxiliary transformer bank consists of three 667 kv.a., single-phase, 60-cycle, 600/6,600 volt D/D oil insulated self-cooled transformers, with grounded neutral. All transformers are mounted on steel trucks and can be readily moved as required.

Current and potential transformers are installed in fire-proof compartments opposite the main transformers.

The high tension oil circuit-breakers connecting the transformers to the high tension bus bars and outgoing lines are of the solenoid operated type, 125 volts, 3-pole, single-throw, 400 amperes, 110,000 volts, with automatic overload trip. The three individual poles of the breaker are entirely insulated from one another. The disconnecting switches are of the three-pole, single-throw, gang operated type, 600 amperes, 110,000 volts, and operation is effected by means of hand levers.

The transfer bus is located on the floor adjoining the breaker rooms, immediately above the main transformer bay, and the main disconnects and high tension busses are on the top floor of the building. The 110 kv. busses are of 1½ inch copper tubing and low tension busses of copper bars.

The main and auxiliary switchboards, relay panels, rheostats and voltage regulators are placed in the control room from which the operation of the station is directed by a complete signal system.

A small motor generator set in duplicate is installed for charging batteries used in connection with the emergency lighting system and other purposes and the building is heated throughout by electrical heaters. A complete machine shop is provided at the north end of the building for repair work and an electrically operated 75-ton gantry crane is placed in the generator room to handle the heavy equipment.

The pumping-plant is located in the basement below the machine shop, and water for fire protection and operating and domestic purposes is taken direct from the river, the domestic supply being chlorinated.

Main Dam

The main dam, which occupies the river channel, adjoins the power-house on the north side and contains

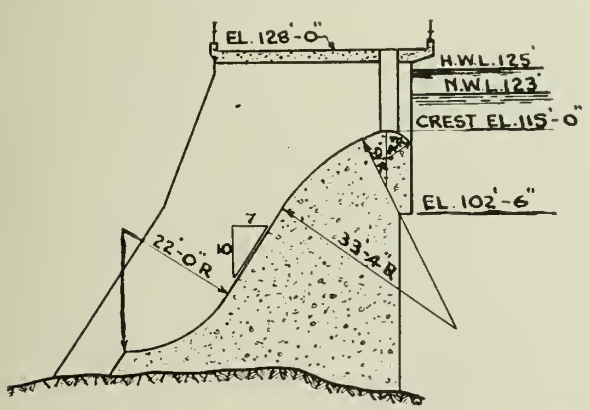

Fig. 9—Section Through Ice Sluice.

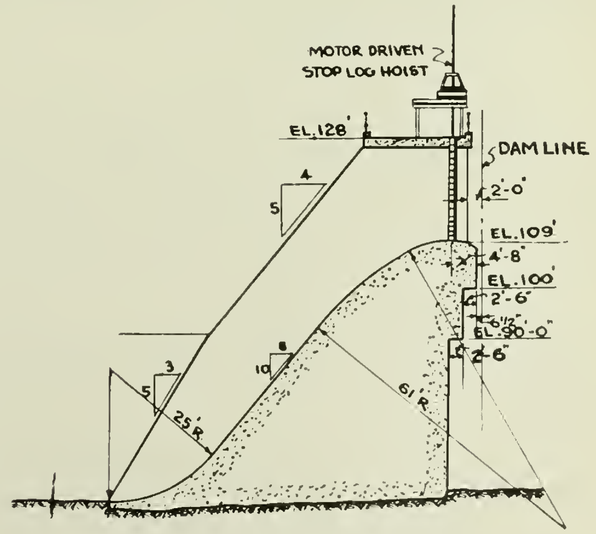

Fig. 10—Section Through Spillway.

three ice-chutes with stop-log control, four large undersluices with submerged gates and a spillway section with thirteen openings fitted for stop-log regulation. The guides for the stop-logs are electrically heated to facilitate winter operation and a stop-log machine is placed on the deck for placing the logs in position or withdrawing them. The undersluice gates are of the fixed roller type, loaded with concrete and raised or lowered by a 30-ton gantry crane with link connections to the gates.

The rollways are of mass concrete and are separated by piers, extending to the river level. The crest is of a compound curve section and is connected by tangents of varying lengths to a reversed curve at the bucket. The north shore connection is made by means of a mass concrete bulwark dam and the overall length of the combined structures from the power-house to the north bank is 468 feet.

The headworks extension south of the power-house is similar in design to the existing works at the power-house and has a length of 139 feet. The south shore connection is an extension of the headworks and is a mass concrete bulwark dam 497 feet long. The proportions for plain concrete were 1:2½:5 used in dams and mass work and 1:2:4 for reinforced concrete with a minimum mixing time of 1½ minutes. The total length of the power dam from shore to shore is approximately one quarter of a mile.

Main Spillway

The main spillway dam is located about one mile to the south of the power dam and is a concrete structure of about 1,000 feet in length with a maximum height of

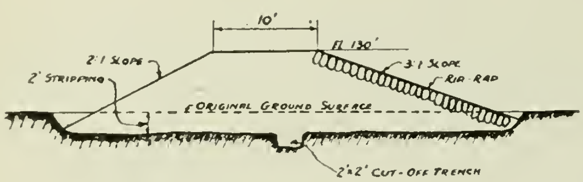

Fig. 11—Typical Section Through Earth Fill Dam.

approximately 40 feet. The rollways are of mass concrete separated by piers which support the operating deck. Forty-six openings 15 feet 6 inches in width are provided to pass the main flow of the river, which is diverted into a spillway channel discharging 1½ miles below the power-house. The deck is 18 feet wide, of tee beam construction, and carries two stop-log machines, and a compressed air system is installed to agitate the water in front of the dam during the winter months. Power is brought from the main plant by a 6,600-volt pole line and is stepped down at the dam to operating voltage.

Cut-off Dams

Nine cut-off dams were constructed at various points along the river bank to prevent the escape of stored water. The dams were made of clay obtained from borrow-pits located away from the dams, and excavated by machine shovels or other means. The dams varied in height from 5 to 20 feet, had 10-foot crests and side-slopes 2:1, 3:1 with benches on the slopes of the larger dams. The slopes were riprapped on the water side, and a rock-filled toe placed on the dry side with suitable drainage.

In constructing the dams the surface soil was stripped to a solid bottom, longitudinal drains were excavated, and the filling material brought up in layers of about eight inches, with a slope rising from the water side, when the whole surface was rolled and sprinkled. The larger dams were constructed from trestles and the material dumped from side cars, after which it was spread by teams and scrapers. Cut-off trenches were excavated wherever a

Fig. 12—View of Power House and Dam.

porous substratum was encountered, and refilled with impervious material.

Transmission Line

The main transmission line to Flin Flon is 58 miles in length with 125 feet cleared right-of-way. The branch to Sherritt-Gordon mine is about 45 miles in length and is of pole construction. The main line is carried on suspension type double circuit towers set in concrete foundation or grouted into rock, and is strung for two 3-phase circuits. A lightning arrester is provided at the power-house end of the line, located on the tailrace operating platform.

Plant Layout

The majority of the plant used on the job was electrically operated. Several miles of standard gauge track were laid and equipped for use of electric locomotives of which five 8-ton and four 20-ton were in use. Material was hauled in side-tip wagons of five cubic yards capacity and flat cars. Two gasoline motors were also used at outlying points.

The mixing and crushing plant was very complete and operated on the gravity system. Two one-yard concrete mixers, a jaw crusher and a cone crusher were installed in this plant and also a plant for making concrete block for the power-house. Concrete was placed by the tower and chute system. An air compressor station containing two 600-cubic foot air compressors and some smaller machines supplied air for the drills and other purposes. Electrical shop, machine shop and carpenters' shop were located adjacent to the power-house, also a plant for welding and general repair work.

The quantities of work comprised in the development exclusive of the transmission line, are indicated by the following figures:—

Excavation and earthworks	194,000	cubic yards
Rock excavation	63,300	"
Riprap	11,400	"
Concrete	83,700	"
Concrete blocks	134,800	pieces
Reinforcing steel	1,140	tons
Structural steel	200	"
Cofferdams	17,500	cubic yards
Freight handled	35,000	tons

From start to finish the whole of the work was completed in a little over two years, but actual construction of the permanent works was completed in sixteen months, and power was being supplied to the mine twelve months after the first ground was broken.

Construction of the works was carried out by the Fraser Brace Engineering Company Ltd., of Montreal, who were also responsible for the general design, and the cost of the undertaking was approximately $7,100,000.

Topographical Study of a Hidden Bedrock Surface by Resistivity Measurements

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Schlumberger Electrical Prospecting Methods, Toronto, Ont., and New York, N.Y.

SUMMARY.—This article describes the results of an electrical exploration carried out in 1929 for the Department of Railways and Canals, in connection with the study of a dam site at Morrisburg, Ont., to obtain further data on the underground contours of the bedrock. The method adopted was developed by Professor Schlumberger, and depends on the measurement of an electrical field set up in the ground by current passed between two electrodes at the ends of a known base line. Several series of measurements are taken with different lengths and directions of base line, thus determining many equipotential curves from which the average resistivity of the sub-soil can be deduced. Most rocks have resistivities of 1,000 to 2,000 ohms per meter-meter square, while clayey formations give corresponding figures of 10 to 400 ohms.

The necessary apparatus is described, and results given for a large series of measurements carried out on both sides of the St. Lawrence river at Morrisburg. Good agreement was obtained between the depths calculated by the electrical method and those measured by actual drilling.

Introduction

The object of the present paper is to discuss the results of an electrical exploration which was carried out in 1929 at a dam site located on the St. Lawrence river, near Morrisburg, Ont. The work consisted of determining at numerous places, by means of electrical measurements performed at the surface, the thickness of an unconsolidated overburden and thus establishing a topographical map of the bedrock.

The electrical process employed was the "resistivity method." Before describing the field survey, the elementary principles underlying the measurements of the specific resistance of large volumes of the ground will be discussed briefly.

Principles of the Resistivity Measurements

The geophysicist and the geologist are, by now, well acquainted with the resistivity method, which they have known for many years[1] and are well aware of its efficacy in supplementing stratigraphical and structural researches. The civil engineer, however, is less familiar with it, since its application to the study of foundation problems is quite recent. The first experiment in this direction was performed on the Connecticut river in spring 1928 near Littleton, N.H.[2]

The principle of the method lies in the fact that the various formations constituting the underground possess different electrical conductivities. Therefore, if a current is sent into the ground by means of two electrodes A and B (Fig. 1), it will create an electrical field, which will be a regular one, provided the ground is homogeneous. If this is not the case, and if there is a buried mass in the area of the electrodes A and B, possessing a conductivity different from the encasing material, the electrical field will be distorted at the surface. The object of electrical prospecting is to interpret such distortions. This simple method of exploration was discovered in 1912 by Professor C. Schlumberger, and was named by him the method of the "Map of the Potentials."[3] Fig. 2 is a diagram representing the Schlumberger field in the case of a homogeneous, isotropic medium. Such a field will be designated later on by the abbreviation: S-field.[4]

It must be pointed out that this figure not only gives the picture of the equipotential curves at the surface of the soil in the area of the two earth contacts A and B, but its lower part (under the line AB), also represents a cross section of the equipotential surfaces in the interior of the soil. The lines of current going from A to B are shown in dotted lines. The numerals 1, 2, ...10 marked on the lines of current, outline the tubes of current containing one-tenth, two-tenths, etc., of the total current sent into the soil through the contacts A and B. This figure clearly shows that there exists a definite relation between the distance AB of the electrodes and the depth of penetration of a certain ratio of the current (1/5 or ½ for instance). This leads to the concept of the depth of investigation of a pair of electrodes A and B located at a given distance apart. This point will be developed in greater detail later on.

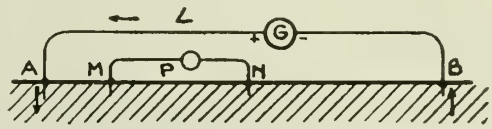

Fig. 1—Measuring Arrangement for Resistivity Measurements of the Underground.

Tracing equipotential curves is a slow process of exploration. As early as 1913, it was evolved by Professor Schlumberger in the measurement of the resistivity of the ground. The computation of this parameter results from a simple formula which applies to the S-field in homogeneous ground. If i is the intensity of the current passed between the two grounds A and B (Fig. 1), if ΔV is the difference of potential recorded between two searching electrodes M and N at the surface, and if R is the resistivity of the ground, we have, with the normal S-field, the equality

$$\frac{1}{R} = \frac{i}{2\pi\Delta V}\left(\frac{1}{AM} - \frac{1}{AN} - \frac{1}{BM} + \frac{1}{BN}\right)$$

In an isotropic homogeneous medium the value obtained for R is the specific resistance of the medium under consideration. This evidently is not the case if the ground is heterogeneous, and the S-field abnormal. The formula will then give for R a figure representing the average resistivities of the subsoil down to a certain depth. The thickness of the layer taken into consideration by the electrical measurement depends, as previously stated, on the distance existing between the pair of electrodes A and B. Experience and theoretical considerations have

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(1) Resistivity measurements of the subsoil were made by Professor C. Schlumberger as early as 1913. The first resistivity patent is chronologically the French patent which is dated September 25, 1925. In 1920 and the years following important commercial surveys have been carried out by Professor Schlumberger and his associates, some of them covering very large areas. Part of this work has been made public. Refer in this connection to:

La Prospection Electrique par les Procédés Schlumberger. Paris, 1927.

E. G. Leonardon and S. F. Kelly—Some Applications of the Potential Methods to Structural Studies—American Institute of Mining and Metallurgical Engineers Tech. Pub. 115. New York, April, 1928.

C. and M. Schlumberger—Mémoire sur la Méthode de la carte des résistivités du sol et ses applications pratiques—Congrès International des Mines, de la Métallurgie et de la Géologie Appliquée.

C. and M. Schlumberger, The method of the ground resisting map and its practical applications. Canadian Mining and Metallurgy Bulletin No. 226, Feb. 1931, pp. 271-294.

(2) This first work was carried out for the New England Power Association. Credit for the discovery of this new field of application of the electrical methods of exploration goes to Mr. Irving B. Crosby, consulting engineer of this company. Some results of the work at Littleton have been published. Refer to:

I. B. Crosby and E. G. Leonardon—Electrical Prospecting as Applied to Foundation Problems. Institute of Mining and Metallurgical Engrs. Technical Publication No. 131. New York, 1928.

(3) C. Schlumberger—Etude sur la Prospection Electrique du Sous-sol. Paris, 1920—Reprinted in 1930.

(4) This abbreviation was first used by S. S. Stefanesco in his mathematical discussions of the Schlumberger field:

Sabba S. Stefanesco—Etudes Théoriques sur la Prospection Electrique du Sous-sol. Institut Geological Romaniei, Vol. XIV, Fasc. 1.

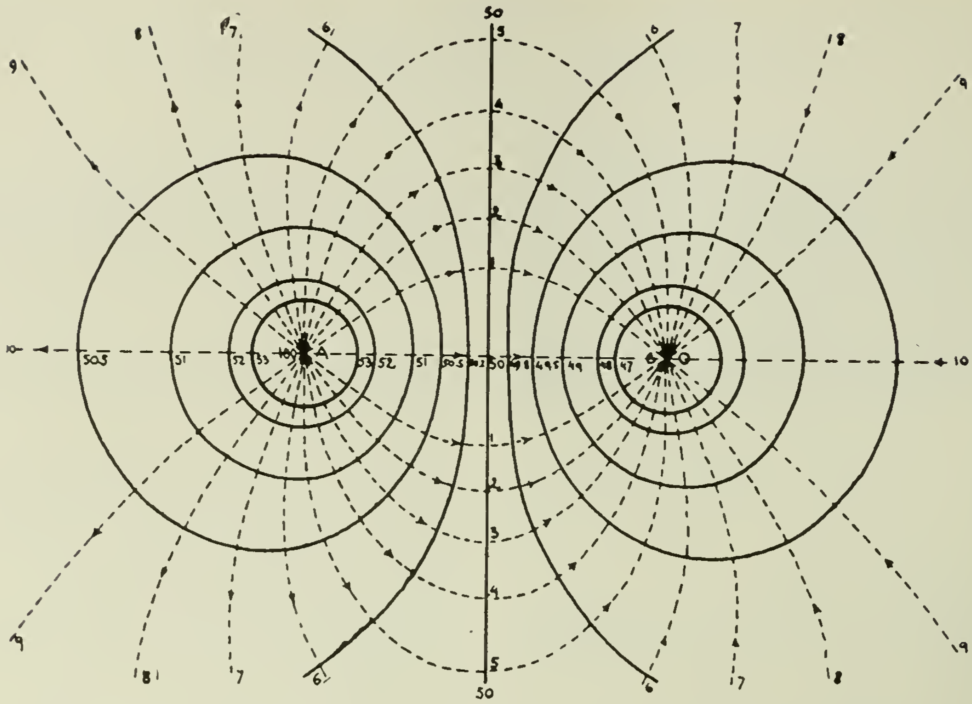

Fig. 2—Electrical Field at the Surface of a Homogeneous Isotropic Ground.

shown that, for practical purposes, the average resistivity obtained with a distance of electrodes AB corresponds to a thickness of the soil of $\frac{AB}{4}$. In other words, the depth of investigation of a certain length of line is practically one-fourth of this line.[5]

It is now easy to imagine a procedure which will investigate the constitution of the subsoil at a given place. It will suffice to carry out at this place a series of resistivity measurements with different lengths of line AB and to compute the average resistivity of the ground for different depths of investigation, thus realizing a "vertical electrical drilling." This "vertical electrical drilling" may be recorded by means of a diagram showing the depths plotted in abscissae against the resistivities in ordinates. The interpretation of the diagram will consist of establishing a correspondence between the variations of the resistivities and certain changes occurring in the constitution of the rocks at depth.

Such a prediction, of course, will not always be possible, and the problem of the interpretation will not lend itself, in all instances, to a satisfactory solution. Sometimes numerous heterogeneities occur in the ground and affect, at the same time, the surface measurements. Some of them are located near the surface, others are deeply buried. They may be very irregular and complicated in shape. Finally, nothing is known about them. The result is that the geophysicist will have no means of differentiating them and will not be able to predict the underground conditions because the latter are not simple enough.

However, among the cases amenable to practical exploration there is the problem of the "horizontal layers," which can be treated mathematically and which is very often encountered in nature, in a more or less ideal form. This problem consists of the case of several parallel, horizontal, homogeneous and isotropic layers possessing distinct electrical conductivities. In this instance, the resistivity measurements depend entirely on the resistivities and positions of the different layers. No other perturbation affects them. This problem has been solved and its solution is of considerable moment in applied geology, since it makes possible the approach to numerous problems concerned with the structural study of horizontal formations.

This study of horizontal, parallel layers also finds its application in civil engineering. For instance, in the preliminary investigation of a dam site or of a tunnel line, it is very important to ascertain whether or not there exists, underground, a solid rock upon which the dam can be built or through which the proposed tunnel can be safely bored. If the surface formations are made up of unconsolidated terrains, as is frequently the case (glacial or alluvial overburden, in particular), it will become necessary to investigate by drill holes, test pits, or other means, the depth at which the bedrock lies. The electrical method is very appropriate for an exploration of this kind, provided that the surface and the bedrock topography are not exceedingly rough and are somewhat parallel. If this is the case, the overburden constitutes a layer of more or less uniform thickness and it is possible to measure this thickness at numerous points at the surface. The electrical measurements provide, then, the data necessary for the preparation of a topographical map of the bedrock. If the overburden is constituted of several layers electrically well differentiated, it will even be possible, in many cases, to give an idea of their respective thicknesses.

It is evident that, in order to solve this problem satisfactorily and with great accuracy, the theoretical conditions of the parallel, homogeneous and isotropic layers must be approximately realized. This however, does not occur entirely in practice, because most of the time, some of the conditions are lacking. Either the surface and the bedrock topography are decidedly irregular or quite non-parallel; or the layers are lenticular; or they lack uniform electrical properties. In all these instances, the electrical diagrams will, then, be more or less altered and sometimes difficult to interpret.

It is, therefore, interesting, in the case of a practical problem to obtain a rapid idea of the accuracy of the

[5] C. and M. Schlumberger—Depth of Investigation Attainable by Potential Methods of Electrical Exploration. American Institute of Mining and Metallurgical Engineers. New York, February, 1929.

measurements. This will be achieved by the means of a few depth determinations on the field. The resistivity curves corresponding to the measurements will be traced and compared with the theoretical diagrams. Their form, the order of magnitude of the discrepancies observed between the two kinds of curves, etc., will make it possible to see to what extent the problem is amenable to electrical prospecting.

Experience has proved that most dam site or tunnel problems can be satisfactorily studied by the electrical method. In the first place, a considerable difference between the electrical properties of the bedrock and of the overburden generally exists. The bedrock is, as a rule, a compact and solid formation, where there are few open spaces or pores. Since the electrical current is transmitted mainly by means of the water which is contained in the rocks, this material is highly resistive. On the other hand, the overburden is frequently composed of unconsolidated material like clays, sands, glacial drift with a high water content and a comparatively good conductivity. For instance, granite, gneiss, marble and in general all metamorphosed rocks possess easily resistivities of 1,000 or 2,000 ohms per meter-meter square, whereas clays and clayey formations, clayey-calcareous soft terrains show corresponding figures of 10 to 400 ohms.

Another point in favour of the method, which should be mentioned here, is the fact that the depth determinations remain quite satisfactory, even in those cases where the surface and the bedrock topography are not parallel and make quite large angles (up to 15 degrees). Under such circumstances, the accuracy of the results will be appreciably improved by performing several series of measurements with the line AB running in different directions. This same procedure also applies when it comes to the elimination of local disturbances due to the lack of homogeneity of the overburden or of the bedrock.

To substantiate these general considerations, it may be mentioned that in the study of more than twenty dam sites or tunnel problems, but one case was encountered which was entirely uninterpretable.

Exploration of a Dam Site on the St. Lawrence River Near Morrisburg, Ontario, Canada

The survey of the dam site near Morrisburg, Ontario, may now be discussed.

This survey was performed in spring, 1929, for the Department of Railways and Canals of Canada, who were studying the location of a dam site on the St. Lawrence river. The results are given with the Department's permission.

Several tentative locations had been chosen for the dam along the river, from Cardinal to Cornwall, and the preliminary study of the project was to be accomplished with all possible speed, so as to take full advantage of the summer season. Therefore, an electrical survey, for the purpose of obtaining a rapid and broad outline of the bedrock conditions and orienting the subsequent drilling exploration was quite justified. A considerable area was systematically covered with electrical measurements at Morrisburg, Ont. and on Ogden island, N.Y. From the data gathered the topographical map of the bedrock shown on Fig. 3 was prepared.[6]

[6] Electrical exploration was also carried out on the Canadian shore at Cardinal, Williamsburg and Cornwall, but much less extensively. These limited surveys are not discussed here.

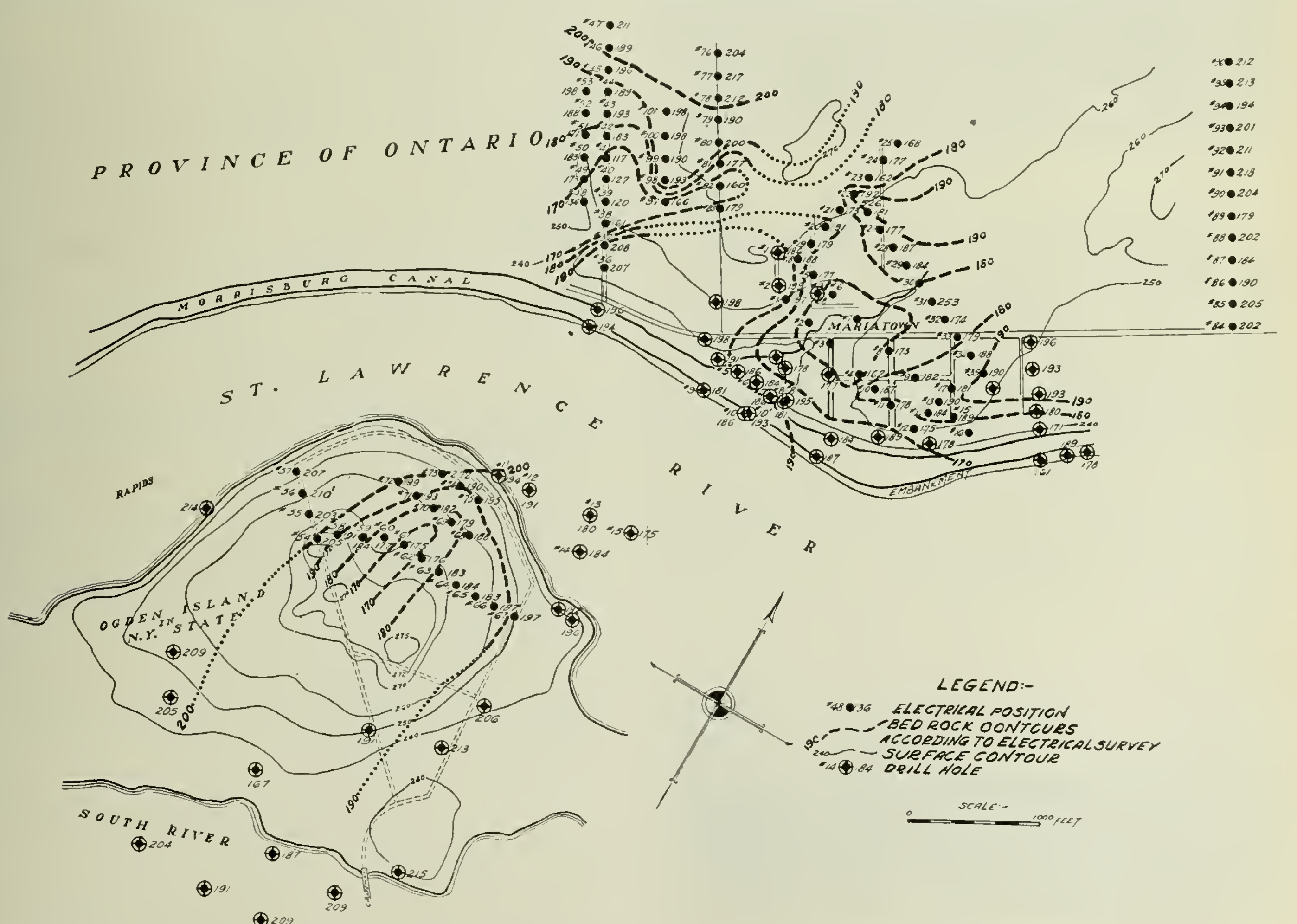

Fig. 3—Topographical Map Showing Exploration at Morrisburg.

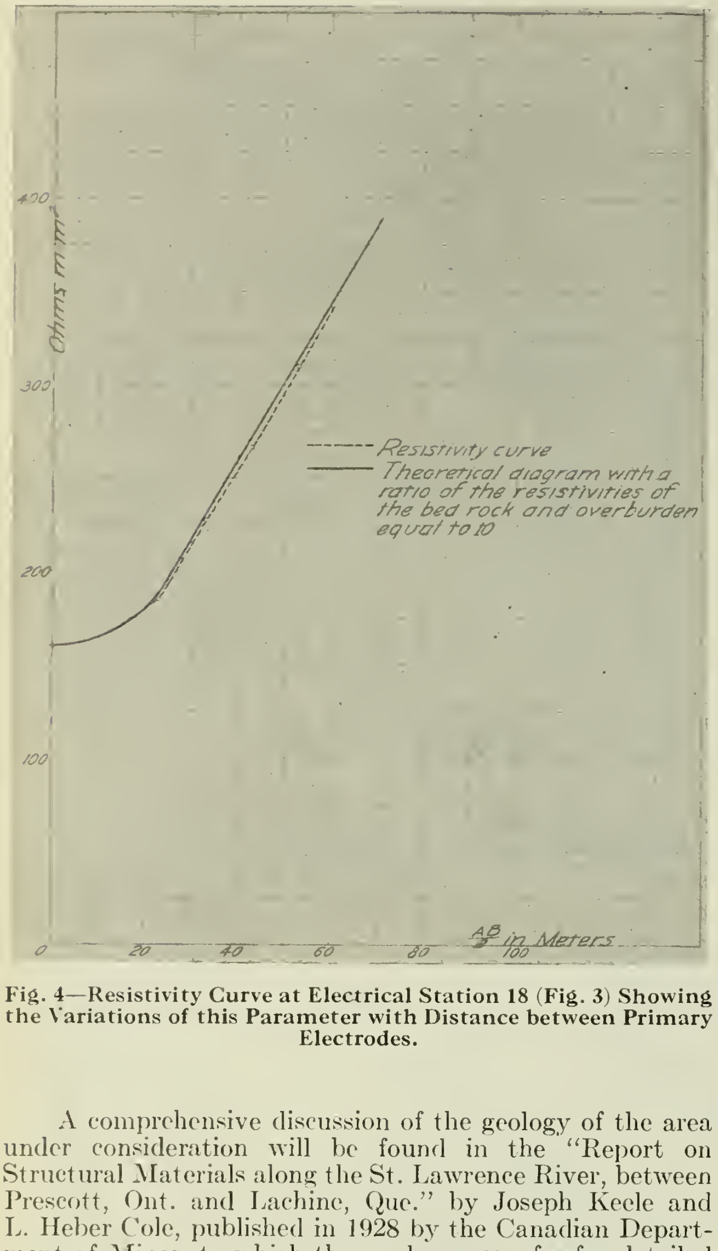

Fig. 4—Resistivity Curve at Electrical Station 18 (Fig. 3) Showing the Variations of this Parameter with Distance between Primary Electrodes.

A comprehensive discussion of the geology of the area under consideration will be found in the "Report on Structural Materials along the St. Lawrence River, between Prescott, Ont. and Lachine, Que." by Joseph Keele and L. Heber Cole, published in 1928 by the Canadian Department of Mines, to which the reader may refer for detailed information. The bedrock in this portion of the St. Lawrence valley is made up largely of nearly flat lying beds of more or less pure limestones, magnesian limestones, dolomites, and shaley limestones, with a minor amount of shale. At Morrisburg the bedrock is composed of dolomites and magnesian limestones with a few narrow beds of dark grey shale, and thin films and layers of shale scattered through two of the dolomite beds. The overburden is composed principally of boulder clay.

Under such circumstances, it was to be expected that the electrical conductivities of the two formations (bedrock and overburden) would be quite different, the bedrock showing much higher resistance than the overburden, and that the problem of the determination of the thickness of the overburden would be amenable to the electrical process. In fact, this is what actually occurred on the field, since the resistivity of the overburden was found to be very uniform and of the order of 150 to 200 ohms, while the bedrock showed everywhere a resistivity 8 to 10 times larger. Fig. 4 represents the resistivity curve registered at station 18. In order to demonstrate how closely the experimental curve checks with the theoretical diagrams, there is also shown on the figure the theoretical curve corresponding to a depth to bedrock of 75 feet (23 meters) and to a ratio of the electrical conductivities (bedrock and overburden) of 10.

All the electrical stations, amounting to 101, are plotted on Fig. 4. With the help of these numerous depth determinations, as well as the results of some drill holes located in the area, it was possible to prepare a topographical map of the bedrock with contour lines at ten-foot intervals, covering an area of more than 100 acres. After the electrical exploration was completed, 15 new holes were drilled. They are marked on the map and numbered 1 to 15. Some of them are located outside of the area covered by electrical measurements and therefore cannot be utilized to determine the precision of the results. This is not the case however, with drillings 1, 2, 3 and 11, which can be used to this effect and give the results contained in the table shown below.

The biggest error is 9 per cent at drill No. 2 and the average error 6.6 per cent. This result is quite remarkable, and even more satisfactory than could be expected, considering the fact that the surface of the bedrock is not at all regular. This point seems evident from the results obtained at drill holes 8 and 8′ and 10 and 10′. Drill holes 8 and 8′ are located a few feet apart; yet they give depths to bedrock of 57 and 47 feet. The discrepancy between the two figures is 37 per cent. At drill holes 10 and 10′ depths of 52 and 45 feet were recorded; the discrepancy between the two figures amounts still to 15.4 per cent. Under such circumstances, the electrical measurements will give an average value of the depth to bedrock in the neighbourhood of the station. This will not necessarily check very closely with the figure obtained by a single drilling, but will, nevertheless, furnish quite a true picture of the underground conditions.

Field Material

The field apparatus is not at all cumbersome. The equipment required for an electrical exploration is shown in Fig. 5, and it comprises a potentiometer, some electrical batteries and two reels of insulated cable. With this very limited amount of material, investigations up to a depth of 300 feet can easily be carried out. If a greater depth of investigation is necessary, the observer need only increase his supply of insulated cable accordingly. Each piece of

1	2	3	4	5	6	7	
Drill hole Number on map	Altitude of rock obtained by drilling	Altitude of ground surface from map contours	Actual depth of rock below ground surface (from columns 2 and 3)	Altitude of rock according to electrical contour lines	Predicted depth of rock below ground surface (from columns 5 and 3)	Error of electrical prediction of depth of rock	
	feet	feet	feet	feet	feet	feet	per cent
1	186	260	74	192	68	6	−8.1
2	199	253	54	204	49	5	−9.2
3	168	248	80	170	78	2	−2.5
11	194	238	44	197	41	3	−6.8

Fig. 5—Apparatus used for Field Measurements.

the equipment has been built so that it can be handled conveniently by a single individual, even under the most trying conditions. No car, no roads, no special preparation of the terrain is necessary for the performance of the survey. Thus the electrical method is especially valuable when the place to be investigated is difficult of access, as is often the case in a preliminary study. Under such circumstances an electrical work will often result in an appreciable saving of time and money.

Conclusions

The practical work described in this paper shows how the geological study of the bedrock conditions at a dam site can be efficaciously supplemented by an electrical survey. When the bedrock and the overburden possess different electrical conductivities, such a survey makes it possible to determine the depth to bedrock at a given place from electrical measurements carried out at the surface. Since the procedure is rapid and cheap, very large areas can be systematically covered, thus enabling the preparation of a veritable topographical map of the bedrock. Such a document is evidently very valuable because it gives a general picture of the underground conditions and can be used to orient any kind of subsequent exploration.

The possibilities of the process are not by any means limited to the study of dam sites, since the measuring of the thickness of an overburden is a problem which is frequently encountered in civil engineering as well as geological work. For instances, the same technique can be utilized in the survey of a tunnel line in order to ascertain whether or not the proposed tunnel will have a safe cover of solid rock all along the line. In mining exploration the outlining of a buried channel carrying high values in gold and silver, or the location of mineralized superficial pockets in a rocky formation, constitute structural studies of the same kind.

The electrical method is advantageous because of its rapidity and economy. This makes its application especially valuable at the beginning of a preliminary survey, at which time heavy expenditure can be avoided by carefully planning the exploration by drill holes, test pits and other expensive means. In particular, if the electrical survey demonstrates that the underground conditions are not favourable to the construction of the proposed engineering work, further unnecessary expense will be avoided. That the process is rapid and economical is shown by the fact that the work described above was performed in 30 working days. During this length of time, 101 depth determinations were made, which cost the Department of Railways and Canals less than $4,500. This is a very small sum for the amount of information gathered. The figures also show that the cost of a depth determination was less than $45 and that an average of 3.4 depth determinations was made per working day. It is evident, that for surveys of a very short duration expenses will be proportionally higher, although not to any considerable extent.

Pont Viau

Construction of a Five-Span, Three-Hinge Arch Bridge, at Back River, Montreal

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, February 12th, 1931.

SUMMARY.—The paper describes a five-span reinforced concrete bridge over the Back river at Ahuntsic, Montreal, built to replace a steel bridge erected in 1865,quite unsuitable for motor traffic.

The new bridge provides for six lanes of traffic, and is 1,050 feet in length, with arches 56 feet wide. The spans are two of 202 feet, two of 212 feet, and a centre span 222 feet, all being three-hinged arches. The hinges consist of steel castings abutting on centre pins placed in the line of the neutral axis of the arch. Special reinforcement was provided at the hinges. The three-hinged arch was decided on as involving simpler calculation and avoiding indeterminate stresses. The pier foundations were sunk to rock by means of pneumatic caissons, and the bedrock surface was from 22 to 32 feet below water level.

Construction lasted from May, 1929, to October, 1930.

The old Viau bridge was built in 1885 and consisted of four through spans 220 feet long and three pony truss spans about 50 feet long alternating with the long spans. These spans rested on six river piers and two abutments all built of stone masonry. The trusses were pin connected, 19 feet centre to centre leaving a clear roadway of 16 feet with no sidewalk. The floor-beams consisted of old 14-inch I-beam sections suspended by U-bolts passing over the pins of the bottom chord of the truss.

This bridge was built some time before motor cars came into use and had been protected by load restrictions since 1914. In late years the traffic loads had been limited to four tons, at four miles an hour.

Two years ago, in view of the constantly increasing volume of traffic, the city administration decided to rebuild the bridge and gave instructions to prepare plans and specifications.

It had previously been decided that the bridge would be erected in prolongation of Lajeunesse street as this had been widened a few years before with this in mind. After consulting a number of authorities with reference to the provisions which it would be necessary to make for traffic in the future it was deemed reasonable to build a structure capable of handling six lanes of vehicular traffic. The design was prepared for a structure carrying a 54-foot

Fig. 1—Viau Bridge, June, 1930.

Fig. 2—New Viau Bridge.

roadway and two 6-foot sidewalks. In the centre of the roadway a depression was left in the structure to permit the laying of tramway tracks if these were required in the future. The lamp posts were the same as those used elsewhere in the city of Montreal and were erected on the edge of the sidewalk.

There was considerable controversy with regard to the type of bridge to be adopted and whether it should be of steel or concrete. It was finally decided to prepare designs and to call for tenders on both the steel and concrete types.

The steel project was designed with seven spans in groups of two spans continuous over two piers and with expansion joints at the centre of every second span which corresponded to the junction between two groups. Each span was composed of two trusses 40 feet centre to centre, of deck type with arched bottom chords.

The floor was a reinforced concrete slab with cantilivered sidewalks and the surface of the roadway was composed of sheet asphalt three inches thick.

The concrete bridge which has now been completed is composed of five spans of unequal length symmetrically distributed over the river and covering 1,050 feet between abutments. The two shore spans are 202 feet, the two intermediate spans are 212 feet and the centre span 222 feet long. The south approach is 350 feet long and the north approach 150 feet long and both are built of reinforced concrete and designed to match the general aspect of the bridge proper, but with this difference that the approaches are of plain continuous beam design whereas the bridge proper is designed with reinforced concrete arches and open spandrels.

The plans were prepared with three principal considerations kept in mind: strength, appearance and minimum cost. To take care of these three considerations the three-hinged arch design was decided on as this had the advantage of being simpler to calculate, and did not involve extensive research covering indeterminate stresses. Another immediate advantage of the hinged arch is the elimination of the clumsy sections required at the skewback in the case of the fixed arch and necessary on account of temperature stresses. This also made it possible to design a thin arch which is an element of beauty. This is also the reason for the choice of a barrel arch. Again, in distributing the stresses on every foot in width the thickness of the rib can be decreased to a minimum.

Another element of beauty is the departure from the horizontal line for the deck. The bridge is designed with the deck in a vertical parabolic curve ending with a tangent on a 4 per cent grade at each approach. This curve explains the variable length of the spans of the bridge. There are three different arches but they all have the same character, same curve and same proportional rise which is about one-tenth of the horizontal distance between lower hinges.

The arches are designed with no particular geometric curve, they are not circular, nor elliptical, nor parabolic but are designed with a curve which gives moments that equal zero at every concentration under the dead load. The only moments which the arches would have to take if their

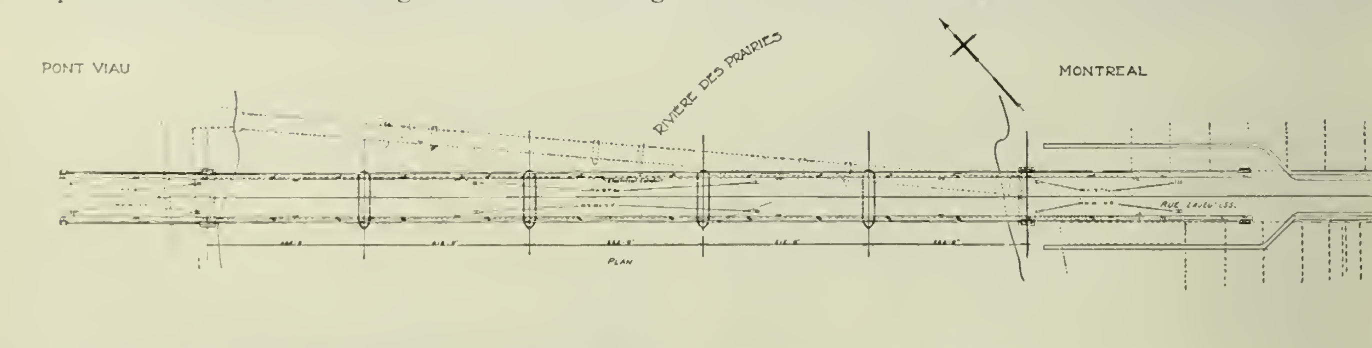

Fig. 3—Plan and Elevation of Bridge.

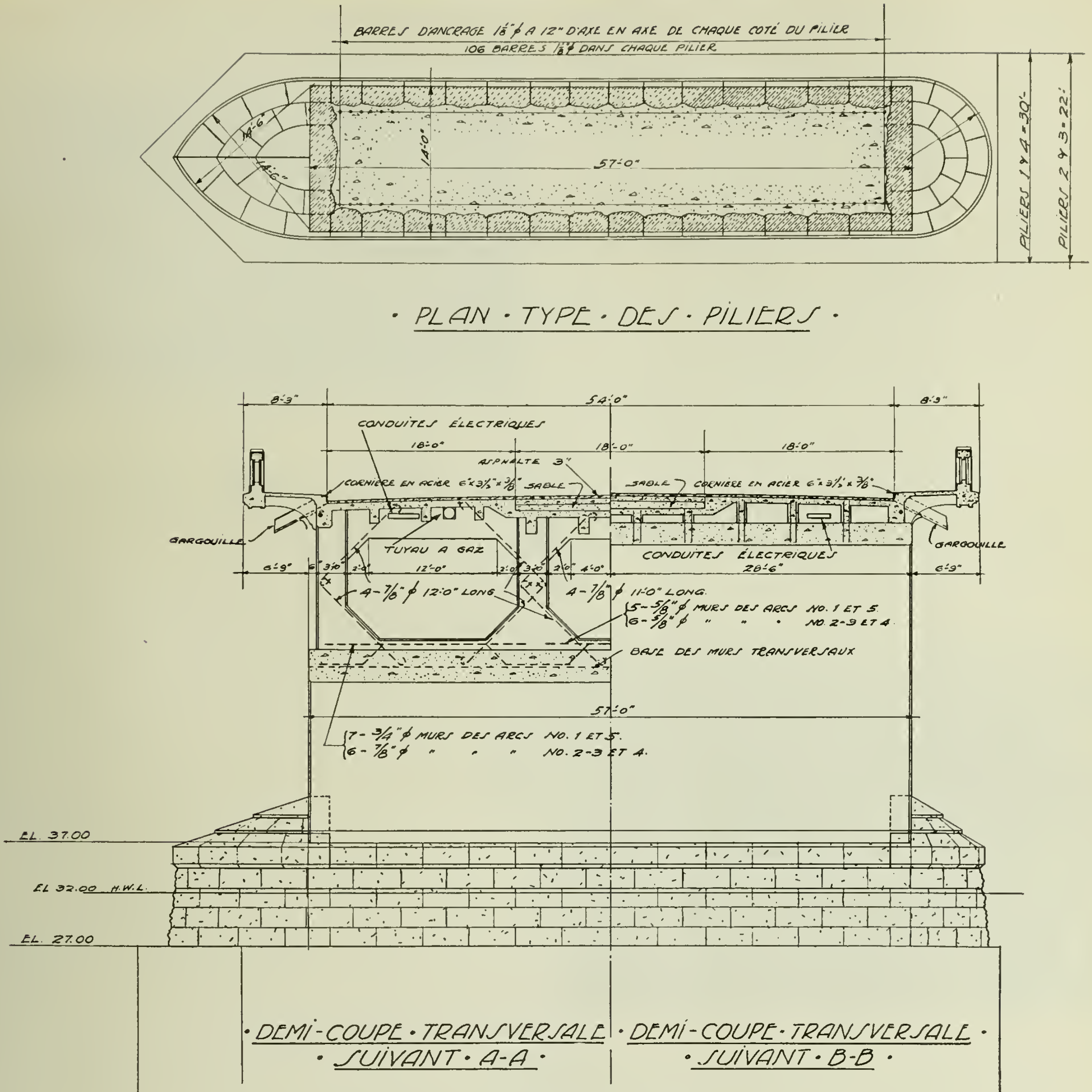

Fig. 4—Plan and Elevation of Pier.

neutral axis after construction followed exactly the curve of the design, would be those produced by the live load. This proves that the bridge should be safe as long as there is no live load on it! The main difference between a truss bridge and an arch bridge lies in the fact that in the former the reactions on the piers are vertical whereas in the latter they are inclined and tend to overturn the piers.

In the case of the Ahuntsic bridge special calculations were made for each abutment and each pier as no two adjacent arches were the same and the resulting thrust on the piers was different for the abutment and the first two piers on each side of the river. Moreover a special study was made for each pier due to the varying depths of the rock on which they were located and this affected the moment of stability.

The largest horizontal component thrust was produced by the shore arch, on account of its smaller proportional rise, although this was the shortest. This amounted to 184,600 pounds per lineal foot of width of the arch which was 57 feet wide. The centre arch produced a horizontal thrust of 168,000 and the intermediate arch was the least in importance with only 165,700.

These figures in each case were the result of the dead load and the combination of live load which produced the maximum stresses on the piers. With these figures it was found that in order to have a proper coefficient of stability the pier between the first and second span required a base 30 feet wide, and yet, with two feet of eccentricity in a direction away from the shore, the pier between the second and third span needed only 22 feet width for base and no eccentricity.

The abutments which received no counter thrust have a base 50 feet wide, that is, in the direction of the thrust, by 82 feet in the other direction.

All these foundations were sunk to rock by means of pneumatic caissons and keyed to the rock by means of a block of concrete which projects downward into the rock,

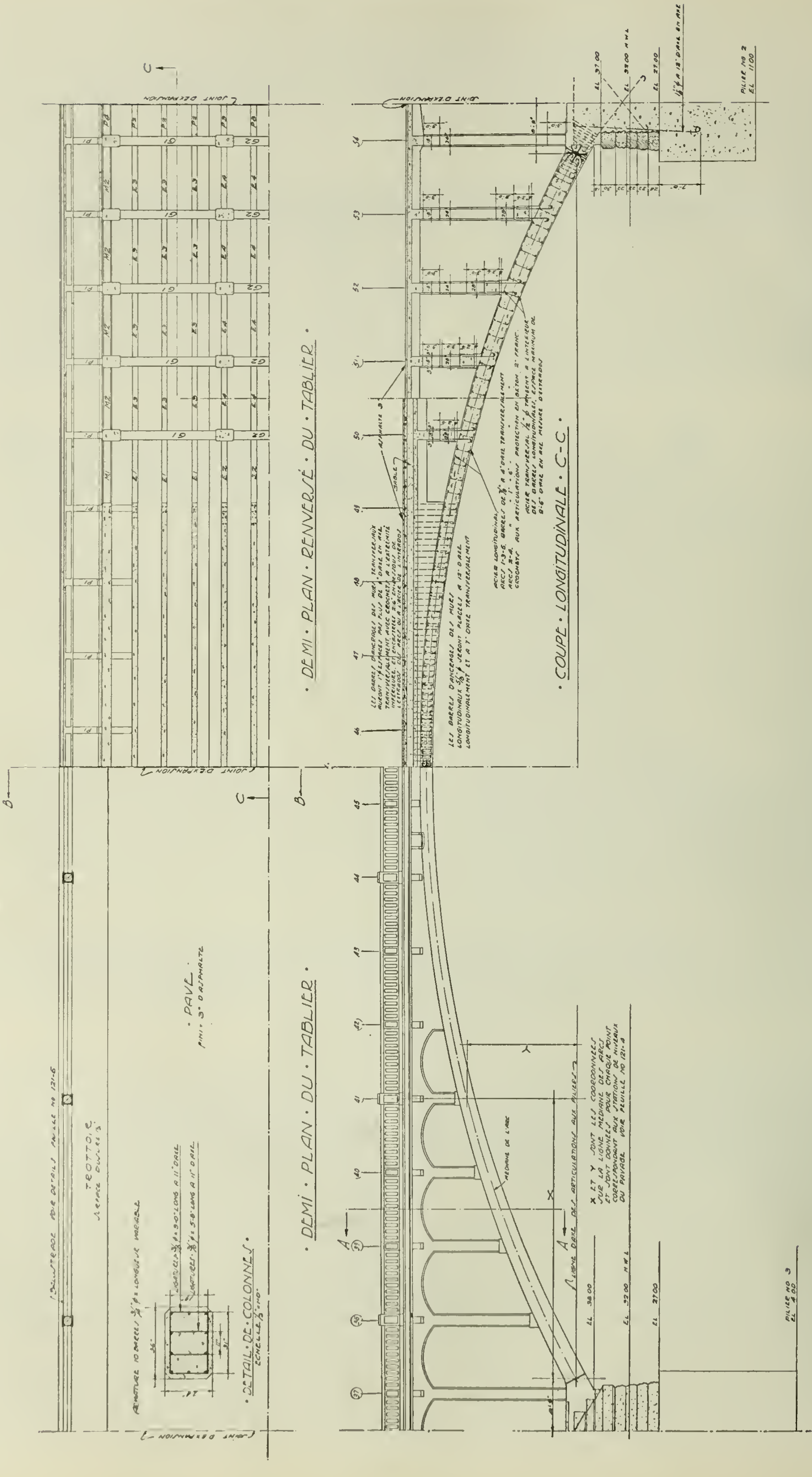

Fig. 5—Elevation and Plan of Arch.

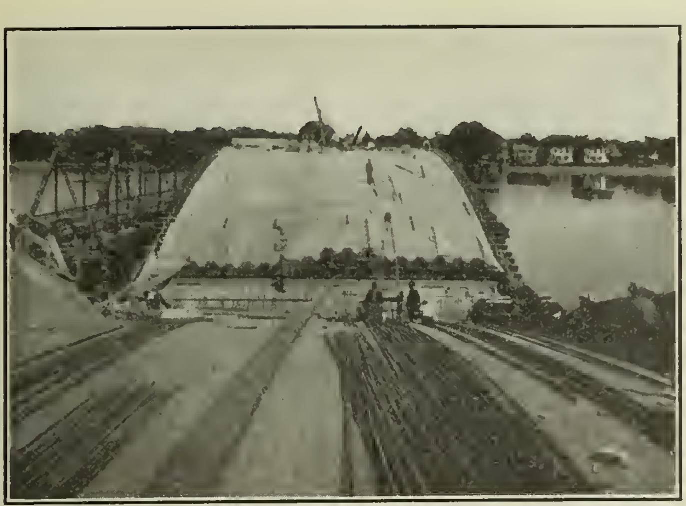

Fig. 6—Forms for Concrete Arches.

the dimensions varying for each pier. Solid rock was found at a depth varying from 22 to 32 feet below water level. The contractor used steel caissons for the river piers and the abutments were made with reinforced concrete caissons, the cutting edge only being steel. No particular difficulty was experienced in sinking these caissons except in the case of two of the piers where it was necessary to cut through old wooden cribs and these had to be destroyed with dynamite and picks or bars under the cutting edge.

The tops of the pier bases were left at elevation 27.00, that is five feet below the proposed water level which the Montreal Island Power Company intends to maintain by regulating the flow at the power house. Above the base the piers all have the same dimensions. They are built of concrete keyed in the base for horizontal shear, reinforced and anchored to the base for the overturning moments which had to be taken care of during erection as well as in the finished bridge.

To remove the shoring from under the first span so as to use it again at the other end of the bridge, all four piers had to take a share of the thrust coming from the swung span. In the finished bridge the five arches rest against one another and this will explain why such expensive centring was built under four of the five spans. Over $100,000 worth of timber, mostly 12 by 12 (and 12 by 16) B.C. fir was used to construct this centring and shoring, which was composed of five longitudinal rows of posts, 13 feet centre to centre, each carrying a truss-like wooden frame whose top chord members were shaped to receive the forms of the intrados of the arch in their erection position. The design of these frames determined the longitudinal spacing of the posts which were located at each bottom intersection of the diagonal members of the frame. Some of these posts had over seventy tons to carry. All were made of two 12 by 16 timbers bolted together and driven with a 3½-ton steam hammer after the resting place on the bed of the river had been prepared by divers. These posts varied in length from 12 to 30 feet. For adjustment and also for uncentring facilities a 12 by 12 short block was introduced on top of hard wood wedges at each point of support. Also all centring was adequately braced transversely and blocked against the piers longitudinally.

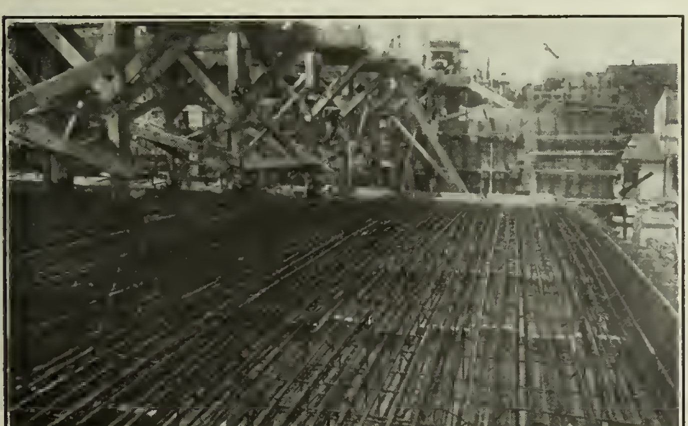

Fig. 7—Arch Reinforcing in Place.

The erection position of the intrados of the arches was determined after taking into account the following factors: temperature, shrinkage of concrete and settlement of the shoring under the load of the fresh poured arch. This settlement was arbitrarily assumed to be one inch. The deflections due to temperature and shrinkage were calculated with the ordinary formula assuming that with a 45-degree drop in temperature the arch would deflect to its geometrical position which corresponded to the zero moment curve.

Observations taken during construction show that these assumptions were not entirely correct. A few of the shoring posts settled as much as one inch more than expected but on the other hand the larger number settled only one-quarter to three-quarters of an inch. The deflection due to shrinkage was also less than expected by about an inch. As a matter of fact when the arches were swung to take stress they dropped only about one and a half inch at the crown, when the calculated figure was two and three-quarter inches, consequently the crown of the arches at the present time is about one and a quarter inch too high. However, this is trifling and does not affect the strength, if anything it improves the coefficient of safety in the event of the temperature falling to 40 degrees below zero.

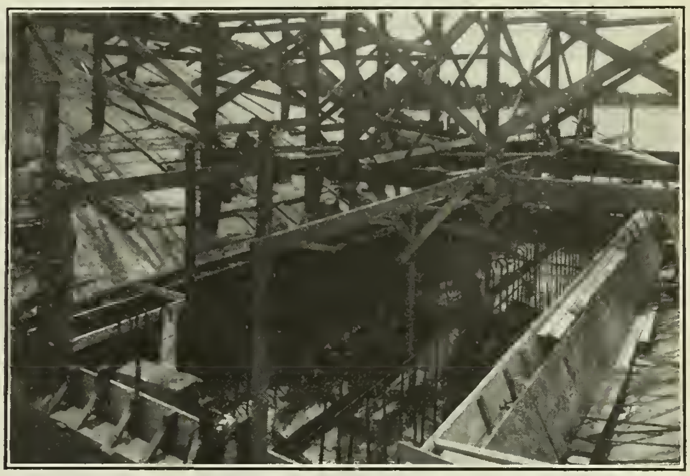

Fig. 8—Forms and Reinforcing, Pier No. 3.

Construction of the Arches

The piers have all been brought to the same elevation, and the intersection of the intrados with the face of the pier is also at the same elevation for all arches. The elevation of the lower hinge pin varies on account of the special curvature of each arch. The hinges are composed of twin steel castings designed to distribute the load from the full thickness of the concrete arch to a centre pin located in the line of the neutral axis of the arch. These were cast in lengths of 3 feet 9 inches and placed end to end fifteen in a row thus covering the 56 feet of width of the arch. The pins were put in place with a graphite coating, carefully aligned and levelled, and the closing row of castings then put in place and bolted tight to those of the first row, the whole resting on three-inch concrete blocks in order to have the castings completely embedded in the concrete of the arch.

Fig. 9—Bridge in August, 1930.

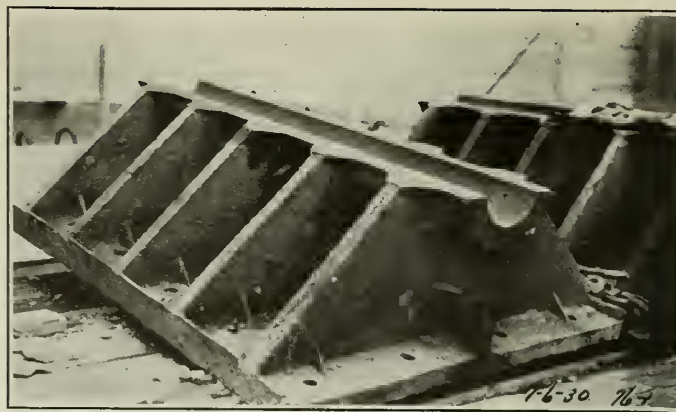

Fig. 10—Steel Castings for Hinges.

The bearing dimension is three feet for the lower hinges and two feet for the crown hinges, the thickness of the arches being 3 feet 6 inches at the springing line and 2 feet 6 inches at the crown.

The calculated unit stress in the concrete was close to 450 pounds per square inch at the lower hinges and 950 pounds at the crown. Special reinforcement was provided at these points through the use of stirrups on close spacing to tie the top and bottom longitudinal reinforcement and make the arch work somewhat in the manner of a spiral hooped column. The arches are reinforced at 0.61 per cent with plain round bars of intermediate steel. It offered quite a network of steel which made it a problem to pour the concrete in voussoirs as was the first intention.

This idea was therefore abandoned and it was decided to concrete each half arch in one continuous operation. This took slightly over twenty-four hours. The concrete plant consisted of a Blaw Knox one yard mixer equipped with inundator and two high speed motor trucks travelling on top of the works to deliver the concrete through portable steel chutes wherever it was wanted.

The specifications called for 3,000 pound concrete in the arches and all test reports which came regularly from the inspectors, J. T. Donald and ,Company Ltd., showed that the twenty-eight day tests gave results well over that figure.

The deck is supported on the arches by means of columns and walls which were designed to obtain a uniform distribution of the stresses across the arches, otherwise the construction does not differ from that of an ordinary viaduct, built of columns, beams and slabs. Reference should also be made to the expansion joints, as in order to allow for the free movement of the arches through temperature variation, the floor is provided with an expansion joint over each crown and each pier. This is a two-inch gap across the deck and is covered with a steel expansion plate.

The deck structure was concreted before any of the centring was removed, and although this precaution was not required, it nevertheless saved the trouble of determining the safe distribution of the deck loads and did away with the necessity of symmetrical pouring which otherwise would have been required in order to avoid dangerous moments in the arches.

The author would express his appreciation of the good spirit showed by the Dufresne Construction Company, contractors, all through the execution of this important enterprise, and for the excellent co-operation received from all the representatives of the company and also from the representatives of J. T. Donald and Company Ltd., who had been appointed inspectors for testing materials and concrete.

It may be interesting to know that 176,000 bags of cement were used in the construction of this bridge and 19,600 cubic yards of concrete were required for the piers and abutments, 5,500 cubic yards for the arches, 4,400 cubic yards for the deck and spandrels, 2,300 cubic yards for the two approaches, and also some 1,000 tons of steel reinforcing.

The air plant used by the Dufresne Construction Company, Ltd., consisted of two low pressure units of about 1,500 cubic feet each and one high pressure unit of about 1,000 cubic feet. All were mounted on a large concrete base, and the three compressors were electrically driven by 150 h.p. motor. There was also a battery of ten portable gasoline air compressors.

Construction started on May 23rd, 1929, and was completed on October 31st, 1930.

Discussion on "Train-Ferry Landings at Port Mulgrave and Point Tupper, N.S."

Paper by D. B. Armstrong, A.M.E.I.C., and W. Chase Thomson, M.E.I.C.[1]

C. S. G. Rogers, A.M.E.I.C.[2]

Mr. Rogers stated that the authors of the paper had performed a real service to The Institute in placing on record a clear description of the design of the ferry landings, for they were structures of a type concerning which there was little literature available.

The paper rightly pointed out that they were more than bridges. The floor systems carried train loads just as did the floor systems of bridges, but otherwise the landings were machines and their operation as machines was the governing factor in their design. Mr. Rogers observed that together with the landings on the Prince Edward Island ferry service there was to his knowledge no other railway ferry landing, in Canada at least, that demanded such strength combined with such flexible construction as to permit of the warping of the end apron leaf to conform to simultaneous list and change of draught in the boat itself while in process of loading, and also to adapt itself to the change of grade on the apron due to these same causes and to the varying tide.

The complexity of the Mulgrave-Tupper landings was due to several conditions. In the first place they carried

[1] This paper was presented at the Annual General Meeting of The Institute, Montreal, February, 1931, and appeared in the January, 1931, issue of The Engineering Journal.

[2] Bridge Engineer, Canadian National Railways, Moncton, N.B.

three tracks; next they must provide on the side tracks for a range of 5 feet 6 inches above and 5 feet 6 inches below mean level for the extremes of tide, listing and draught; finally they must carry train loads equivalent to Cooper's E 60.

These heavy train loads were, of course, due to the coal and steel industries of Cape Breton Island. Thirty years ago when the landings now renewed were built it was felt that the future was well provided for when the structures were designed to carry theoretical locomotives weighing 314,000 pounds. Now on both sides of the straits there actually were locomotives weighing 558,750 pounds. Those weights were not direct indices of the strength of the structures required as the lengths of engines were not the same, but they did represent on the one hand the train loads originally designed for and on the other hand the actual results after thirty years of life.

Mention had been made in the paper of the corrosion of the steel work and Mr. Rogers thought that this condition was to be expected. Parts of the floor system such as the suspended cross girders were seldom dry. What with actual submersion, with wave action and splashing from propellers, combined with the eroding action of ice and water shot against the steel, one would think no severer agents of corrosion could be found. But moist sea air was an even more active re-agent in inducing rust than the salt water. In fact in the old structures, whereas the flange angles on the main outside cross girders which were most constantly wet were reduced fairly uniformly in their long life from five-eighths inch thick to one-quarter inch thick, the overhead bracing which was subject to the salt laden damp sea air had completely rusted away in several places. A little reflection would show these as the natural results. Rusting of course was just a changing of iron to iron oxide by the combination of the oxygen of the air, and/or oxygen from the chemically broken up water, with the iron in the structure; and those parts of the structure actually immersed were insulated by the water itself from contact with the oxygen of the air so that the steel below the water line had not the doubly available oxygen to attack it. In the port of Halifax a like condition was found a few years ago. At Pier No. 2 the windows in the ventilator tops had metal sash. These were replaced with wood sash as they had completely rusted away though only exposed to damp salt air. Another contributing factor in this result was of course that intensely active oxygen in the form of ozone was always present in sea air. This did not suggest that water was a preservative, for steel must be kept dry to preserve it and this could be done by means of painting frequently where the steel was above the water line. That in the water was subject to erosion as well as rusting and was very difficult to protect.

It might be interesting to know that several rust-resisting compounds had been tried on the landings, with little difference in results. Some of them wore off quickly; others were pulled off by ice which formed on the steel in periods of quiet, only to be broken away with the protective coating under propeller or wave action; others were just poor paints. The problem of rust-prevention therefore still remained.

Special care was taken in the new installation to avoid water and dirt pockets and to clean and paint thoroughly all steel-work with good red lead and good graphite paints prepared according to the railways' own standards and experience showed that this was the best that could be done.

The authors had referred to the "first" landing at the site, but of course this meant the first landing of a similar type. From 1892 till the completion of the steel landing just replaced, cars were transported on two scows on either side of a ferry steamer, the cars being loaded on the scows by means of timber aprons which required no warping but merely adjustment to suit tide and the changing draught of scows.

Mr. Rogers wished to comment on the high calibre and engineering efficiency of Canada's bridge building companies. During the course of the renewal of the landings 1,300 tons of steel were placed and 750 tons of old steel removed during construction, four regular first class passenger trains were transported across the straits daily, except Sunday, and the ferries made ten to fifteen trips daily. Yet in spite of that the landings were completely renewed without delay to train service.

F. O. Condon, M.E.I.C.[3]

Mr. Condon remarked that the authors had given a very complete account of the reconstruction of the ferry landings in 1930, and he desired to pay his tribute to the ability and ingenuity displayed by the engineers of the Dominion Bridge Company in carrying out this very difficult undertaking. The paper had referred to the old structure erected in 1901 by the Dominion Bridge Company for the Intercolonial Railway. At that time W. B. MacKenzie, M.E.I.C., now retired, was the chief engineer, and the late John Forbes was bridge engineer, the latter working in very close touch with the engineers of the bridge company. This work, like that now described, required long discussions and studies, with close consideration of each detail, but he would point out that in the structure now described even more careful preparations had to be made, as it was of the utmost importance that traffic should be maintained without interruption. With the original installation this factor did not exist.

P. L. Pratley, M.E.I.C.[4]

Mr. Pratley observed that the use of burning was becoming an important factor where demolition of structures was involved, and he was sure the bridge company would have found it much more difficult to remove the old structure in the twenty hours at their disposal if it had not been possible to use the torch to advantage. One of the detailed points which had occurred to him was the stiff shape of the gantry frames which consisted of two vertical posts each composed of four angles latticed and a double webbed girder placed across them. With a fairly stiff anchorage this constituted a rigid frame and under the live load conditions there would arise a certain bending moment at the top of the vertical posts and at the end of the gantry girder. He therefore wished to inquire whether this moment was calculated, whether it amounted to very much, and whether it called for any modifications in the section such as the increase of the internal over the external angles, and whether the shear was of sufficient amount to affect the dimensions of the latticing.

P. B. Motley, M.E.I.C.[5]

Mr. Motley desired to ask what precautions were taken to safeguard projecting pieces of steel from floating ice. The approach span on the landing seemed to have its floor beams below it, and if the waterline were somewhere near the floor beams, it was possible that ice would find its way in. He would also ask why it was necessary to employ such an elaborate and long apron for an extreme rise and fall of tide of ten feet. It would be interesting to know what was the worst grade that could occur when a train was coming on or off a ship. Mr. Motley did not know whether these questions had to be solved by the engineer in charge of the work or not. They were, however, general questions

[3] Principal Assistant Engineer, Canadian National Railways, Moncton, N.B.

[4] Monsarrat and Pratley, Montreal.

[5] Engineer of Bridges, Canadian Pacific Railway, Montreal.

which were usually decided by the railway company's engineer. Insofar as the Canadian Pacific Railway Company's experience was concerned, a difficult condition existed in Ladysmith, B.C., where there was a tide of 16 feet. The maximum grade at which cars would uncouple was the ruling factor and this had been found to be about 6 per cent, this being the maximum at which any car would stay coupled when passing over the vertical kink in the track at the end of the apron.

D. B. Armstrong, A.M.E.I.C.[6]

Mr. Armstrong, in reply to Mr. Motley, said that in order to give protection from ice, wooden fenders were fitted across the slip to keep the ice from piling in the slip, when the ferry churned up the water. This fender was located about in line with the front girder *B*.

As regards the grade of the apron, he would point out that the gantry *I* was very seldom operated, and five feet plus or minus was probably the maximum ever called for. This, in 100 feet, the length of the outer half of the landing, would give about a 5 per cent grade. The total length of the landing being about 200 feet, there would be about a 2½ per cent grade, providing everything were in a straight line.

W. Chase Thomson, M.E.I.C.[7]

In reference to Mr. Pratley's comment, Mr. Chase Thomson stated that the gantry posts were not figured for bending moment due to continuity.

The load on the track itself would have little or no lateral effect on the gantry because the track was suspended by hangers, and was simply steadied by guides attached to the posts and the masonry below.

C. M. Goodrich, M.E.I.C.[8]

Mr. Goodrich remarked that there were one or two notes which he would like to present, after adding his compliments to those already paid the authors for so excellent a paper.

In connection with secondary stresses in the lifting frames, Professors Van den Broek and Timoshenko of the University of Michigan, and Professor Kist of the University of Leyden, and a number of others had pointed out that steel is not only elastic, but is ductile; the gentlemen who had spoken so earnestly about secondary stresses for so many years had omitted to consider the matter of ductility, and if this were looked into it would be found that in steel we had a material which would stretch a little and then after distributing stresses more favourably, be perhaps 20 per cent stronger than it was before.

Mr. F. C. McMath had stated that one could assume any reasonable distribution of stress for a structure and proportion it to carry the resulting stresses, and if the structure did not want to carry them that way, it would carry them in some other easier way. This was a very pleasant and very true way of putting the thing.

Mr. Goodrich referred to the three-track ferry apron at Mackinac. This was composed of the usual number of girders for three track aprons, held at the rear by pins which were held horizontally by rather heavy springs. There was the usual gantry, and a stiff transverse member at this point. The top flanges of the longitudinal girders were of angles and plates and the bottom flanges of plates only; the plane of the top flanges was accordingly stiff and yet it could warp because of the flexibility of the bottom flanges.

The first apron of this type had been constructed about five years ago, and had had rough treatment, yet the only maintenance had been painting; previous to this installation the maintenance cost had been very heavy. Thus, a stiff and yet readily warping floor seemed to be a good solution.

H. S. Grove, A.M.E.I.C.[9]

Mr. Grove referred to the angle between the pins and apron stringer, and remarked that the outer ends of the apron stringers would ordinarily move in planes at right angles to the axis of the pins, but warping of the deck would tend to cause the outer ends to deviate from these planes.

Was this deviation sufficient to make special clearances or curved bearings necessary?

P. L. Pratley, M.E.I.C.

Mr. Pratley also noticed the inclined position of the stringers of the intermediate span resting on the cross girders and asked whether there was any motion laterally on the cross girders.

D. B. Armstrong, A.M.E.I.C.

Mr. Armstrong pointed out that on the shore span and intermediate span there was no tilting whatever. The transverse girder *E* and the girder *I* always remained horizontal. The only tilting occurred in the apron. Of course, there would be a slight tilt in the shore end of the apron stringers, but this required a very small play on the pins. As far as he knew, there was no adverse effect.

W. Chase Thomson, M.E.I.C.

Mr. Thomson also explained that the stringers were not supposed to tilt. In fact, they were stiffened at the girder *E* with a box section to prevent them from tilting.

Hinged spacer struts had been put in at the ends to prevent the girders from spreading, but that had a very slight effect on the width.

P. L. Pratley, M.E.I.C.

Mr. Pratley thought Mr. Thomson had misunderstood the question, which referred to the longitudinal tilting of the apron in respect to the intermediate span; the stringers being longitudinal would tilt in longitudinal planes, and therefore, as these longitudinal stringers tilt, and as they are on an incline to the pin axis, there must be some movement laterally. What provision had been made for that movement?

H. B. Blackman[10]

Mr. Blackman was interested in the same question, and noted that in Fig. 9 the longitudinal girders were apparently secured so that when the apron tilted the four longitudinals remained vertical. What would prevent them tilting at the outer end where there was nothing to support them?

W. Chase Thomson, M.E.I.C.

Mr. Thomson replied that the strength of the inner end, that is, the torsion value of the girder itself, was the only thing that held them; they did not tilt.

Referring to Mr. Pratley's suggestion that there should be some provision for lateral movement due to the fact that the longitudinal girders are inclined to the axis of the pins, he explained that bevelled steel fillers had been riveted to the ends of these girders, providing vertical bearing surfaces parallel to the longitudinal axis of the structure. Thus the ends of the girders are, in effect, perpendicular to the axis of the pins.

[6] Erection Engineer, Dominion Bridge Company, Ltd., Montreal.

[7] Designer, Dominion Bridge Company, Ltd., Montreal.

[8] Chief Engineer, Canadian Bridge Company, Walkerville, Ont.

[9] Designing Engineer, Power Corporation of Canada, Ltd., Montreal.

[10] Canadian Vickers, Ltd., Montreal.

Discussion on "Structure and Oil Prospects on the Eastern Foothills Area, Alberta, Between the Highwood and Bow Rivers"

Paper by Dr. G. S. Hume[1]

J. A. Allan[2]

Professor Allan remarked that a few years ago the geology of the foothills of Alberta was considered to be moderately simple. Most geologists having a knowledge of Alberta geology would have agreed with this statement. Structures suitable for oil accumulation were then believed to be extensive and widespread within the foothills.

Fortunately for Alberta, and possibly for the investing public of Canada, the Geological Survey of Canada had assigned the colossal task of detailed geological investigation in Alberta to one so able as the author, who had shown, as a result of his extended detailed surveys, that the foothills of Alberta really contained the most complicated geological structures. If this statement were doubted, he would advise inspection of the author's advance issue of his maps of Turner valley and the Fisher creek sheets, west and northwest of Turner valley. Faults were so numerous and "nappes" so narrow that there was little room for petroleum accumulation. This was one reason why more oil pools had not been encountered in Alberta foothills, and was also a reason why the outside public should be careful to consider the geological position and the structure before paying fabulous sums for ridiculously small blocks of acreage. Ignorance of these facts too frequently produced the inevitable results. Had the detailed structure along the Highwood and northwest or Turner valley been known even a decade ago, many would be better off financially to-day, but blame for this could not be attributed to the author.

Professor Allan did not wish to give the impression that all foothills structures were unsuitable for oil accumulation. It was only necessary to examine Figs. 2 and 3 in the paper to arrive at the conclusion that certain areas were more favourable than others, and furthermore that the Turner valley structure was more favourable as to depth than most other positions on the lines of his sections.

In 1914 the Turner valley structure seemed quite regular and moderately simple. As drilling continued, the structure proved to be progressively more difficult of interpretation. However, even though Turner valley was classed as a gas field, from which over 60 billion cubic feet of gas had been produced from a block of 1,000 acres, yet that gas had produced a barrel of naphtha from every 25,000 to 60,000 cubic feet of gas, worth about $3.50 per barrel. The Turner valley structure had produced a valuable product, whatever it might be called.

Referring more specifically to the paper, Professor Allan noted that Fig. 1, apparently through lack of space, had been turned sidewise. There was no north sign and unless acquainted with Alberta, it would be difficult for the reader to get orientated geographically.

Although all the formations were of sedimentary deposition, as noted by the author, there were pyroclastics, in the form of volcanic ash beds in the Cretaceous sedimentary formations. The author had omitted to note a rapid variation in the thickness of the formations in an east-west direction, and also from north to south along the strike of the foothills. A formation 2,000 feet thick on one part of the foothills might be two or three times as thick fifty or a hundred miles away, or vice-versa. The formations were of both marine and fresh or brackish water origin. The marine members tended to thicken to the southeast and the latter to thicken towards the northwest. Even the Belly River formation was in part of brackish or marine origin, especially in the southern foothills.

The changes in the interpretation of the Turner valley structure had been marked in the past five years, as a result of more extended drilling, and there was no doubt that as additional drilling was completed, structural details as now recognized might have to be revised. This was to be expected where complicated structures existed such as those in this part of the foothills of Alberta. In this change the number of faults would be more apt to increase than to diminish.

In spite of the complicated system of faulting which the author had indicated, he had sounded an optimistic note in stating that there were favourable prospects of petroleum accumulation in certain parts of the foothills. This optimism on his part was to be commended, for a study of Dr. Hume's sections might cause the reader to conclude that oil prospects in this part of the foothills of Alberta were poor. Professor Allan agreed with the author that there were structures in the foothills worth testing by drilling, but at the same time would point out that these structures were not of wide extent, and drilling sites should be selected only after all available geological facts had been obtained. A mistake of even a few hundred feet in the location might result in failure instead of success. If a number of engineers would take the author's hints as to favourable structural conditions, then we might expect increased drilling activity in the foothills of Alberta in the near future, on locations outside the bounds of Turner valley.

Professor Allan remarked that he was very grateful to have had the opportunity of discussing Dr. Hume's lucid, informational, and at the same time, technical paper.

B. F. Hake[3] and Robin Willis[4]

Messrs. Hake and Willis stated that the paper appeared to them to be the best exposition of the geologic structure of the Alberta foothills which had thus far been published. The facts as presented were in close conformity with their own observations. The author's estimates of the oil and gas possibilities of the region seemed reasonable. They wished, however, to invite attention to a few points of interpretation concerning which they were not in agreement with him.

Noting the statement in the summary that "the foothills are considered to be an overthrust mass thrust eastward on to the relatively flat-lying sediments of the plains," Messrs. Hake and Willis, observing the eastern margin of foothill folding from Waterton river northward as far as Peace river, had failed to find evidence which would confirm this statement. On the contrary, their observation was that this margin almost everywhere consisted of a pronounced east dip involving a thick section of rocks and merging to the eastward into the undeformed sediments of the plains.

They found that where relationships were clear, the outcrops of the most easterly major faults lay west of this east dip, their character suggesting faults developed as a result of folding rather than faults which were primary features and which controlled the folding. Speaking of Turner valley, Dr. Hume had said "this anticlinal structure, however, is in reality a drag fold developed above the low

(1) This paper was presented at the Annual General Meeting of The Engineering Institute of Canada, held in February, 1931, at Montreal, and appeared in the January, 1931, issue of The Engineering Journal.

(2) Professor of Geology, University of Alberta, Edmonton, Alta.

(3) and (4) Nordon Corporation Ltd., Calgary, Alta.

angle thrust plane and was caused by the resistance to eastward movement along the fault plane." The cross section of Turner valley shown in Fig. 3 was a representation of structural conditions with which they were in close agreement. It did not, however, appear to them as a picture of a drag fold on a sole fault, but rather a primary anticline which had passed into a thrust fault.

The method used by the author in projecting the cross sections below the observed surface information appeared to be somewhat illogical and to give too optimistic results in the light of drilling experience in the foothills. Although Dr. Hume's surface observations showed closely compressed folds with sharp axes of the similar type, he had not projected this type of fold in depth, but had used the concentric construction which rounds off and broadens the synclines and flattens out the anticlines. This gave a minimum depth below the surface for any given horizon at any point in the cross section. Numerous disappointments and failures to reach the limestone at estimated depth had indicated that the similar type of construction should be carried to depth and that estimates of the position of the limestone should be made in a much more conservative manner.

Specifically, in Fig. 3, five miles from the west end of the cross section, the northern extremity of the Highwood uplift was shown as having a minimum drilling depth of 2,200 feet and a maximum depth, for a width of a mile, of 3,000 feet. In this locality the Highwood uplift plunged to the north, and therefore drilling depths south of the author's cross section should be less than those indicated by him. In contrast to this the No. 1 well of the Calgary Development and Production Company, located along the strike of the uplift about one and one-half miles south of the cross section, was now drilling below 3,700 feet and had not yet encountered the limestone.

They would ask Dr. Hume how the second principal fault from the west end of Fig. 3 happened to be a thrust fault with a large throw at the surface, although at the same time it had a normal displacement in the opposite direction at a depth of 2,500 feet.

They were of opinion that the names "Upper Alberta Shale" and "Lower Alberta Shale" proposed by the author to replace "Upper Benton" and "Lower Benton" would add unnecessarily to our profusion of formation names and would themselves be subject to at least some of the objections inherent in the older terms. In a more northerly portion of the foothills, Malloch* had described the unquestionable equivalents of these two formations and had given to them the names Blackstone shale (lower) and Wapiabi shale (upper). They favoured the acceptance and general use of these names, which had priority and referred to definite lithologic units and definite type localities. The identity of these with the author's Upper and Lower Alberta shales had been established by several workers, including Messrs. Hake and Willis themselves, both by tracing out the outcrops and by collection of fossils.

T. A. Link[5]

Mr. Link observed that the paper under discussion dealt with an area which was intimately known to him, and that the stage had now been reached with respect to the foothills structure when various theories and ideas were being put forth in print with some degree of confidence. As stated by the author, many of these ideas had been developed in the geological department of Imperial Oil Limited, where much first hand sub-surface and detailed surface geological information had been assembled.

The paper presented, quite definitely, some of the current conceptions regarding foothills structure, and should serve to give one not familiar with the area a good picture of these conditions. There were however minor details of structure which would, no doubt, be interpreted in a different manner by those familiar with these details.

The incorrect orientation of the map in Fig. 1, was unfortunate and might give rise to confusion.

Mr. Link further remarked that since the Jumping Pound structure was generally recognized as the fold indicated by No. 2 on that map, it was to be regretted that the author had termed the Highwood-Waite valley uplift the "Highwood-Jumping Pound Anticline." This would lead to considerable misunderstanding. He would suggest that the author should retain the locally used and established names in the government publications which would follow on this area.

The author's contention that the Highwood structure is too large to effect "sufficient concentration in any one area" recalled remarks of a similar nature made regarding the Big Sweet Grass Arch before commercial production was obtained there. In Mr. Link's opinion the Highwood structure was sufficiently cut by faults and was composed of enough subsidiary folds to afford plenty of opportunity for local concentration.

He pointed out that the Fisher creek structure was underlain by what appeared to be a very low-angle overthrust fault and that the topographic expression of this major fault was such that the Fisher Mountain uplift appeared to be a thin overthrust sheet of considerable areal extent. If the Palaeozoic limestone were not encountered at a depth shallower than 3,000 feet it appeared highly probable that it might never be reached, on account of the presence of this low-angle sole fault. The several high-angle slice faults above the sole might cause enough repetition of beds to prevent reaching the limestone before the major sole fault was encountered. In view of these facts Mr. Link believed that the author's statements regarding the test on the Fisher creek uplift were somewhat too optimistic.

The substitution of the name "Alberta Shale" for "Benton Shale" had caused considerable discussion among geologists working in western Canada. The general consensus of opinion was that the introduction of the new term "Alberta Shale" was unnecessary, because it did not offer any solution of the problem of a Colorado and Montana fauna in the Benton shales. It was felt that there were at the present time suitable names available which had priority over "Alberta Shales." He considered that since the province of Alberta covered a rather large area, of which only a narrow belt exposed Benton shales, it seemed inadvisable to employ the name "Alberta Shales."

T. Madgwick[6]

Mr. Madgwick observed that the paper presented a valuable résumé of certain aspects of the author's work on the geology of the oil and gas fields of western Canada. The final word both as regards tectonics and economic prospects was a matter for the not-immediate future, but, as regards the particular area covered by the paper a considerable step forward had been made.

There were two striking points, first, the complexity of the structures with which oil and gas are associated in the foothills, and second the confidence with which the writer regarded the future of the oil and gas industry. Mr. Madgwick thought that a certain degree of caution was advisable as to exactly *how* these minerals did occur.

As a result of drilling it had been demonstrated that a low angle thrust fault underlies Turner valley. Fig. 3 represented the utmost that could safely be drawn at present to illustrate this. As to the exact nature of that

*G. S. Malloch, "Bighorn Coal Basin, Alberta," Geol. Surv. Can., Memoir 9-2 (1911).

[5] Geologist, Imperial Oil Limited, Calgary, Alta.

[6] Petroleum Engineer, Department of the Interior, Ottawa, Ont.

thrust fault opinions were divided, as a recent discussion in Calgary had clearly shown. Curiously enough, in spite of the much greater drilling activity which had taken place in Turner valley compared with the adjacent New Black Diamond section, there would appear to be less unanimity regarding the kind of thrust faulting in the two areas. This, he supposed, was due to the fact that the flatter part of the Turner valley fault was deeper and that as yet but few wells had reached it, neither was their interpretation agreed upon. The deep well shown in the east of the section might be taken as representing certain wells which had failed to meet not merely the limestone but some overlying formations. They entered a formation at about a mile depth, which owing to lithological similarities between various Cretaceous sandstones had not been definitely tied up with any, but may have been Belly River. But a quarter of a mile west the limestone was struck at 3,800 feet.

The few wells that had actually passed through the fault from the limestone had entered beds in regard to which controversy also existed. One well might have struck Benton, another Blairmore, whereas some observers would regard both as in Belly River. A recently published section definitely showed Belly River.

The distinction was important, for if the latter were the case, then the hypothesis of a bedding plane fault along the Belly River or the overlying Bearpaw would be tenable, whereas if Benton or Blairmore were there encountered, then the faulting might be subsidiary to the folding and the limestone not have been torn so completely from its roots and perhaps translated a considerable distance eastwards into the bargain. In the first case there was shear thrusting, in the second break thrusting. The difference was not merely of academic interest, for it must have a bearing on our ideas of the size of the reservoir from which the wet gas is coming.

Before leaving the subject of the interpretation of subsurface structure by means of boreholes Mr. Madgwick referred to a divergence of opinion current amongst geologists in the west regarding the reliance to be placed on information thus acquired, owing to the crookedness of holes. It was only during the last three or four years that petroleum engineers had become interested in the verticality of their holes, although the results of crookedness had long been known. Various methods of surveying boreholes were in existence, but most engineers would agree that although the angle of inclination from the vertical is relatively easy to determine, the direction is much more difficult. A number of holes had been surveyed in Turner valley and it had been found that rotary drilled holes are worse than those drilled with cable tools, particularly where there had been an attempt to rush a rotary hole down. Looking at Fig. 3 and the more western wells shown in Turner valley, it was clear that the possibility of the deflection of a hole several hundred feet either way might have an important bearing on the interpretation of the log geologically.

Some would consider that the results are so vitiated by this uncertainty that it is inadmissible to publish any section of the kind here shown. Such meticulous precision to his mind was absurd. Nobody who took the trouble to study all the well logs in Turner valley would interpret the information blindly. Such a section as the author had given supposed the drawing of many other sections and the elimination of much doubtful information.

To look at things in a more general way, he noted that in Fig. 1 the author had the system of thrust faults arranged "en coulisses." Mr. Madgwick suggested that this might favour a moderate amount of thrusting, on the lines of A. J. Goodman's recent paper, rather than a too definitely pronounced type of sole fault. It would be difficult to picture sole faults with great displacements without introducing tear faults between the ends of these separate sections, and even then it would be hard to reconcile the results with the mapped longitudinal continuity of the outcrops of strata in the foothills. Tear faulting was another vexed question in the foothills. By introducing smaller thrusts these difficulties were largely removed. Thrusts could give place to folding laterally, and new thrusts could come in to take up the stress in the same way.

There was great reluctance on the part of western geologists to admit evidence of flowage in the Alberta shales. It would of course be necessary to suppose something of this sort if Turner valley were to be accepted as showing break thrusting. Elsewhere in the foothills where cores of Alberta shales had been taken, whole zones were characterized by slickensiding and the development of an incipient schistose appearance, in which sandstone bands pinched out, apparently by compression. It was worthy of note that in Fig. 3, beneath the little syncline in front of the New Black Diamond well (on the left hand side of the section) flowage was indicated. Although such shales could hardly be expected to behave like rock salt, the Menelite shales of the Polish Carpathians, a region to which the writer made reference, very similar in texture, undoubtedly exhibited the flow. Whilst referring to the Carpathians, Mr. Madgwick mentioned that in the case of Boryslaw, the principal field, the analogy with which must not be stressed too far, there is a flattening in the drag fold towards the southwest, so that productive wells extend as far as Mraznica. It had not yet been proved that something similar does not occur at Turner valley.

Although the author did not specifically say so, Mr. Madgwick imagined that he regarded the Palaeozoic limestones as being the competent beds through which the thrust had been transmitted from the west. Was it not true that where visible the limestones tended to form structures with decreasing thrust from the southwest to the northwest? In Mr. Madgwick's opinion the Lewis thrust represented something quite different from the structures now considered. He must confess that he had not yet found any reliable theory of the mechanics of this kind of thing. He did not decry the interesting work done experimentally, but felt that the conditions which one ought to take into consideration in this particular case were quite impossible to reproduce in a laboratory, such conditions being the loading, ratio of thickness to area involved, lateral variation both in thickness and lithology and complexity of floor and incidence of thrusting forces. An incalculable factor, but one which might have played an important role in Turner valley, was the resistance of the autochthonous beds to the east. These had probably been thickened in the process and he thought that the rapid rise in the surface from the Bow river towards Turner valley in part expressed this.

Coming now to the oil and gas prospects, he believed that the author had given a correct picture, on the conservative side if anything. The exact manner of occurrence of the wet gas had yet to be determined and as usual it would fall to the driller to help out in this respect. The amount of drilling accomplished, even in Turner valley, was small. Elsewhere, particularly in view of the tectonic problems requiring solution and the area to be prospected, drilling had been insignificant. All the same, the results measured on this scale had been very good. It would be altogether unprecedented were the whole of the author's Highwood-Jumping Pound Anticline to prove oil or gas productive, and Dr. Hume had rightly called attention to certain sections of it where the drilling would be watched with interest. If the analogy of the Polish Carpathians were pressed, we might expect to find many fields with varied structure and grade of oil, not all equally productive, and it must not be forgotten that Boryslaw-Tustanowice, like its Albertan parallel, lies on the outer margin of the foothills. The area so far studied in detail was tiny compared with that over which oil is known to occur. The oil and gas industry of western Canada had made a good start; it had a long and very promising life before it.

J. B. Webb*[7]

Mr. Webb, referring to the structural conditions along the eastern border of the foothills in the vicinity of Highwood river, observed that his interpretation of the geology would lead to conclusions at variance with those expressed by the author.

In his paper, Dr. Hume had emphasized the undoubted presence of a major low-angle thrust fault plane beneath the outermost foothills folds and had made the statement that "the whole foothills area is underlain by a low angle major thrust plane along which the sediments have been pushed on to the relatively flat-lying sediments of the plains." The inference would be that one continuous fault is found along the eastern edge of the foothills, but this first statement was later qualified in the paper as follows:—"To the south of Turner valley, another fault west of the Turner valley fault becomes the low angle thrust under the Highwood area. Thus although we are not always dealing with the same fault, we are dealing with the same faulted conditions, and the evidence points to the whole foothills belt in this general area being underlain by such a low angle fault." The author, referring further to the Highwood structural conditions, had written "To the south and west of Turner valley is the Highwood anticline area. A low angle fault cuts under the Highwood area and hence structurally the Turner valley conditions are again duplicated."

Mr. Webb stated that he had spent considerable time in detailed mapping of the Highwood river and Bull creek sections and the outer hills of the Highwood district. The conclusion he had reached was that definite surface evidence of an overthrust of major proportion in the east flank of the outer Highwood folds was lacking. Furthermore, the subsurface evidence provided by four deep wells drilled in this territory did not indicate the presence of such a fault.

On Highwood river there existed outcrop evidence of a displacement, with a stratigraphic throw believed to be less than 400 feet. This break occurred about due south of the Imperial Highwood well, and had been regarded by some geologists as the surface expression of a great sole fault, which had been extended far to the south along the east front of the Highwood-Pekisko hills. Such an interpretation was seriously questioned, on the basis of surface evidence alone, and was practically disproved by the log of the Imperial Highwood well.

If, then, this structural break were regarded as of comparatively minor proportions, where did the hypothetical major thrust plane appear at the surface? If the Highwood river were followed eastward, it would be found that successively higher (younger) formations appeared in an east dipping series, until the coal-bearing beds in the basal portion of the Edmonton formation were reached. There followed a broad zone, about 1½ miles in width (measured normal to the strike) in which the basal part of the Edmonton and the Bearpaw formations are extremely contorted, folded and slightly faulted, but without indication of any major displacement. On the east side of this belt the beds again had a regular east dip. If the Highwood thrust fault existed it must be present in this highly distributed zone, but, as stated above, no large thrust fault had been observed. However, a tremendous amount of east-west foreshortening was still expressed in the contorted belt of Edmonton and Bearpaw strata.

*Discussion published by permission of Hudson's Bay Oil & Gas Company, Ltd.

[7] Geologist, Hudson's Bay Oil and Gas Company, Ltd., Calgary, Alberta.

In Mr. Webb's opinion, southward from Highwood river to the Pekisko creek district there was no more conclusive evidence of a great overthrust in front of the Highwood anticlinal area than had been found on the Highwood river section. The strip of territory between the basal Belly River sandstone in the east flank of the Highwood structure and the most easterly outcrops of the Blairmore formation was sufficiently wide to accommodate the entire section of Benton shales. At several localities along the east flanks of the hills the top sandstone of the Blairmore, displaying an east dip, emerged from beneath the Benton shales. There was no indication of over-riding by the Blairmore rocks on to the younger formations to the east, except on a comparatively minor scale.

The subsurface information obtained from the four wells drilled between Highwood river and Pekisko creek did not establish the existence of what could be regarded as a major fault. The deepest of these holes (Imperial-Highwood No. 1, depth 4,525 feet) which was located on the east flank of the structure, encountered the top of the Palaeozoic limestone at 4,229 feet, but passed through a minor overturned fold in this formation and ended in Fernie shale. It was believed that the limestone would have been re-encountered at greater depth. The other three wells were located on either the axial portions or the west flanks of outer folds and did not meet with any recognizable repetition of strata. The deepest of these three wells (Hudson's Bay Oil and Gas Co., Highwood No. 1) reached the limestone at the shallowest depth, 2,156 feet, and was drilled to 4,067 feet without encountering any evidence of faulting.

In conclusion it might be stated that there was a considerable amount of surface and subsurface information available in the Highwood river area which was contradictory to the existence of a major thrust fault plane beneath the outer folds, as postulated by the author.

F. D. Adams, Ph.D., Hon.,M.E.I.C.[8]

Dr. Adams, while not prepared to discuss the details of the complicated sections which had been prepared by the author and presented with his valuable paper, called attention to the great strides which had been made by geologists within the last few decades in unravelling the exceedingly complicated structures presented by many of the mountain ranges of the world. These studies had commenced in the Alps, which, running through the centre of Europe, were early made the subject of investigation by the geologists of the several countries traversed by these mountains.

Some of the individual peaks in this range offered to the geologists of those days veritable geological riddles. One of these was presented by the twin peaks of the Greater and Lesser Mythen near Brunnen on the Lake of Lucerne. This massif rose abruptly from an area of relatively level land which was underlain by flat stratified rocks. The rugged massif itself was clearly seen to be composed of three sets of stratified rocks overlying one another which could be distinguished even from the plain by their differences in colour. They were in the form of a syncline or downward bending fold. Not only was this sharply folded mountain mass superimposed upon a plain composed of strata which had not been folded, but the clear evidence of the fossils in the rocks of the mountain showed that the lowest of the three sets of strata of which it was made up was the newest, while the strata forming the summits of the mass were the oldest. The mountain had been turned upside down and was in fact standing on its head. No one could then understand what had happened, but the facts were incontrovertible.

[8] Montreal.

Dr. Adams remembered showing the section of this mountain, given in Gredner's Geology, to one of the older geologists under whom he was working in those early years, who informed him that any one who drew such a section showed thereby that he knew nothing of geological science, because such a structure could not exist.

The study of the Alps had now been continued by a host of geologists for three generations, and the mountain range had been mapped in great detail foot by foot. The knowledge thus gained enabled one to understand what had really happened, not only in the Alps but in other great folded mountain ranges of the world, including the Rockies.

The tremendous lateral pressures to which the mountains had been submitted and which in fact had brought them into being, were so intense and long continued that the strata had not only been thrown into great folds but these folds had been overturned and bent back upon, and even forced over one another again and again, while in other cases great faults had been developed and one great mountain block had been shoved bodily over the other, the process often being repeated again and again as shown in the author's sections.

The Mythen was merely a fragment of a great overturned fold carried by a horizontal fault, upside down, over a tract of level country and then cut off by erosion from the rest of the range, in which the continuation of its structure could now be traced.

S. G. Porter, M.E.I.C.[9]

Mr. Porter did not feel competent to discuss the geological problems involved, but thought it would be of interest to give some information as to what had been done in the way of development and to what extent production had been secured.

Drilling and production operations had been carried on in the field from 1914 to date, and in 1924 the horizon of high pressure gas and naphtha was discovered in Royalite No. 4 well, which had led to the intensive developments set forth in the tabulated statement shown below of the results obtained in the Turner valley.

[9] Manager, Department of Natural Resources, Canadian Pacific Railway Company, Calgary, Alta.

Dr. G. S. Hume[10]

The author, in reply, pointed out that the geological structure of the foothills was so complicated that it was not surprising to find a divergence of opinion as to its interpretation. As new data became available from drilling, certain modifications of present ideas would be inevitable and the present discussion was a welcome contribution toward the solution of this difficult problem. The admission that low angle faults occur in such structures as Turner valley, New Black Diamond, Jumpingpound, and Wildcat hills had served to direct attention to this important feature of foothills structure and it was obvious that locations for new test wells would be made with much more care than had been the case in many instances in the past. Certain objections had been made to the author's interpretation of local structure. He realized that various interpretations were admissible on account of the relatively small amount of data available at the present time and that no one opinion should be accepted as final until more information had been acquired.

In regard to the use of the name "Alberta Shale," a new name had some objections on account of the common use of the old. The name "Benton," however, was objectionable because the strata included in that formation are not the same age as the Benton in the type section, and hence the use of the name assumed a correlation that did not exist. The formational names applied in the more northerly parts of the foothills could not be used where the Cardium member of the so-called Benton could not be recognized, and a general formational name seemed desirable, hence the name Alberta shale had been introduced.

The author wished to thank those who had contributed to the discussion, which had been very helpful in trying to solve many difficult problems.

[10] Geological Survey, Department of Mines, Ottawa, Ont.

Turner Valley Production

Year	Gasoline or naphtha, bbls.	Value	Crude oil, bbls.	Value	Total Value
1914 to 1921	(From Govt. reports)		56,599	$ 388,646.00	$ 388,646.00
1922	9,294	$ 39,034.80	6,559	51,882.00	90,916.80
1923	8,060	33,852.00	1,943	8,126.00	41,978.00
1924	13,205	62,063.50	844	4,135.00	66,198.50
1925	165,717	667,839.51	2,926	10,241.00	678,080.51
1926	211,008	901,004.16	2,609	9,131.50	910,135.66
1927	290,270	1,100,123.30	38,808	139,708.80	1,239,832.10
1928	410,623	1,630,173.31	70,734	254,642.40	1,884,815.71
1929	908,741	3,271,467.60	72,480	224,688.00	3,496,155.60
1930	1,314,098	4,467,933.20	50,545	156,689.50	4,624,622.70
Total	3,331,016	$12,173,491.38	304,047	$1,247,890.20	$13,421,381.58

Gas

	M.cu.ft.	Value
Calgary-Lethbridge:		
Gas Company System, 1922 to 1930 inclusive	27,042,785	$ 2,211,908.32
Imperial Oil Refinery, 1926 to 1930 inclusive	5,431,660	217,266.40
	32,474,445	$ 2,429,174.72
Used in Field:		
Estimated, 1914 to 1930 inclusive (Value estimated at 2c. per M.C.F.)	37,454,450	$ 749,100.00
Total Gas—Quantity and Value	69,928,895	$ 3,178,274.72
Add Total Value Naphtha and Oil (as above)	...	13,421,381.58
Total Value Naphtha, Oil and Gas		$16,599,656.30

Discussion on "The Alexander Power Development on the Nipigon River"

Paper by T. H. Hogg, D.Eng., C.E., M.E.I.C.[1]

J. T. Johnston, M.E.I.C.[2]

Mr. Johnston remarked that the engineers of the Hydro-Electric Power Commission appeared to have thoroughly appreciated the possibilities of the site and to have fully availed themselves of the opportunity, both to secure excellent construction conditions and to save expense at the same time. This same foresight was evident in the utilization of surplus rock to obtain so satisfactory a downstream toe-wall and in the manner in which the fill was placed. The securing of a satisfactory dam at the rate of construction necessitated by the shortness of the season was in itself an achievement.

He had been greatly interested in the methods used to secure a satisfactory junction between concrete and earth sections for both auxiliary and main dams. Another matter of interest was the design worked out for headworks which could be operated satisfactorily under severe winter conditions without the provision of an expensive superstructure; engineers would be anxious to hear whether the methods adopted had come fully up to expectations.

W. S. Lee, M.E.I.C.[3]

Mr. Lee observed that in every power house certain power was dissipated as heat, and that this heat must be disposed of through ventilating fans, ducts or by some other method. The hot air coming from the generating room could be passed through ducts and utilized to keep the bulkheads, gate housing and gate apparatus in proper working condition, and also to free the bulkhead entrances from ice. The author adopted this system, which had also been used at Isle Maligne on the Saguenay river. There the hot air went through tunnels to the bulkhead and entrances and under no weather conditions was there ice interference, although this station had been operating in a severe climate for a number of years. This same scheme was being incorporated in the Beauharnois station.

There was another feature at Alexander which he considered an excellent one. For the operation of the gates or other machinery on the bulkhead there was a standard gauge railway track with a locomotive crane, thus providing not only a locomotive crane for the bulkhead, but also a useful piece of apparatus which could traverse various yard tracks and serve the entire power plant.

A most interesting feature of the Alexander plant was the method of building the earth dam. He might add one or two features to the author's explanation. The lower part of this dam was a rock fill, approximately 45 feet high. That amount of rock would not have been placed in the toe, but the stone was available and instead of wasting it it was dumped into the river, before the river was diverted, forcing the river to a narrow channel on the opposite side which was closed with stone just before the dumping of earth began. The rock foundation beneath the earth dam was probably 150 to 200 feet below the bed of the river. This area was filled with debris, gravel, sand, laminations of clay and perhaps some broken stone that had been weathered off the rocky sides. They had expected it to leak, and the next problem was to devise some plan to seal the flow of water and prevent it from flowing under the dam, and out below the rock toe. It was decided that the proper procedure was to seal or caulk this gravel drain under the dam. If a very fine clay were dumped in a quiet pool of water in one spot the clay would flow and spread itself out under the water. He had seen fine clays in solution dumped in this way into a quiescent pool, flow as much as 1,000 feet and there would not be over five-tenths of a foot variation in the top elevation of the layer of clay. It seemed to flow like heavy oil or molasses. Accordingly three or four feet of impervious clay were deposited between the upstream toe of the earth dam and the cofferdam.

The author had stated that in the construction of the Alexander plant his superintendent and his resident engineer were the same man, Mr. Stanley. That was an excellent practice when installing any piece of work built by the owner. In this case the Commission built the plant. One of the most important points in the construction of any engineering work was to co-ordinate the construction with the design. When an engineer could be used both in the capacity of engineer and that of superintendent a great step had been taken towards co-ordination. By that plan it was possible to cut the costs and speed the work very materially. Personally he would like to see many more engineer-superintendents than in the past, because the superintendent should be a well-educated engineer in order to cope with some of the intricate problems which the author had outlined.

R. C. Flitton, A.M.E.I.C.[4]

Mr. Flitton desired to ask the author what was the reason for deviating from the previous practice of operating the flyballs from the generator leads through step-down transformers.

B. Ottewell, A.M.E.I.C.[5]

Mr. Ottewell believed that so far as Canada was concerned this was the only installation having this type of pilot exciter, but there were several instances in the United States. He would suggest that before dropping the scheme some further investigations should be made.

G. A. Gaherty, A.M.E.I.C.[6]

In regard to Dr. Hogg's design for the transition section between the concrete and the earth fills of the Ghost dam, Mr. Gaherty stated that no leakage whatever had developed at this point in the dam, although the dam had now been in service for over a year. This was the case notwithstanding that there had been considerable settlement in the earth fills themselves. Some slight leakage had shown up through the earth fill hydraulically placed, but strangely enough it was all near the top of the core. This was attributed to the difficulty in the placing of the hydraulic core of preventing layers of sand from extending across the core where it was narrow. There was also some slight seepage through the rock foundation of the fills.

M. V. Sauer, M.E.I.C.[7]

Mr. Sauer asked whether any special provision had been made to consolidate the clay in the pond above the dam so that later velocities which might occur when the dam is discharging would not stir it up?

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(1) This paper was presented at the Annual General Meeting of The Institute, Montreal, February, 1931, and appeared in the March, 1931, issue of The Engineering Journal.

(2) Director, Dominion Water Power and Reclamation Bureau, Department of the Interior, Ottawa, Ont.

(3) Vice-President and Chief Engineer, Duke Power Company, Charlotte, N.C.

(4) Chief Engineer, William Hamilton, Limited, Peterborough, Ont.

(5) Engineer, Canadian General Electric Company, Peterborough, Ont.

(6) President, Calgary Power Company, Ltd., Calgary, Alta.

(7) Hydraulic Engineer, Beauharnois Construction Company, Beauharnois, Que.

F. W. Caldwell, M.E.I.C.[8]

Mr. Caldwell enquired whether the fineness of the material which was used in the clay core of the dam had been specified. Was the fineness about 200 mesh? In regard to the material underneath the clay core of the dam, were borings taken so as to obtain samples of it, and were any tests made as to the amount of water flowing through the material below the core?

He had had the opportunity to look over a clay dam on the Sacandaga river in the state of New York, which was very similar to the case described in the paper. There, the rock fill had been used for the toe, and that material had been obtained from the spillway which was excavated in the rock ledge on one side. The material in the stream bed was gravel, but on excavating a key section 30 feet deep a tight clay blanket several feet deep was found, although there was material below that which would leak. It was not necessary to place a clay blanket above the dam. The general construction of the work as a whole was semi-hydraulic. The clay was obtained locally.

T. H. Hogg. M.E.I.C.[9]

Amplifying the geographical notes in the third and fourth paragraphs of the paper, the author stated that the distance between Lake Superior and Lake Nipigon was about 22 miles. The Alexander development was about eight miles from Lake Superior, and utilized a head of 60 feet. The Cameron falls plant, a mile and a half farther upstream, utilized 78 feet. Lake Nipigon ranged in elevation from 846 to 855 feet above sea level, and as the average level of Lake Superior was about 604, the fall in the river was about 250 feet. Of this, 138 feet was utilized at Alexander and Cameron falls, and there remained about 112 feet of fall at present unused, of which about 108 feet occurred in the twelve miles of the river between the Cameron falls plant and Lake Nipigon, and four feet below the Alexander development.

The Hydro-Electric Power Commission had made surveys of the power sites between Cameron falls and Lake Nipigon, and while there was a possibility of developing the available power in this part of the river in two stages, it was also quite feasible to utilize the whole of the available head of 100 to 105 feet in a single development at Pine Portage. Thus ultimately, perhaps in another eight or ten years, the whole head from Lake Nipigon to Lake Superior would be in use, and of the whole fall, probably only five or six feet would not be concentrated at the power sites, the major portion of which would be between the tailwater of Alexander development and Lake Superior.

Referring to Fig. 9, in the paper, it would be noted that the auxiliary dam, which ran from the west side of the river to the power house, was also an earth fill structure, with a clay core. At one point a difficult situation had been found, extending for a distance of about 300 feet, where there was gravel lying on the rock, some 12 or 15 feet in depth. The question arose as to how this was to be cut off, the choice being between steel or wood sheeting, or a cut-off of clay. The author did not favour the use of steel or wood sheeting, if it were at all possible to avoid it, and resort was had to trenching such as is employed in bad ground on sewer construction. The trench was sunk 12 or 15 feet to rock, and filled up with clay, which resulted in very satisfactory freedom from leakage.

The author also drew attention to a method of construction which was used for the first time by the Calgary Power Company on the Bow river in connection with the attachment of concrete walls to earth fill. Those who had had experience in this type of work would know that danger always existed at the contact of the earth fill and concrete structure, and that it was exceedingly difficult to avoid the possibility of leakage developing there. The earth fill invariably shrank away from any vertical face of concrete as the fill dried, and before it became saturated again it would leak. The scheme adopted at the Alexander dam was shown in Fig. 7. At the end of the concrete buttressed sections, two wing walls had been splayed into the earth fill, forming a U section, and these wing walls had not in any respect any vertical face. They were sloped in every direction, so that the earth fill, when sinking, would flow around or be compressed around the concrete. Thus in shrinking, it remained in contact with the concrete.

As regards the installation of a fourth unit, he would point out that the three units installed were quite able to take care of the flow available from the present drainage area, since there was a very high load factor on the Thunder Bay system. Pulp and paper plants used large amounts of power, and the grain elevators provided a summer load, which tended to compensate for the winter peak. Three units thus were ample to use the present flow of the river.

However, it must be noted that there was a possibility of a dam being placed on the Ogoki river at some later date. This river drained the area west and north of Lake Nipigon, and, swinging to the east around the north part of Lake Nipigon, joined the Albany river, which flowed into James Bay. By a dam placed easterly of Lake Nipigon on the Ogoki river, the drainage from 6,000 square miles could be diverted across a height of land from the James Bay watershed into the Great Lakes watershed. A dam, 50 feet high, involving an expenditure of probably one and a half million dollars, would throw an additional 4,000 or 4,500 cubic feet per second through the Jackfish river into the north end of Lake Nipigon, increasing the flow of the Nipigon river by 60 per cent. It was very probable that this would be done in the future, and for that reason space had been left in the station at Alexander for the installation of a fourth unit.

J. H. Hunter, M.E.I.C.[10]

Mr. Hunter inquired whether there was any possibility of a dam across the Albany river.

T. H. Hogg, M.E.I.C.

In reply, the author stated that there was a possibility, but not an economic probability, of a dam across the Albany river, which would throw the Albany, as well as the Ogoki, down through Lake Nipigon. If that were done, it would bring down an additional 12,000 cubic feet per second, but the topography was not sufficiently favourable to justify such a structure. It would also be possible to dam the Albany above the junction point between the Ogoki and the Albany, thus diverting part of the Albany water into the Ogoki and thence into the Nipigon. That, however, was remote. A dam across the Ogoki would not involve the flooding of territory to any great extent, as would the damming of the Albany, and would probably produce only about one hundred square miles of lake area. A dam, 50 feet high and about 500 feet long, would be required. The cost had been estimated at about $400,000 or $500,000; but the site was very inaccessible, some fifty miles from the Canadian National Railways, and material would have to be brought in.

The author would refer to the arrangement described in his paper for driving the governor flyballs, as follows:

> "A three-phase tap has been taken from the armature of the pilot exciter of each generator and run direct to supply the governor flyball motor. This eliminates the necessity of step-down potential trans-

[8] Consulting Engineer, Montreal.

[9] Chief Hydraulic Engineer, Hydro-Electric Power Commission of Ontario, Toronto, Ont.

[10] General Superintendent and Chief Engineer, Canada Starch Company, Montreal, Que.

formers and connections to supply the flyball motors and supplies a potential direct to the flyball motor as soon as the generator is rotated, whether the 12-kv. connections are connected to the generator or not."

The standard practice which had developed in the last few years, and had now become almost universal, was an electrical drive for the flyball head, instead of the mechanical belt drive or gear drive. Such electrical drives had been installed in some fifteen units in the Commission's systems, and had worked very satisfactorily and without any interruption. In these cases, energy for the flyball drive was supplied from the generator leads.

Any change in the speed of the unit would be mirrored at once in the speed of the flyball head. But the difficulty with that arrangement was that until the generator was excited the flyball motor would not rotate. That was not a serious matter, because before the machine reached full speed the generator would be excited. Again, by this arrangement, the governor would operate in accordance with the speed corresponding to the bus frequency and not the speed of the unit, and although these speeds were identical under normal operating conditions, it is conceivable they might be greatly different, in which case the governor would not function properly to perform its duties. In the Alexander plant, this difficulty had been avoided by driving from the pilot exciter with a low frequency drive, thus obtaining generator speed on the flyball head, and this as soon as the machine started to operate.

For steady operation, this was probably satisfactory, but with sudden changes of load, results had not been good; there had been hunting and oversurge. The pilot exciter connection was therefore being replaced by a connection to the main leads.

In reply to Mr. Flitton and Mr. Ottewell, the author pointed out that the reason for making the change was perhaps more of an academic than a practical nature. With the governor drive hitherto in use, the flyballs did not begin to turn until the generator was excited. This did not matter so long as there was excitation before reaching the point of synchronization of the machines. The governor should be operating before the machine got up to speed, and usually there was enough residual magnetism in the machine for this purpose. Thus the objection was more or less academic, as long as all protective equipment operated properly and there was no practical objection to coming off the main leads.

Nevertheless he was heartily in favour of driving the flyball from the pilot exciter if it were possible to do so; perhaps it could be done by getting a higher frequency. But in this particular case a change was being made. There were several other plants using the pilot exciter drive; he believed there were fifteen developments of the International Paper Company, and the Chute à Caron also had it. He considered it a very proper method of handling the matter; it had advantages. But he was not prepared to leave it in Camp Alexander under present conditions, as satisfactory results were not being obtained.

In reply to Mr. Sauer, the author remarked that the clay blanket would not be affected by any discharge through the dam, because the cofferdam which had been put in ahead of the construction of the earth fill dam provided a dead pocket of water. There would be no flow beyond the cofferdam, because the earth fill was a dead structure.

In reply to Mr. Caldwell he stated that there were rigid specifications for the quality of the material to go into the core, and the average on the core ran about 95 per cent through the 200-mesh sieve. As regards the borings, test pits had been put down some 20 feet, so as to get a cross section, in addition to the wash-borings that were made over the area. The results plainly indicated that while there was gravel and sand, it was not in continuous layers; it was in lenses, in which the fine material segregated, which of course was favourable. There was a great deal of clay material below the dam, but it was broken up.

Discussion on "The Technique of Placing Concrete on Steep Slopes Without Forms"

Paper by I. E. Burks [(1)]

J. A. McCrory, M.E.I.C.[(2)]

Mr. McCrory stated that he knew of no industrial organization which had given more practical study to the placement of concrete than that with which the author was connected. Developments along the line which they had finally worked out and had used on the work described constituted a distinct advance.

There were one or two points upon which the author's paper did not touch which should be of interest. One of these concerned the class of concrete that is used in mass work. He understood that in the heavy mass construction, two classes of concrete were used designated as classes "A" and "C." Class "A" concrete, which was placed on the two faces of the dam, tested out to a minimum of 3,000 pounds per square inch compression, and had a water-cement ratio of about 0.9. Class "C" concrete was placed in the interior and was there solely for the mass that it gave to the structure and the strength did not exceed 1,500 to 1,800 pounds per square inch, and he thought had a water-cement ratio of 1.2. The separation of these two classes of concrete was rather easy considering the extremely dry concrete which was used but it would be more difficult in the ordinary type of construction. He believed however that it resulted in a very distinct economy in the structure, and in cases where a large amount of concrete was used, such as the case in question where there was something like 500,000 yards, the saving in cement bulked very largely in the total cost.

Mr. McCrory remarked that another point that impressed him when he first saw photographs of it was the screeding of the concrete on the steep slopes.

He was under the impression that a layer of mortar was spread on the surface in order to obtain a smooth face with the straight edges when screeding. However he had been informed by the author that this was not the case, as the action of the vibrators was depended upon to work the mortar in the concrete to the surface, with the result that the aggregate was close to the surface and the concrete very dense.

(1) This paper was presented at the Annual General Meeting of The Institute, Montreal, Que., 1931, and appeared on page 160 of the March, 1931, issue of The Journal.

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Some Problems Connected with Fluid Motion

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Presented on April 10th, 1931, before the Aeronautical Section of the Ottawa Branch of The Engineering Institute of Canada (Ottawa Section, Royal Aeronautical Society).

SUMMARY—Theories of fluid motion which have been practically useful in aeronautics assume that the air is frictionless and devoid of viscosity, but model work and the interpretation of results in wind tunnels involve the consideration of viscosity.

The paper first sketches the development of the theory of fluid flow and notes the important results following from Prandtl's hypothesis postulating the existence of a thin layer of fluid close to the body in which the frictional force between adjacent fluid layers is proportional to the velocity gradient normal to the direction of motion.

Starting with the Eulerian equations, the author shows the result of the addition of the viscous term by Stokes and then of Prandtl's modification for the boundary layer, and applies these considerations to the case of two-dimensional flow around circular cylinders.

The author, in his work on this subject at the Royal College of Science, obtained results which show a considerable measure of agreement between the observed boundary layer velocities around a cylinder and the theoretical distribution. From photographs of the air flow around the cylinder it is evident that there is at one point a complete change of flow, and a sheet of discontinuity is formed which breaks up into eddies. This is also in agreement with the mathematical results.

The paper points out that in addition to the consideration of viscosity it will probably be necessary, in dealing with aircraft of a very high speed, to take into account the compressibility of air. This may be ignored as long as the speed is not comparable with the velocity of sound in air, but aeroplanes have already reached a speed of one half that amount and in the operation of high speed air screws it is quite possible to have tip speeds of this order.

The subject of fluid motion, in common with many other fields of human endeavour, has aroused a great interest in the minds of men who have had widely different training.

The mathematician is interested in fluid motion from a philosophical point of view, and in consequence, he has been more engrossed with the behaviour of perfect fluids, which are devoid of compressibility and viscosity, rather than with the real fluids of everyday life which exhibit these properties. It is to be understood that air is included, and, in fact, all gases, in the category of fluids. This attitude of the mathematician need cause no alarm; it is customary for him to amuse himself with the manipulation of quantities which are themselves nothing but mathematical abstractions, having no real existence. In the same way, his perfect fluid has no actual reality, apart from its existence in his own mind, but yet the results deduced from the theory of perfect fluids are of great value when we come to consider the motion of bodies through real fluids, like air.

The physicist, displaying a profound interest in matter in all its forms, has been intrigued by fluid motion and the forces arising in virtue of that motion. He has been able to formulate a theory of viscosity, based on the kinetic theory, which gives a mechanical picture of the way in which viscous forces are generated by the fluid motion, and on the practical side, the exact measurement of the coefficient of viscosity has caused him no little difficulty.

Last of all, we have the engineer, turning a practical eye on the progress of science; he too has been drawn into the problems of fluid motion, in the hope of increasing the efficiency and reducing the running costs of the many devices he has which depend for their action on the flow of fluids.

It is customary, in a paper of this nature, to give a brief history of the subject, and it is necessary to go back nearly two hundred years in order to do this. In the study of fluid motion, the mathematician was the first man in the field, beginning in 1755 and doubtless, as usual, he will have the last word to say in the matter. The physicist was not far behind.

The aeronautical engineer has just got there, and is still somewhat breathless with haste. To him, the problems of fluid motion are of vital importance; the very fact that his aircraft do fly, that his airscrews develop thrust sufficient to overcome the resistance to motion of his aeroplanes, the existence of this resistance itself, are all consequences of the properties of viscous fluids. His task today is not one of producing more stable aeroplanes, for the modern machine does not leave much to be desired as regards stability and manœuverability. His chief problem now is the reduction of head resistance, and the consequent decrease in the minimum horsepower required for flight, together with an increase in top speed. This cannot be achieved until there is a full understanding of the manner in which this resistance arises, and it is here that the mathematician may prove useful to the aeronautical engineer.

The resistance is a direct outcome of the viscous property of fluids, but it is indeed strange that the only theories which can be applied practically to aeronautics assume that the air is frictionless or inviscid, and no theory of viscous fluids is at present useful to us. All model work, however, and interpretation of results in atmospheric wind channels, compressed air tunnels and water tanks depends on the theory of "dynamical similarity" and this involves a consideration of viscosity which is very important in these cases.

Euler gave the first theory of inviscid or perfect fluid flow, in his contribution to the memoirs of the Berlin Akademie in 1755. In the development of the theory of fluid motion, a mathematical definition of viscosity was necessary in order to account for the forces that arose from shearing both in the main mass of the fluid and also where it approached the surface of solid bodies placed in its stream. The mathematicians guessed that viscosity is directly proportional to the shear in fluids and this was subsequently verified by Poiseuille in his well known work on the flow of fluids through tubes.

It was in 1845, nearly a hundred years later, that Sir George Stokes contributed the viscous term to the equations of motion as given by Euler, and thereby established the three equations which imprison the secrets concerning the complete behaviour of real fluids. Since 1845, the equations have existed in unaltered form to the present day, their complexity has baffled mathematicians and in their entirety no solution to them has, as yet, been found.

To return to the perfect fluid theory of the mathematician, it yields the very surprising result that a body in motion through it experiences no resultant force whatever; there is no lift or drag on an aerofoil moving in a perfect fluid. If however, the fluid is endowed with a tendency to circulate round the aerofoil section, a lift force can be developed and the results of the theory based on this conception of the origin of lift agree fairly closely with wind channel experiments. But we still have to explain how the circulation is developed, and further, the theory is incapable of yielding any drag force on the aerofoil. In a real fluid we can look to viscosity for our answers: the viscosity is probably responsible for the circulating tendency and is undoubtedly the factor which governs the creation of the drag force.

It was in 1904 that the next step forward was made in the investigation of these phenomena. Professor Prandtl(1) at Göttingen advanced the hypothesis that there can be no relative motion between a solid and the fluid immediately in contact with it, in other words, the fluid sticks to the surface of the body. This was not generally accepted at first, and a slipping coefficient was suggested but was finally abandoned. The Prandtl hypothesis postulates the existence of a thin layer of fluid close to the body, in which there is intense shearing due to the influence of the solid surface, where the fluid velocity is reduced to zero. Since the frictional force between adjacent fluid layers is proportional to the shear or velocity gradient normal to the direction of motion, it follows that in this thin film of fluid the viscous forces are relatively large, but that outside this "boundary layer" the fluid can be sensibly assumed frictionless, being sufficiently remote from the surface for the shearing to be negligible. This hypothesis presents a revised view of what is happening when a body is moving in a real fluid, and it is seen that there are now two distinct regions in which the conditions existing, and the type of flow resulting, are both dissimilar. At some distance from the body the viscous forces are small, due to the comparative absence of shearing, but the dynamic forces, which depend on the square of the velocity, are large. Without serious error, the fluid in this region can be treated as a perfect fluid—the limiting case of a real fluid whose viscosity has been reduced to zero. Close to the surface of the body is a thin layer where the viscous forces are of the same order of magnitude as the inertia forces.

It has already been stated that viscosity is the responsible factor as far as the creation of drag is concerned and if it is assumed that the viscous forces are confined to the boundary layer, it becomes evident that any search for the mechanism which creates resistance will have to be made in the boundary layer itself.

Not only did Prandtl's theory narrow down the field of enquiry, it also enabled him to simplify the three viscous fluid equations when considering the flow in close proximity to a solid surface. This simplification(2) of the equations when applied to the region known as the boundary layer, stimulated the efforts of mathematicians to find a solution to them, but although twenty-seven years have elapsed since Prandtl first advanced his theory, there are but few solutions existing today, simply because the application of these equations to the flow past a body leads to unmanageable difficulties except in a few special cases. Blasius(3) has solved the equations for the flow along a flat plate where a further simplification can be made in virtue of the fact that the pressure gradient along the surface of the plate can be assumed negligible. Some work also has been done on the flow through pipes. Around curved bodies, the flow conditions are more complex; at least one attempt to perform the solution for the motion of a fluid round an aerofoil has met with failure and efforts have therefore been concentrated on the more simple shape of the circular cylinder. It is some of these attempts to solve the boundary layer equations for two-dimensional flow round circular cylinders that will now be discussed.

The three equations of Eulerian flow(4) which refer to a perfect fluid can be written thus:—

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = -\frac{1}{\rho}\frac{\partial p}{\partial x}$$

$$\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} = -\frac{1}{\rho}\frac{\partial p}{\partial y}$$

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$$

u and v are the components of velocity parallel to the X and Y axes respectively, ρ is the density of the fluid and $-\frac{\partial p}{\partial x}$; $-\frac{\partial p}{\partial y}$ are the components of pressure along the X and Y axes respectively.

The left hand side of the first two equations has the dimensions of an acceleration, and the right hand side has the dimensions of a force divided by a mass, so that the first two equations are statements of Newton's Second Law of Motion applied to a fluid element. The third equation is the equation of continuity, and depends on the fluid being incompressible; it expresses the fact that there can be no increase or decrease in the quantity of fluid contained in any elementary volume chosen at random in the fluid.

The next step was the addition of the viscous term by Stokes. Consider motion of the fluid parallel to the axis of X. The velocity of a fluid layer relative to a parallel layer unit distance away will be $\frac{\partial u}{\partial y}$ and hence the frictional force between them will be $\mu \frac{\partial u}{\partial y}$ per unit area of the layers, where μ is the coefficient of viscosity. Now consider the viscous forces on an element of fluid $ABCD$ of unit depth normal to the XY plane. At AB (Fig. 1) the shearing is given by $\frac{\partial u}{\partial y}$ and hence at CD its value is

$$\frac{\partial u}{\partial y} + \frac{\partial}{\partial y}\left(\frac{\partial u}{\partial y}\right) . \delta y$$

and the corresponding frictional forces on each face will be

$$-\mu\frac{\partial u}{\partial y} . \delta x \quad \text{and} \quad \mu\left(\frac{\partial u}{\partial y} + \frac{\partial^2 u}{\partial y^2} . \delta y\right) . \delta x$$

since the area of the faces AB and CD is δx .

Hence the resultant force on the element due to viscosity will be

$$\mu\left(\frac{\partial u}{\partial y} + \frac{\partial^2 u}{\partial y^2} . \delta y\right)\delta x - \mu\frac{\partial u}{\partial y} . \delta x = \mu\frac{\partial^2 u}{\partial y^2} . \delta y . \delta x = \mu\frac{\partial^2 u}{\partial y^2}$$

per unit volume or $\frac{\mu}{\rho}\frac{\partial^2 u}{\partial y^2}$ per unit mass, but $\frac{\mu}{\rho}$ is the kinematic coefficient of viscosity ν .

A similar force $\nu \frac{\partial^2 u}{\partial x^2}$ will be experienced by the element due to variation of u with x and in addition there will be similar forces depending on motion parallel to the Y axis.

Hence the total force on the boundaries of the element due to viscosity will be

$$\nu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right) = \nu \nabla^2 u \text{ in the } X \text{ direction}$$

and $\nu \nabla^2 v$ in the Y direction.

The three viscous fluid equations as given by Stokes are then

$$\left.\begin{aligned}
\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} &= -\frac{1}{\rho}\frac{\partial p}{\partial x} + \nu\nabla^2 u \\
\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} &= -\frac{1}{\rho}\frac{\partial p}{\partial y} + \nu\nabla^2 v \\
\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} &= 0
\end{aligned}\right\}$$

In steady motion, the terms $\frac{\partial u}{\partial t}$, $\frac{\partial v}{\partial t}$ are zero. Before imposing Prandtl's modification for the boundary layer on a cylinder, it is convenient to put the equations in a non-dimensional form by dividing lengths and velocities by representative values of length and velocity.

If lengths are all expressed as fractions of 'd' the diameter of the cylinder, velocities as fractions of the channel speed 'V', and if pressures are all measured as fractions of ρv^2, the equations become

$$\left.\begin{aligned} u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} &= \frac{1}{R}\nabla^2 u - \frac{\partial p}{\partial x} \\ u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} &= \frac{1}{R}\nabla^2 v - \frac{\partial p}{\partial y} \\ \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} &= 0 \end{aligned}\right\}$$

where $R = \frac{Vd}{\nu}$ = Reynold's number.

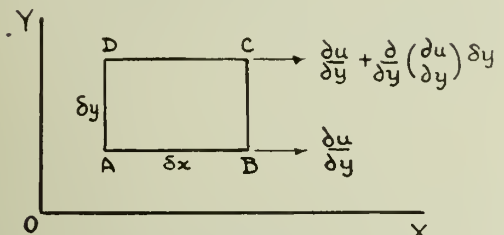

Fig. 1.

In the case of a circular cylinder it is more convenient to express these in curvilinear co-ordinates. With the axes as shown in Fig. 2, s denoting distance round the cylinder, r distance normal from the surface, and velocities w and q signifying radial and tangential velocities respectively, the equations transform to:—

$$\left.\begin{aligned} &-q\,.\frac{\partial q}{\partial s} - w\,.\frac{\partial q}{\partial r} - w\,.\,q\,.\frac{\partial \alpha}{\partial s} \\ &\quad = \frac{1}{R}\left\{-\frac{\partial^2 q}{\partial s^2} + q\,.\left(\frac{\partial \alpha}{\partial s}\right)^2 - 2\frac{\partial w}{\partial s}\,.\frac{\partial \alpha}{\partial s} - \frac{\partial q}{\partial r}\,.\frac{\partial \alpha}{\partial s} - w\,.\frac{\partial^2 \alpha}{\partial s^2} - \frac{\partial^2 q}{\partial r^2}\right\} + \frac{\partial p}{\partial s} \\ &q\,.\frac{\partial w}{\partial s} + w\,.\frac{\partial w}{\partial r} - q^2\,.\frac{\partial \alpha}{\partial s} \\ &\quad = \frac{1}{R}\left\{\frac{\partial^2 w}{\partial s^2} - w\,.\left(\frac{\partial \alpha}{\partial s}\right)^2 - 2\frac{\partial q}{\partial s}\,.\frac{\partial \alpha}{\partial s} + \frac{\partial w}{\partial r}\,.\frac{\partial \alpha}{\partial s} - q\,.\frac{\partial^2 \alpha}{\partial s^2} + \frac{\partial^2 w}{\partial r^2}\right\} - \frac{\partial p}{\partial r} \\ &\frac{\partial q}{\partial s} + \frac{\partial w}{\partial r} + w\,.\frac{\partial \alpha}{\partial s} = 0 \end{aligned}\right\}$$

These look very formidable, but fortunately Prandtl's approximations greatly reduce this complexity. His first condition is that R is supposed large compared with unity. This is usually true in wind channel work with cylinders where R is of the order of 100,000.

His second assumption is that q is large compared with w the normal velocity, and is true if the motion is laminar. Lastly derivatives with respect to r are supposed large compared with those with respect to s. This is experimentally satisfied.

With these assumptions, the equations reduce to

$$\left.\begin{aligned} -q\,.\frac{\partial q}{\partial s} - w\,.\frac{\partial q}{\partial r} &= -\frac{1}{R}\,.\frac{\partial^2 q}{\partial r^2} + \frac{\partial p}{\partial s} \\ 0 &= \frac{\partial p}{\partial r} \\ \frac{\partial q}{\partial s} + \frac{\partial w}{\partial r} &= 0 \end{aligned}\right\}$$

The second equation states that the boundary layer transmits normal pressures on it unaltered and we can therefore assume $\frac{\partial p}{\partial s}$ to be sensibly independent of r.

These then, are the equations to be solved, and the solution will give the tangential velocity q in terms of r and s for all positions round the cylinder, and will indicate the value of w the normal velocity.

Dr. Thom[5] at the University of Glasgow attempted a step by step solution, but after the first twenty degrees round the cylinder, an examination of his results suggested a new method of attack. He noticed that at any definite distance from the surface of the cylinder, the ratio $\frac{q}{v}$ was nearly independent of s, the distance round the cylinder, where v denotes the velocity just outside the boundary layer at the section being considered.

As a first approximation then, he assumed that $q = vx$ where x is a function of n only, n denoting values of r beyond the surface of the cylinder, that is, distances measured normal to the surface through the boundary layer. Also in his first approximation he neglected the term $w\,.\frac{\partial q}{\partial r}$ since w the normal velocity is a small quantity.

Then if, $q = vx \qquad \frac{\partial q}{\partial n} = v\,.\frac{dx}{dn}$

$$\frac{\partial^2 q}{\partial n^2} = v\,.\frac{d^2 x}{dn^2} \qquad \frac{\partial q}{\partial s} = x\,.\frac{dv}{ds}$$

and by differentiation of Bernoulli's equation for constancy of total head we get

$$\frac{dv}{ds} = -\frac{1}{\rho v}\,.\frac{dp}{ds}$$

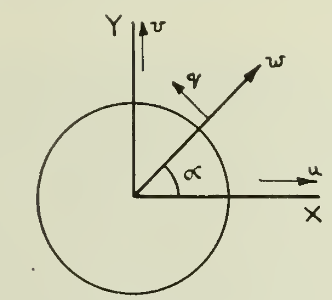

Fig. 2.

Substituting these values in the dimensional form of the first boundary layer equation, remembering that

$$\frac{\partial}{\partial r} = \frac{\partial}{\partial n}$$

and dividing by v yields

$$\frac{dv}{ds}x^2 - \frac{dv}{ds} = \nu\frac{d^2 x}{dn^2}$$

This can be integrated twice to give a relation between n, and x or $\frac{q}{v}$, the boundary conditions giving the appropriate constants of integration. Hence the solution gives the distribution of velocity through the boundary layer at the various positions round the cylinder. It was found that this did not give as good agreement with experimental observations of boundary layer velocities as the original step by step method of solution, but this was only to be expected from the nature of the initial assumptions. Thom therefore examined the neglected terms and modified his solution to make allowance for the errors involved in his first assumptions. The term $w \frac{\partial q}{\partial n}$ was included, and also a term $\frac{\partial x}{\partial s}$ to allow for variation of x, and hence q, with s.

His final solution appears in the form

$$n = \sqrt{\left(\frac{r\nu}{\sqrt{h}}\right)}\, F(x)$$

where $F(x)$ is a complicated function of x, r is the radius of the cylinder, V is the channel speed, and h is an expression involving $\frac{dp}{ds}$ the pressure gradient. This solution agrees well with experimental measurements over its range of application. The thickness of the boundary layer is given in the form $\delta = c \sqrt{\dfrac{\nu}{\frac{dv}{ds}}}$ where c is the value of $F(x)$ at the outside edge of the layer.

It is evident that where the velocity gradient $\frac{dv}{ds}$ becomes small or negative the solution is no longer valid, since this quantity appears under the root sign, and this occurs in the neighbourhood of 55° to 60° round the cylinder for $R = 10^5$.

In solving the equations it is necessary to make some initial assumption concerning the character of the velocity q. Thom suggested q a function of n only, and later modified the assumption to q a function of n and s. Falkner and Skan[6] have derived a particular solution of the boundary layer equations for the case where the tangential velocity outside the boundary layer can be expressed as $v = ks^m$

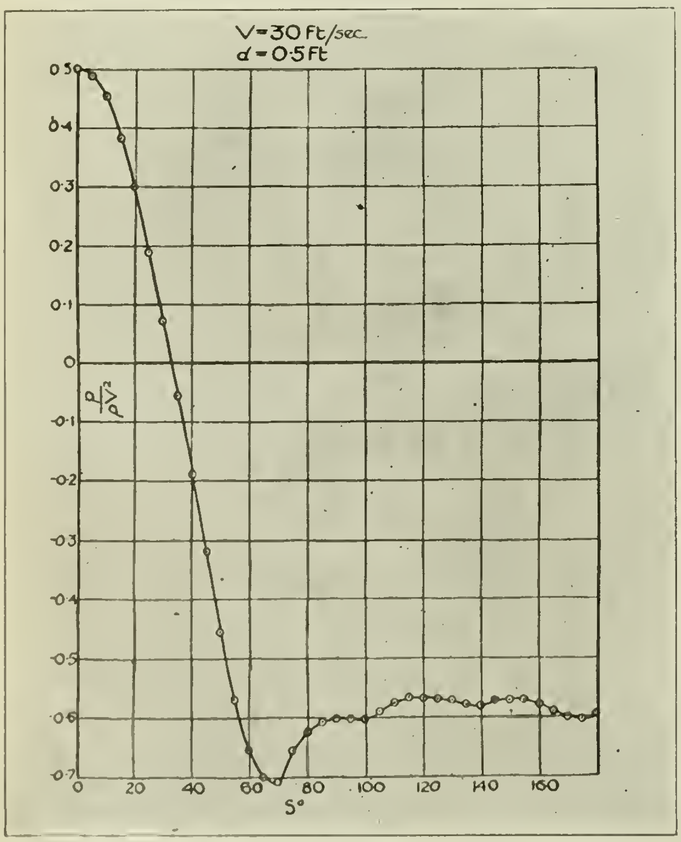

Fig. 3.

where k and m are constants. They showed that Blasius' solution for a flat plate is a particular case of this solution when $m = 0$. For a circular cylinder they claim that m is unity at the stagnation point and very nearly unity over a considerable range on the front portion of the cylinder. The particular solution is used as a basis for two approximate solutions of the boundary layer equations in the general case and comparison between experiment and calculation is made for a plate, circular cylinder and an aerofoil.

A method tried by the author at the Royal College of Science[7] was to assume a solution which expressed q as a power series in n and s and by substitution in the equations evaluate the coefficients.

The initial assumption was that

$$qR = nf_0 + \frac{n^2}{\lfloor 2}f_1 + \frac{n^2}{\lfloor 3}f_2 + \ldots\ldots = \sum_{\alpha=1} \frac{n^\alpha}{\lfloor \alpha} f_{\alpha-1}$$

R = Reynold's Number, f_0, f_1, etc. are functions of s only and n represents values of the radial co-ordinate measured from the surface out into the boundary layer. By differentiation of this equation, at the surface of the cylinder we get $f_0 = R\left(\frac{\partial q}{\partial n}\right)_{n=0}$ and since $\left(\frac{\partial q}{\partial n}\right)_{n=0}$ is the velocity gradient at the surface, f_0 is a measure of the skin friction.

Combining the initial assumption with the equation of continuity yields

$$\frac{\partial}{\partial n} wR = -\frac{\partial}{\partial s} qR = -\sum_{\alpha=1} \frac{n^\alpha}{\lfloor \alpha} \cdot \frac{\partial}{\partial s} f_{\alpha-1}$$

hence

$$wR = -\sum_{\alpha=1} \frac{n^{\alpha+1}}{\lfloor \alpha+1} \cdot \frac{\partial}{\partial s} f_{\alpha-1}$$

and

$$\frac{\partial}{\partial n} qR\ ;\ \frac{\partial^2}{\partial n^2} qR,$$

can be got from the initial assumption by directly differentiating.

Multiplying the first boundary layer equation throughout by R^2 gives

$$-qR \cdot \frac{\partial}{\partial s} qR - wR \cdot \frac{\partial}{\partial n} qR = -\frac{\partial^2}{\partial n^2} qR + R^2 \frac{\partial p}{\partial s}$$

and substituting the various values derived from the initial assumption yields an expression which ean be written as

$$-\sum_{\alpha=2} n^\alpha \sum_{\beta=1} f_{\beta-1} \cdot f'_{\alpha-\beta-1} \cdot \frac{\alpha - 2\beta + 1}{\lfloor \beta \cdot \lfloor \alpha-\beta+1} = \sum_{\alpha=0} n^\alpha \cdot \frac{f_{\alpha+1}}{\lfloor \alpha} + R^2 \cdot \frac{\partial p}{\partial s}$$

The dashes denote differentiation with respect to s. The coefficients in the equation for qR are then easily deduced by giving α and β successive values in this expression, thus:

$\alpha = 0$ gives $f_1 = R^2 \cdot \frac{\partial p}{\partial s}$

$\alpha = 1$ $\quad f_2 = 0$

$\alpha = 2$ $\quad f_3 = f_0 f_0'$

$\alpha = 3$ $\quad f_4 = 2f_0 f_1'$

$\alpha = 4$ $\quad f_5 = 2f_1 f_1'$

$\alpha = 5$ $\quad f_6 = 4f_0^2 f_0'' - f_0 (f_0')^2$

⋮

etc.

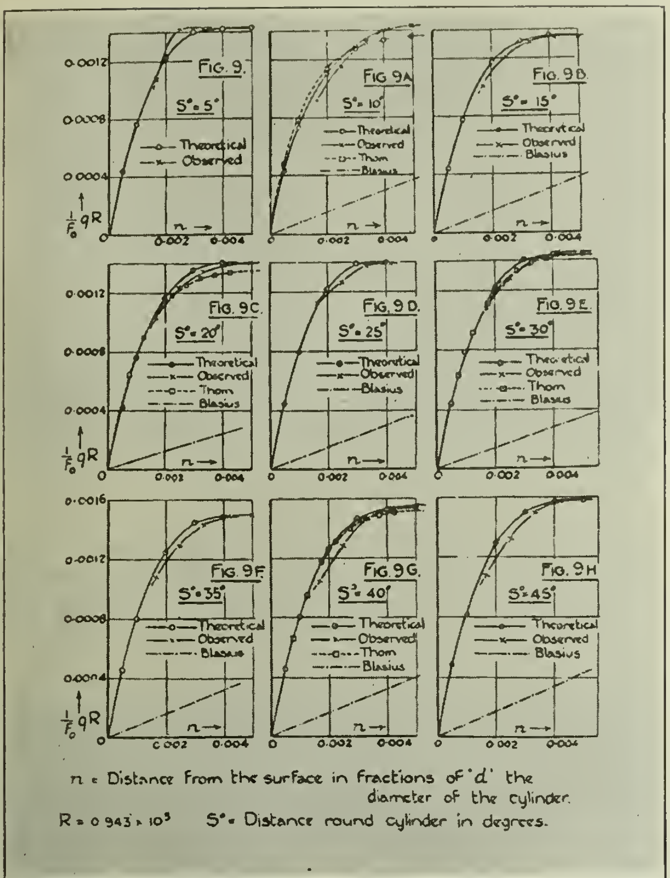

Fig. 4.

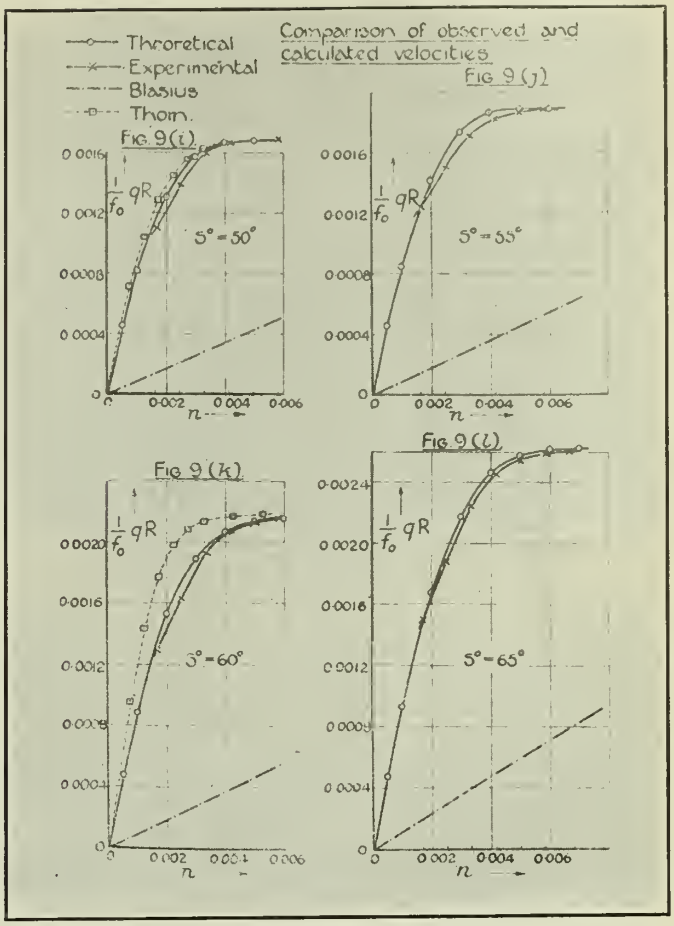

Fig. 5.

The last term employed was

$$f_9 = 7f_0{}^3f_0{}''' - 24f_0{}^2f_0{}'f_0{}'' + 27f_0(f_0{}')^3 + 40f_1{}^2f_1{}'' - 16f_1(f_1{}')^2$$

Hence all the coefficients needed in the solution are expressible in terms of f_0, f_1 and their derivatives with respect to s. Inserting these values in the expression for qR and differentiating gives

$$\frac{1}{f_0}\cdot\frac{\partial}{\partial n}\,qR = \left(1 + n\,.\frac{f_1}{f_0}\right)\left(1 + \frac{n^4}{\lfloor 5}\,.\,2f_1{}'\right) + \frac{n^3}{\lfloor 3}\,.f_0{}' + \frac{8n^4}{\lfloor 5}f_1{}' + \ldots\ldots$$

The method of solution was then to evaluate the f coefficients, which are now known in terms of f_0, f_1 and their derivatives, for each step round the cylinder, insert in this last equation, plotting the values of $\frac{1}{f_0}\,.\,\frac{\partial}{\partial n}\,qR$ for various values of n. Integration would then yield $\frac{1}{f_0}\,.\,qR$ giving the theoretical velocity distribution through the layer for that position on the cylinder.

The above analysis revealed that $f_1 = R^2\frac{\partial p}{\partial s}$, and $\frac{\partial p}{\partial s}$ the pressure gradient round the surface of the cylinder was derived experimentally by measuring the pressure distribution. This was done in the usual way using a micromanometer. Only one pressure hole was drilled in the cylinder at its mid section, and rotation of the cylinder on the trumpet of the wind channel balance enabled the pressure to be measured at any desired position round the cylinder. Fig. 3 shows the pressure plotted as fractions of ρV^2 against S. It will be noticed that the pressure falls to a minimum value, after which there is a reversal in the direction of the pressure gradient. The values of the functions f_1, $f_1{}'$ and $f_1{}''$ are obtained by successive differentiation of this curve employing a graphical method and it only remains to evaluate f_0 and its derivatives before the solution is complete.

Near the stagnation point or 0° position it is easy to obtain a close approximation to the value of f_0 by restricting the number of terms in the series value of qR. Similarly it was possible to obtain two approximations for $f_0{}'$ the first derivative at this position, which agreed quite closely; $f_0{}''$ at this position was deduced in a more laborious fashion which will not be discussed here.

Having obtained approximate values for the f_0 coefficients at 0° their values at 5° were deduced by a Taylor's expansion

$$(f_0)_{s+ds} = (f_0)_s + ds\,.\,(f_0{}')_s + \frac{ds^2}{\lfloor 2}\cdot(f_0{}'')_s + \frac{ds^3}{\lfloor 3}\cdot(f_0{}''')_s + \ldots\ldots$$

Similarly the values of $f_0{}'$ and $f_0{}''$ at 5° were extrapolated and the nature of the method was such that the error in the values of the functions was reduced at every step made round the cylinder.

It was necessary to guess a value for $f_0{}'''$ at each position round the cylinder. In practice three different values are guessed, which it is hoped will enclose the correct value. These guesses are arrived at by inspection of the f_0 and $f_0{}'$ curves which are known up to the preceding point. For

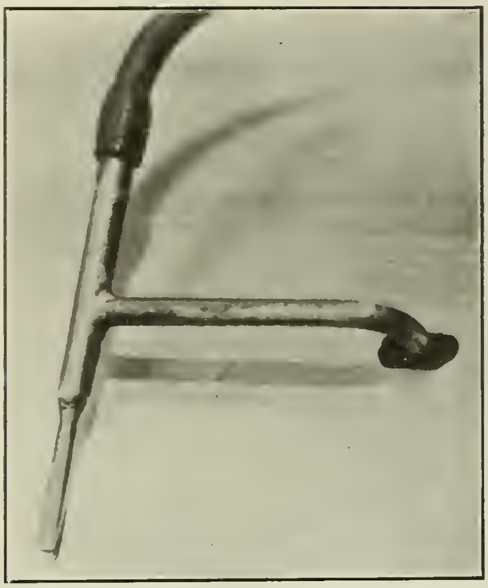

Fig. 6.

each of the guessed values, the entire number of f coefficients are evaluated and the equation for $\frac{1}{f_0} \cdot \frac{\partial}{\partial n} qR$ solved for f_0. The three values for f_0 are then compared with the initial assumed values, and the correct value of f_0''' is that which makes the initial and final values of f_0 the same. The usual method was to plot the two values of f_0 against the corresponding values of f_0''' and the point of intersection of the two curves gives the true value of f_0''' with considerable accuracy.

Having determined the correct value of f_0''' the computation is repeated to give the correct solution, and the distribution of velocity through the boundary layer is plotted before advancing to the next point round the cylinder.

Figs. 4 and 5 show comparison between observed boundary layer velocities and the theoretical distribution, and it will be seen that on the whole the agreement is good.

The small pitot tube which was used for exploring the velocity distribution experimentally is shown in Fig. 6. It consists of a one-half inch length of hypodermic syringe needle let into a one inch length of larger bore tube. The finer tube was flattened at the end, to yield a slot of an approximate width of one-fiftieth of an inch.

It was found that the solution entirely failed at 73° round the cylinder. The skin friction was found to be falling

Fig. 7.

rapidly from about 50°, likewise a very rapid reduction in the value of q, the tangential velocity, was found to exist over the same range. The normal velocity w had been steadily growing until finally it was comparable with the falling value of q, which indicates a failure of Prandtl's second assumption. The mathematics indicates a change of flow at this point. Prandtl's hypothesis no longer holds, and the fluid, ceasing to flow along the surface, is tending to flow away from the surface. The boundary layer is breaking away.

The fluid near the surface is moving very slowly, but whilst the pressure gradient is in the direction of main stream flow, it will continue to move in that direction. After the point of minimum pressure (69°), the speed of the fluid is reduced owing to the reversal of the pressure gradient, acting in conjunction with the viscosity, and further round the cylinder there is a tendency to back-flow, the effect of which is to force the forward flowing layer to leave the surface and a sheet of discontinuity is formed which ultimately breaks up into eddies.

Fig. 7 shows a closeup of the breakaway of the boundary layer and the formation of a sheet of discontinuity.

Fig. 8 shows back-flow along the surface of a cylinder behind the point where the boundary layer breaks away.

Both of these two photographs were secured with the aid of titanium tetrachloride smoke.

Fig. 8.

In conclusion, the fact should be stressed that the effects of viscosity are twofold and the hope of future advancement is based on the possibility of controlling this duality. The direct effect of viscosity is that it induces a viscous drag over the surface of bodies in motion through the fluid: this is usually referred to as skin friction and is not of very great magnitude. The indirect effect of viscosity is to cause complications of the flow pattern past bodies, which greatly affects their resistance. As has been seen, the viscosity, by slowing up the fluid particles, causes the boundary layer to leave the surface, resulting in a stagnant wake and two sheets of discontinuity which, being unstable, break up into a succession of eddies, forming what is known as a Kármán vortex street, named after von Kármán who studied this type of flow[8]. Figs. 9 and 10 show the formation of a vortex street behind an elliptic cylinder moving in a water channel, the flow being rendered visible by a suspension of white particles, obtained from a mixture of condensed milk and alcohol which was poured into the water. Now the drag due to these eddies is called the form drag, which, together with skin friction, makes up the profile drag of two dimensional motion. The form drag depends on the shape of the body, being negligible for a well streamlined body like a good aerofoil, where the vortex wake is small; in such a case the profile drag is composed mainly of the skin friction. For a bluff body, the vortex

Fig. 9.

wake is strong and hence the form drag, which depends on the energy dissipated in the vortices, is very much larger than the skin friction. Once more the mathematician is able to chime in and calculate the form drag, from a knowledge of the strength of the eddies and the width of the vortex street, but this again is based on the assumption that the fluid is perfect or frictionless.

It is not always possible so to streamline bodies that the form drag is negligible. We are still a long way from the streamlined aeroplane of theory. In a perfect fluid there is no drag, the stream divides at the nose of a body, flows smoothly round the contour of the body however bluff, and rejoins at the tail. If the breaking away of the boundary layer could be prevented when dealing with the fluids of everyday life, if it could only be coaxed, however unwillingly, to stick closely to the contours of bodies that are not well streamlined, the vortex street would be eliminated in those cases, and the resistance would be enormously reduced. The viscous drag would still be left, but viscosity would have been robbed of its trigger action in setting up the larger eddy resistance. Thus it is now a problem to discover means of restraining the contrariness of the boundary layer in its efforts to break away. One method of controlling the breakaway of the flow which has been more or less successful is to suck away air at suitable points near the tail of bodies, thus causing the flow to collapse back on to the surface. The principle has been demonstrated, but the method is doubtful as a practical means of reducing head resistance. The Handley Page slot and the Townend ring are two successful inventions which do actually prevent the breakdown in flow in special cases, and doubtless more devices of this nature will be forthcoming. A field of research still exists for the further examination of the flow conditions at the point of breakaway as well as those existing in the wake of bodies, in order to understand fully the breakdown in flow, and what possibilities there are of preventing it.

The large part played by viscosity in the behaviour of real fluids as compared with the perfect fluid of the mathematician has been indicated. With the growth of aeronautics, a new problem has arisen. It is enough at present to consider the air as a viscous incompressible fluid as far

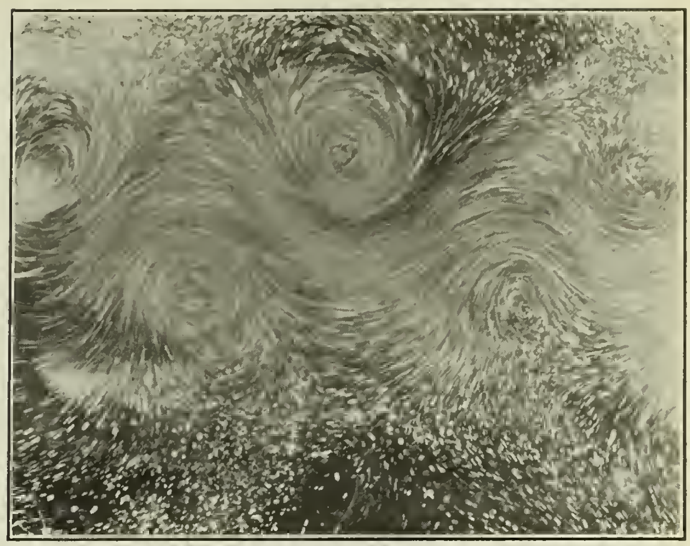

Fig. 10.

as aircraft are concerned, but with the rise in top speed of these machines, it seems reasonable that the compressibility of the air will have to be taken into account in our fluid theory. It is well known that the compressibility may be ignored as long as the speed is not comparable with the velocity of sound in air, but already a speed one half of that value has been reached, and nobody would suggest that this is the limit. Further, in the operation of high speed airscrews, it is quite possible to have tip speeds in the neighbourhood of the velocity of sound, in which case the air flow round the blades will be complicated by the rising significance of compressibility, and a detailed study of high speed air flow cannot fail to be beneficial to design. Work on these lines is already in progress in England and a number of new problems are facing the research worker in the realms of fluid motion. It is to be hoped that the solution of these problems will not only be of academic interest, but will prove useful to the aeronautical engineer.

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The National Research Council of Canada

The Thirteenth Annual Report of the National Research Council for 1929-1930 has just been issued, and gives an interesting review of the Council's activities. During the early period of its existence, from 1916 to 1924, the work of the Council was mainly directed towards relieving the shortage of scientifically trained men which the country was then experiencing. This was done by the establishment of post-graduate research scholarships in the universities, while at the same time advisory committees were appointed in some of the more important branches of science and technology in order that the Council might have the benefit of their advice in extending its operations.

Since 1924 a large number of associate research committees have been appointed, directing investigations on major problems of importance to the country, and in addition, pending the provision of accommodation for national research laboratories, arrangements have been made for assisting co-operative research in the laboratories of federal and provincial government departments and the universities.

As at present organized, the National Research Council reports to a special Committee of the Privy Council, and, while continuing the support of assisted researches and more than sixty post-graduate scholarships at the universities, is building up its own staff of investigators, which is at present organized under three main divisions—Physics, Chemistry, and Agriculture.

It is expected that the laboratories and offices of the Council will be transferred shortly to the new building now approaching completion in Ottawa on Sussex street, the accommodation in which will be supplemented by the space already available in the aeronautical and other laboratories now existing in the older buildings on the Edwards property in John street.

The Council's revenue of less than $500,000 a year is very modest compared with the sums available for research in other countries, the United States Bureau of Standards, for example, having expended nearly three million dollars during the year 1929-30.

The Council has at present over one hundred assisted researches in progress, dealing with such varied topics as catalysts, the utilization of natural gas, the chemistry of fish curing, the chemical control of weeds, the cross-breeding of sheep, and the continuity of welded steel beams, taking half a dozen titles almost at random. To this work the Council has been devoting the greater part of its expenditure (about $220,000 in 1929-30), and the co-operation of twenty-eight associate committees, acting in an advisory capacity without remuneration, whose membership includes the best available industrial and scientific authorities. These associate committees, in their turn, co-operate with industrial and other organizations interested in their special subjects.

One branch of the Council's work which is of special interest to The Institute is that of the committee which is carrying on and continuing investigations on the constitution of Portland cement, and the deterioration of concrete in alkali soils. It will be remembered that this work was taken over by the Council from one of The Engineering Institute committees in 1929, and that it deals with a very pressing problem for western Canada where the losses due to the deterioration of concrete are so serious. Gratifying progress has been made in the last two years, as may be seen from the report.

The Research Council is also greatly interested in engineering standardization work, the Canadian Engineering Standards Association ranking as one of its associate committees. Engineers are, in fact, largely indebted to the National Research Council for the possibility of carrying on the work of the Canadian Engineering Standards Association in its present effective form. In a country like Canada, where many industrial concerns are branches of non-Canadian companies, and therefore carry on their industrial research elsewhere, it is particularly important to have a Canadian organization with the staff and funds to undertake the investigation of purely Canadian problems. Until the establishment of the National Research Council this task fell upon individual government departments, the already overworked staffs of our universities, or upon individual investigators, for whom adequate support was lacking. This condition has now been removed, and it is indeed encouraging to note the continued expansion of the Council's external activities, which are proving increasingly beneficial both from the industrial and scientific points of view.

Proposed Amendments to Sections 66 and 67 of the By-laws

The report of the scrutineers on the ballot closing May 4th, 1931, on the amendments proposed by Council to Sections 66 and 67 of the By-laws, was presented to Council at its meeting on the 19th instant, and showed that of 729 valid ballots, 257 were for and 472 against the proposal.

The amendments in question, dealing with the constitution of the Nominating committee, were therefore declared lost.

Aeronautical Sections of Institute Branches

On the completion of the arrangements with the Royal Aeronautical Society which were described in the Engineering Journal for December, 1930, page 696, notifications were sent to a large number of engineers interested in aeronautical work throughout Canada, and over five hundred and fifty replies were received, indicating a widespread interest in the proposal to organize aeronautical engineers in Canada in this way.

Aeronautical sections have now been formed in connection with the Montreal and Ottawa Branches, and these will probably be followed by others. Such sections, in accordance with the agreement with the Royal Aeronautical Society, will be recognized as Canadian local sections of that body, and their members will have access to the Royal Aeronautical Society publications, and an opportunity for obtaining wider publicity for papers which they may contribute than can possibly be afforded in the columns of any Canadian publication.

Members of The Institute of all classes will wish success to this new undertaking, which marks a new and promising development in the policies of The Institute and of the Royal Aeronautical Society.

Engineers in Russia

The remarkable industrial experiment which is being tried on such a vast scale in Russia is of great interest to engineers, for it has been found necessary to enlist the aid of a large number of technically trained men from capitalist countries to plan and operate various engineering projects in the U.S.S.R.

The employment of engineers in the development of the resources of foreign lands is not uncommon, but, as a rule, when leaving their own countries, they go to others where living and employment conditions are known, and where social institutions are more or less similar to those to which they are accustomed. This is not the case at the present time in Russia. The many reports and articles which have appeared in the public press on conditions in that country leave the impression that non-Russian engineers are meeting there with considerable difficulty and hardship.

Recognizing the general interest in this matter, the national engineering societies in the United States have recently devoted attention to a study of the conditions under which professional and technical men are employed in Russia, and statements have now been issued containing valuable information for the guidance of those contemplating employment there. In these reports stress is laid on the fact that the form of government in Russia is different from that of any other country, and that the vast mass of Russians are living, and have been living for some years, under conditions with which few residents of other countries would be content.

A very interesting report on engineering employment in Russia, prepared by a committee of the American Society of Civil Engineers, appears in the May issue of "Civil Engineering" and is based on the personal experiences of engineers who have worked in the U.S.S.R.

A somewhat similar report, drawn up by a committee appointed by the American Institute of Mining and Metallurgical Engineers, appears in the April issue of "Mining and Metallurgy," from which the following significant extracts are reproduced here by permission:

Living Conditions

a. Food, generally speaking, is scarce; some of very poor quality. It is extremely expensive unless bought at government stores with a government food card. While conditions are not uniform throughout Russia, in Moscow and Leningrad long lines of people are obliged to stand in front of these stores waiting to enter.

In certain places the government has opened special stores for foreign employees. Accounts differ as to how satisfactory conditions are in these stores. Undoubtedly these vary in different districts.

The importation of food as a general proposition is forbidden unless it is agreed upon in the employment contract or arranged for by the contractor or the head of a group. Here again, opinions differ as to whether importation of food is feasible even if agreed upon. This apparently indicates the advantage of employment of engineers by large American engineering firms or contractors, rather than the taking of independent employment.

b. Housing conditions. In cities such as Moscow there is a great shortage of accommodations. In other districts there is said to be no shortage.

c. Articles of clothing, shoes, etc., are difficult of purchase, of poor quality and expensive, throughout Russia.

d. Other conditions, such as medical attendance, hospitals, etc., vary greatly in different parts of Russia, but nowhere are these facilities said to be good, except possibly those provided by some American contractors or engineering organizations operating on a large job.

Without question, an engineer should not take children into Russia. Most people familiar with conditions there strongly advise against the taking of wives, unless they be strong, healthy, robust individuals, accustomed to discomforts and inclined to enjoy overcoming difficulties and the fighting of adverse conditions.

Legal Status and Personal Safety

a. An individual accepting employment under the Soviets must appreciate that he is working for an autocratic government.

Adequate reasons may develop for the breaking of a contract, but still the government has the arbitrary power to take away passport and food card, and/or prevent the employee from leaving the country. In such case great difficulty may be experienced in subsisting. The engineer may be fined or forced to do menial work in punishment for alleged breaking of his contract.

b. Fear is entertained that, if the five-year plan should not eventuate as represented to the people, or if some plant or installation should fail to deliver anticipated results, the Soviets will seek a "scapegoat." If so, who would be more suited to the role than the foreign engineers in charge of that particular piece of work? Many people have been executed or imprisoned as "scapegoats."

Recommendations in the Event of Accepting Service

If he decides that his particular situation is such that he must accept Russian work regardless of the known unfavourable conditions, then he should if possible give preference to employment with some large American contractor or engineering firm, rather than attempt an individual contract with the U.S.S.R.

While the matter of performance of an employment contract by the Soviets is a matter of faith, on account of the impossibility of bringing any dispute before an American court, still as far as we know they have thus far shown a disposition to live up to the letter of the contract. This being so, it becomes important that the contract terms should embrace every possible contingency. No dependence whatever should be placed on verbal statements or assurances. It has been found repeatedly that assurances made here have no force whatever when the employee arrives in Russia.

Whether going as an individual or as a member of a group, one should see that the following points, among others, are provided for:

a. Adequate provision for first-class transportation and expenses from America to place of employment and return.

b. The extent to which payments will be made in dollars in the United States and rubles in Russia. He should insist on receiving as large a portion as possible, certainly not less than 50 per cent of his remuneration, in dollars, to be deposited or paid as directed in the United States. It must be remembered that foreign money can be brought out of Russia only to the extent to which it was taken in, less the amount the authorities decide he should have spent while in Russia. After residing in Russia for a certain length of time, no foreign money can be taken out. While a certain amount in Russian currency can be sent out, it has only a greatly depreciated value in foreign countries.

c. Amount of money the engineer will be required to spend in Russia. Visitors to Russia are required to spend a certain minimum per day, and the engineer should inform himself to what extent these regulations apply in his case.

d. A non-resident citizen is subject to our Federal income tax, but should be free from taxation by the Soviet government on amounts deposited in this country to the citizen's credit. A definite understanding should be had as to the amount of taxes on salaries paid in Russia as well as on all other taxes.

e. Provision of living quarters, domestic servants, water, heating, light, cooking and sanitary arrangements, either free of charge or at a definite price.

f. Fuel for heating and cooking and price thereof.

g. Supply of food and privilege of purchasing food, clothing and other supplies at commissaries established for foreign diplomats and engineers.

h. Privilege in regard to taking in and importing into Russia later, foodstuffs, clothing, toilet articles, etc., free of duty, coupled with guarantee of arrival.

i. Outlining of duties and responsibilities of service to be rendered.

j. The conditions under which employees are privileged to resign with safe conduct and expenses back to the United States, etc.

k. Discontinuance at one job not to give Soviet the privilege of transference to another.

l. Various Soviet industrial organizations operating through Amtorg Trading Corporation in New York, engage American engineers and technicians to work in Russia. As there are no relations between the government of the United States and that of the Soviet Union, the signature of the Amtorg for itself as an American corporation should always be obtained to any contract.

The thanks of the engineering profession are due to the societies responsible for these reports, which should be carefully studied by anyone who thinks of proceeding to Russia in the near future.

Meeting of Council

A meeting of Council was held at Headquarters on Tuesday, May 19th, 1931, at eight o'clock p.m., with Vice-President W. G. Mitchell, M.E.I.C., in the chair, and six other members of Council present.

The early part of the meeting was taken up with discussion regarding the formation of specialized sections of Institute branches in connection with military and radio engineering, representations being made in connection with these subjects by Lt.-Col. W. L. Malcolm, M.E.I.C., and Lt.-Col. W. A. Steel, A.M.E.I.C., who attended by invitation.

Attention was drawn to the satisfactory working of the arrangement already concluded with the Royal Aeronautical Society, and it was decided to place the whole subject in the hands of a committee for study, the committee's report, if possible, to be available for consideration at the Plenary Meeting of Council in September. It was decided that the committee should be asked to study the general question of co-operation or affiliation with other technical societies with a view to the adoption of a uniform policy in dealing with problems of this kind.

It was decided that the Plenary Meeting of Council for 1931 should be held on Monday, Tuesday and Wednesday, September 21st, 22nd and 23rd, 1931.

The report of the scrutineers appointed to canvass the ballot for the proposed amendments to Sections 66 and 67 of the By-laws was received, from which it was noted that the proposed amendments in question were lost by a considerable majority.

The membership of the Past-Presidents' Prize committee of The Institute for the year 1931 was approved as follows:

C. M. McKergow, M.E.I.C., Chairman
F. A. Combe, M.E.I.C.
E. F. Fetherstonhaugh, M.E.I.C.
T. R. Loudon, M.E.I.C.
J. B. Porter, M.E.I.C.

The Finance committee submitted a memorandum pointing out the unsatisfactory results of the present procedure with regard to members in arrears of fees. The Finance committee suggested that this question should receive early consideration from Council and that it should form one of the subjects for discussion at the Plenary Meeting.

The subjects proposed for the Past-Presidents' Prize competition for the prize year 1931-1932, as submitted by the various branches, were considered, and after considerable discussion it was resolved that the subject for the above named prize year, ending on June 30th, 1932, should be "The Effect of the Development of the Electronic Valve on Electrical Engineering and Industry."

Recommendations for the award of the Sir John Kennedy Medal for the year 1931 were presented from five of the branches of The Institute, and, after discussion, it was unanimously resolved that no award of the medal should be made this year.

In accordance with Section 13 of the By-laws, on the recommendation of the Executive committee of the Saskatchewan Branch, it was unanimously resolved that Dean C. J. Mackenzie, M.E.I.C., be appointed as Councellor from the Saskatchewan Branch until the next annual election, replacing the late R. W. E. Loucks, A.M.E.I.C.

The newly elected officers of the Saint John Branch were noted.

The report of the Board of Examiners on the May, 1931, examinations of The Institute was submitted and approved, from which it was noted that three candidates out of six had satisfied the examiners.

Four resignations were accepted and three Life Memberships were granted.

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

Elections		*Transfers*	
Member	1	Assoc. Member to Member	3
Associate Members	5	Junior to Assoc. Member	2
Juniors	7	Student to Junior	4
Students admitted	4		

The Council rose at twelve twenty-five a.m.

OBITUARIES

Gordon F. Cairnie, A.M.E.I.C.

Regret is expressed in recording the death of Gordon F. Cairnie, A.M.E.I.C., which occurred at Montreal, Que., on May 5th, 1931.

Mr. Cairnie was born at Melbourne, Que., on March 17th, 1864. From 1881 to 1882 he was engaged as a rodman on a survey of the Trent canal from Trenton to Georgian Bay and from 1882 to 1886 he was engaged as a junior assistant engineer on the construction of the Fenelon Falls canal and locks, Buckhorn canal and lock, and the Burleigh canal locks and dams. From January to July, 1887, Mr. Cairnie had charge of harbour improvements, piling, wharfing and dredging at Midland, Ont., and later in the year was in charge of the construction of the Peterborough and Chemong lake railway. During the years 1888-1892 he was assistant engineer on the Midland division of the Grand Trunk Railway, during which period he had special charge of bridge construction, culverts, bridge and elevator foundations, location surveys, etc. In July, 1892, Mr. Cairnie entered private practice.

Mr. Cairnie joined the Canadian Society of Civil Engineers as an Associate Member on February 14th, 1887, and was made a life member of The Institute on January 22nd, 1929.

Edward Parke Cameron, A.M.E.I.C.

We regret to record the death at Montreal on May 11th, 1931, of Edward Parke Cameron, A.M.E.I.C.

Born in London, Ont., in 1893, Mr. Cameron was educated at the Ottawa Collegiate Institute, and at McGill University, where he took the degree of B.Sc. in chemical engineering in 1920.

Mr. Cameron's professional career has been almost entirely with the Dominion government in the Forest Service of the Department of the Interior. Entering the service as technical assistant in the Forest Products Laboratories of Canada in Montreal shortly after graduation, he was promoted to chemist and chief of the division of pulp and paper in 1923. Since that time he has been acting as the director of the Division of Pulp and Paper under the co-operative research agreement between the Canadian Pulp and Paper Association and the Dominion government. Just about the time that he was given charge of this work, the project inaugurated by the Pulp and Paper Association for a pulp and paper building with facilities for research work, put upon Mr. Cameron the major responsibility for the design and equipment of the semi-commercial pulp and paper mill. One of the important results of the work done under his direction was the perfection of apparatus for the control of pulp mill operations in the form of a freeness tester. Mr. Cameron served with distinction in the Canadian Expeditionary Force as a Captain in the artillery during the War.

Mr. Cameron became an Associate Member of The Institute on April 27th, 1926.

Sydney Stuart Gear, A.M.E.I.C.

The death is recorded at Bridgeburg, Ont., on March 22nd, 1931, of Sydney Stuart Gear, A.M.E.I.C.

Mr. Gear was born at Fort Erie, Ont., on January 19th, 1884, and graduated from the University of Toronto in 1908.

Following graduation he joined the engineering staff of the Bethlehem Steel Corporation at Buffalo, N.Y., and during the years 1914-1916 was connected with the Donner Steel Company, Buffalo, as a draughtsman. In 1921 Mr. Gear joined the Horton Steel Works, at Bridgeburg, Ont., as sales engineer, and in 1922 was appointed contracting engineer for the company, which position he held up to the time of his death. Mr. Gear took a keen interest in the activities of the Canadian Water Works Association and was the Association's president for the current year.

He joined The Institute as an Associate Member on May 18th, 1928.

PERSONALS

George R. Revell, S.E.I.C., who graduated from Queen's University in 1930 with the degree of B.Sc., has been appointed assistant research fellow in fuels by the Ontario Research Foundation, and is located at Toronto, Ont.

B. B. Hogarth, A.M.E.I.C., is now employed by the Department of Mines and Natural Resources of the province of Manitoba, and is at present acting as resident inspecting engineer on the Slave Falls power development on the Winnipeg river. Mr. Hogarth was formerly connected with the Dominion Water Power and Hydrometric Bureau at Winnipeg, Man.

Nicol MacNicol, Jr.E.I.C., was recently appointed as engineer of Forest Hill Village, Ont. Mr. MacNicol graduated from the University of Toronto in 1919, with the degree of B.A.Sc., and for the last seven years has occupied the position of engineer of Etobicoke township. He also spent two years on the staff of James, Proctor and Redfern, Ltd., as resident engineer.

G. S. Walker, A.M.E.I.C., is at present employed as county road engineer for Lanark county, and is located at Perth, Ont. Mr. Walker, who is a graduate of Queen's University of the year 1922, was for a time with the London and Pacific Petroleum Company, Ltd., at Negritos, Talara, Peru, and was later connected with the Border Construction Company, Ltd., at Walkerville, Ont.

G. E. Booker, A.M.E.I.C., formerly with the Power Corporation of Canada at Montreal, Que., is now with the Wabi Iron Works at New Liskeard, Ont. Mr. Booker was for a time with the Riordon Pulp Corporation at Temiskaming, Que., and later acted as office engineer for the James Ruddick Construction Company at Quebec, Que. In 1928 he was connected with the Metabetchouan Sulphite and Power Company, Ltd., at Desbiens, Que.

F. A. Macpherson, M.E.I.C., is resuming his former position as office engineer, Highway and Utilities Office, Department of Public Works of British Columbia, at Vancouver, B.C. For the past year Mr. Macpherson, who has been on the staff of the department since 1917, has been acting as highway traffic and utilities engineer, being in charge of the offices opened up to take care of all work connected with the licensing and control of the operation of public passenger and freight vehicles under the Public Carrier Regulations.

J. H. Ings, A.M.E.I.C., has joined the staff of the Beauharnois Construction Company, and is located at Beauharnois, Que. Mr. Ings, who is a graduate of the University of Toronto of the year 1925, was for a year resident engineer on the construction of Section 7 of the Kapuskasing-Smoky Falls Railway with Messrs. Morrow and Beatty, Ltd., he later became connected with the Spruce Falls Power and Paper Company at Kapuskasing, Ont., and in 1930 was with the Gatineau Power Company at Ottawa, Ont.

H. W. B. Swabey, M.E.I.C. has been appointed a director of J. T. Donald and Company, Montreal and Toronto. Mr. Swabey has been associated with the Donald organization since 1926. He was supervising engineer on the construction of the Atlantic, Quebec and Western Railway, resident engineer for a time on the construction of the Quebec and Saguenay Railway, and served the Canadian Pacific Railway Company as resident engineer on construction of the Campbellford-Lake Ontario and Western Railway. During the War, as chief inspector of steel, he had charge of the inspection of all steel and forgings for shells manufactured in Canada for the British government.

J. A. Burnett, M.E.I.C., consulting engineer, Montreal, has been appointed by the city council of Lachine, Que., to make an appraisal of an electric light and power plant owned by the city. Mr. Burnett has had a wide experience with the Royal Electric Company, Canadian General Electric Company, the construction of a large sub-station for the Montreal Light, Heat and Power Company, the construction of the Montreal and Southern Counties Railway, and the appraisal of all the electrical equipment on the Grand Trunk System for the government arbitration. In 1930, he made a physical appraisal of the manufacturing plants in the town limits of Lasalle, Montreal. Mr. Burnett took over the office of M. A. Sammett, A.M.E.I.C., in 1922.

S. J. Fisher, M.E.I.C., formerly Mill Manager of the Lake St. John Power and Paper Company Ltd., at Dolbeau, Que., has recently moved to Montreal, and is now residing at 4997 Grosvenor avenue. Mr. Fisher was for six years sales and service engineer for Babcock and Wilcox Ltd., and from 1916 for three years was engaged in mechanical engineering work at Ottawa for the Canadian and British governments. At the close of 1921 he entered the news print field with the E. B. Eddy Company Ltd., at Hull, Que. where he was woods manager for four years, and also supervised the engineering, installation and start of operation of the new Eddy newsprint mill. In 1926 he joined the staff of John Stadler, M.E.I.C., in charge of the drawing office of the Lake St. John Power and Paper Company Ltd. After supervising the installation of the machinery in the new newsprint mill at Dolbeau, he was appointed mill manager, and started up and operated the mill for over three years.

R. A. Logan, A.M.E.I.C., has recently returned from South America, where he was associated with the Pan American Airways Extension and Development Department in connection with air mail routes, and is located at Ship Harbour Lake, N.S. In the past fifteen months, Major Logan travelled over fifteen thousand miles of air routes between Porto Rico, Miami, Fla., Panama, Peru, Santiago, Chile, Buenos Aires and Rio de Janeiro. In 1927 he joined an aerial survey expedition for the Aircraft Operation Company Ltd. in Northern Rhodesia, and in 1928 was manager of an African expedition for the same company at Bulawayo, Southern Rhodesia. Major Logan is a graduate of Nova Scotia Technical College, of the year 1911, and was also a student at the University of Alberta. In 1915 he was appointed aeroplane pilot and engineer in the Royal Flying Corps, and became flight commander in 1917. Subsequently Major Logan was appointed officer in charge of ground instructional section, Canadian Air Force, Camp Borden, and since September 1st, 1921, has held the rank of squadron leader (major). In 1922 he was engaged on special investigation of flying conditions in the Arctic regions with the Canadian Arctic Expedition of that year. Later he was appointed manager of the mapping division of the Fairchild Aerial Camera Corporation in New York.

CORRESPONDENCE

40 Lorne Avenue,
St. Lambert, Que.
April 23rd, 1931.

The Secretary,
The Engineering Institute of Canada,
2050 Mansfield Street,
Montreal.

Sir:—

After listening to Mr. Busfield's exposition of the work of the Committee on Remuneration, the writer carried away with him the idea that there was present in the meeting a feeling that Mr. Busfield was right, and that he had said all there was to say, when he told us that the average engineer was quite satisfied with his remuneration, and that his financial rewards were quite as large as those of either the lawyer or physician. There was too much complacency altogether about the question of remuneration; it was regarded as a purely personal matter, instead as it should be, a question of solidarity.

The one place where engineers should receive due recognition is in communal affairs, for there in contact with his immediate neighbours, he can deal with matters on which he, above all others, is best fitted to express an opinion, but unfortunately, a man's standing in the community is not determined by his knowledge or by his outstanding ability in some certain line, but by the amount of wealth he displays; and the vast majority of people place most weight on what an affluent person says. If that affluence be reinforced with ignorance, that very fact will enable him to express definite opinions so easily absorbed by the average mind.

If the engineer was consulted more, 90 per cent of the world's business would be immeasurably better, but what is the use of knowing this and not doing anything, and how can we raise our standing to a greater height in the community if we ignore the measuring stick which the man in the street uses. We must get out of the vicious circle of supply and demand into an increasing spiral where increased remuneration will give increased recognition, and with increased recognition, an opportunity for increased service; then, when we arrive at the second turn of the spiral, it will be the time to see if we are aiming too high. As has been said many times before, the engineer is an inarticulate being; that he does his work, and does not like to talk about it; but there is a worse state than being merely dumb, that is, to be blind as well: there is some hope for a person who cannot express himself, but who has aspirations for the future; his very work will gain him recognition at last: but to be blind as well as dumb, to be inarticulate and without vision, can only result in degradation.

Consider what the medical and dental professions have done during the past twenty years and are still doing, with such marked success that they have even persuaded the government to pay a large part of the cost of their advertising, as was to be seen on a large bill-board in Montreal some weeks ago where it said in effect "If your child is backward at school, consult a physician, there may be some hidden trouble." A most clever example of practical psychology, for it stands to reason that any person who is interested in his children's welfare would gladly pay for advice, and the point to be noted, Sir, is that you and the rest of us are paying for thus advertising the medical profession.

If such advertising raises the general standard of public health or relieves some suffering individual, more power to it, but we cannot hide the fact that it is advertising. We all hear over the radio that we should use Tompkin's tooth paste and see our dentist twice a year; we all read directions for hygiene and first aid, with instructions to consult our physician every time; in fact, in spite of the restrictions against personal use, the medical and dental professions are the best advertised in the world.

Lawyers and physicians are in direct touch with the individual person. Everyone requires the services of a physician at some time of their lives, and many are glad to avail themselves of the advice of a lawyer, but the engineer and his work are practically unknown to the great mass of people; they know that a physician's business is to restore health, that a lawyer knows the law, but to them the engineer is the man in the cab of the locomotive or the man who runs the boilers and looks after the pipes in the apartment house; so while it is comforting to know that we are riding in the same priced car as the members of the other professions, it is rather disturbing to find out that we are sitting back and driving our car around in fancy curves and circles, while the physician is going somewhere, and we engineers are not.

The question of paramount importance is, not whether the engineer is better paid than other professional men, but whether the engineer obtains from the public a just appreciation of his services, which may be expressed in terms of wealth, honour or place; but it must ever be kept in mind that the vast majority of people, especially those who take an interest in mundane affairs, are all admirers, if not worshippers, of the great international god Mammon, and are therefore always especially respectful to those on whom the god has showered favours, looking up to them as benefactors, or possible dispensers; the engineer having nothing to give, need not be considered.

The above is a statement of the standing of the engineer in the community. Doubtless many are quite satisfied, but for those who are not, the writer proposes next month to outline a scheme of advertising.

Yours truly,
C. D. NORTON, A.M.E.I.C.

BOOK REVIEWS

Canadian Trade Index, 1931.

Compiled and published by Canadian Manufacturers' Association, Inc., Toronto, 1931. Cloth, 6½ x 10½ in., 884 pp., tables, $6.00.

This is the seventh annual issue of the Canadian Trade Index. The special feature is the inclusion of a 54-page special export section, provided by the Department of Trade and Commerce of the Dominion government, and giving an analysis of Canada's trade, with data designed to aid in the further development of our exports.

The present edition contains an alphabetical and classified directory of over 10,000 Canadian manufacturers and their products; a produce section giving the names of producers of a variety of agricultural products; and a complete survey indicating those firms interested in and prepared to do export trade. The lists are not limited to members of the Association.

This work is very valuable as a reference aid, and is the only comprehensive book of its kind published in Canada.

Applied Aerial Photography

By Capt. Ashley C. McKinley. Wiley & Sons, New York, 1931, cloth, 6 x 9 in., 341 pp., front., photos, figs., tables, $5.00.

Those interested in modern aerial photography will find this book of great help and benefit, as it gives a compact outline of this comparatively modern science in a clear and concise form without going into long technical detail.

The author has had considerable experience in aerial photographic work with the United States Air Service, and was the official aerial surveyor with the Byrd Antarctic expedition. His book is divided into three parts — taking aerial photographs, finishing the photographs, and mapping with or from the photographs. It also contains a chapter on oblique aerial surveys by A. M. Narraway, M.E.I.C., chief aerial surveys engineer, Department of the Interior, Canada, which is devoted to a description of the grid method used in Canada in mapping from the oblique photographs which are taken by the Civil Government Air Operations Branch, Department of National Defence.

Part I deals with the methods employed in taking aerial photographs, the duties of the pilot and camera operator, different types of aerial photographs and their uses, instruments used in navigation and modern types of aerial cameras and accessories; there is also a chapter on the essential features of lenses used in aerial survey work.

Part II is devoted entirely to laboratory work in aerial photography and contains some interesting and instructive sections on the construction ofa photographic laboratory and photographic chemistry; it also covers fully the processing of the aerial film, developing, printing and copying, etc.

In Part III the methods employed in constructing maps from aerial photographs are fully described, special chapters being devoted to types of aerial photographic errors, maps and map readings, relief, control, methods of assembling mosaic photographs and line maps, etc.

The volume contains a great deal of valuable and instructive information usually only found in technical bulletins published by the Air Services. It is well illustrated and could be used at all times as a work of reference.

The reviewer would recommend the book to all readers of The Engineering Institute of Canada.

J. R. C.

Wind Stresses in Buildings

By Robins Fleming. Wiley & Sons, New York, 1930, cloth, 5¾ x 9 in., 193 pp., illus., figs., tables, $3.50.

John Portas, A.M.E.I.C.*

The publicity which has been given to the many conflicting theories and specifications dealing with the action of wind on tall buildings has roused widespread interest in this major problem of modern engineering. Mr. Fleming's valuable contributions to the development of modern structural steel practice have earned for him an international reputation, but it is to be feared that those who take up his book, in the search for enlightenment on the subject of wind stresses, will be somewhat disappointed.

The first part of the book contains much irrelevant matter regarding the classification of winds. A chapter on the "Relation of Wind Pressure to Velocity" describes at some length various types of anemometers and discusses the well known formulae of Hutton, Duchemin, etc.

The hackneyed subject of wind stresses in mill buildings is treated in the conventional manner and is followed by an exposition of the well-known methods for analysing wind stresses in tall buildings, which have been associated with Mr. Fleming's name for some years.

In the application of these methods a sense of humour is of more value than a knowledge of mathematics and those who, like the reviewer, have indulged in the undignified chase of refractory points of contra flexure all over an unsymmetrical building, have probably emerged with little faith in approximate solutions. Some reverence, however, is due to those methods by which the majority of tall buildings have been designed.

Mr. Fleming places emphasis on the importance of measuring actual deflections of tall buildings subjected to high winds; surely it is empirical data thus obtained, rather than mathematical gymnastics, which will ultimately lead to rational design of these complex structures. If, as is suggested, the "architectural clothing" increases the rigidity of the frame "300 to 400 percent," we need not mourn too deeply our inability to find an accurate and practical method of stress determination—based on quite irrational assumptions.

The remainder of the book deals with details for connections, windload distribution in the Lincoln building, and a chapter on earthquakes. These last chapters strike a familiar chord, consisting as they do of reprints of articles by various writers from current engineering literature.

Mr. Fleming's book may be helpful to students desirous of delving into history, but perhaps its chief value lies in the many references to a wide range of periodicals and books dealing with wind and its effect on buildings.

Union-Management Co-operation on the Railroads

By Louis A. Wood. Yale University Press, New Haven, 1931, cloth, 6 x 9 in., 326 pp., $4.00.

John E. Armstrong, A.M.E.I.C.†

This book is an impartial presentation of the facts in regard to Union-Management Co-operation, a comparatively recent development in the trend of industrial relations toward industrial democracy by means of which organized workers share in managerial responsibility. It deals principally with experience on the Baltimore and Ohio Railroad since 1923, on the Canadian National Railways and the Chicago and Northwestern Railway since 1925 and on the Chicago, Milwaukee, St. Paul and Pacific Railroad since 1926, in connection with maintenance of equipment.

The introductory chapters explain the economic compulsion generally applicable and the legal compulsion specifically applicable in the United States and Canada, respectively, to maintain equipment, outline the industrial processes involved and the organization for doing the work, cite the organization and jurisdiction of the several labour organizations concerned, and review the historical background culminating in the shop men's strike of 1922.

The following chapters deal with the origin of the co-operative plan, the developments leading to its adoption by the railways, the technique of co-operation, the attitudes of management and labour toward it, and in some detail the types of matters co-operatively considered. There is also discussion of the resulting improvement in morale and its effect upon the worker, the work and the employer, the problems of measurement of co-operative gains, including stabilization of employment, and the difficulties involved in the fair sharing of these gains between workers and employers.

In the concluding chapters such matters as apprentice training under co-operation, the relation of incentive wage payments to co-operation and the adoption fo co-operation in other railway department and in organizations other than railways are considered.

The text throughout is fully referenced to original sources of information and the subject is handled in a clear, concise and non-technical manner, the author consistently drawing attention to both sides of all controversial matters.

The book should prove both interesting and instructive to the general reader and particularly so to anyone concerned in recent developments in industrial relations. To the student of industrial relations in those departments of railways concerned with maintenance of equipment it should prove invaluable.

*Chief Engineer, J. W. Cumming Manufacturing Co. Ltd., New Glasgow, N.S.

†Assistant Chief Engineer, Canadian Pacific Railway, Montreal.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Presented by the Societies:

- American Standards Association: Year Book, 1931.
- American Society of Civil Engineers: Year Book, 1931.
- American Institute of Mining and Metallurgical Engineers, Inc.: Directory, 1931.
- Engineering Society, University of Toronto: Transactions and Year Book, 1931.
- American Institute of Electrical Engineers: Quarterly Transactions, March, 1931.
- American Society of Mechanical Engineers: Transactions, Vol. 51, parts 1 and 2, 1929; and Vol. 52, parts 1 and 2, 1930.
- The Society of Naval Architects and Marine Engineers: Transactions, vol. 38, 1930.
- The Society of Engineers (Inc.): Transactions for 1930.

Presented by Mrs. G. A. McCarthy—*from library of the late G. A. McCarthy, M.E.I.C.:*

- American Railway Engineering Association: Proceedings, vol. 24, 1923.

Reports, etc.

Topographical Survey, Canada:

- [Map of] Tramp Lake, Saskatchewan, [1931].
- [Map of] Parry Sound, Ontario, [1931].
- [Map of] Cross Lake, Manitoba, [1931].
- [Map of] Sipiwesk, Manitoba, [1931].
- Bulletin No. 63: The Aneroid Barometer and Altimeter, 1931.

Dept. of Mines, National Museum, Canada:

- Rapport annuel, 1929—Travaux généraux du Musée.

Dept. of Mines, Canada:

- Rapport du ministère des mines pour l'année financière se terminant le 31 mars, 1930.

Dept. of Mines, Mines Branch, Canada:

- Les abrasifs produits du Canada, technologie et applications—Partie I: Abrasifs siliceux.
- Investigations of Mineral Resources and the Mining Industry, 1929.
- The Canadian Mineral Industry in 1930.

Dept. of Mines, Geological Survey, Canada:

- Rapport sommaire, 1928—Partie C.
- Rapport sommaire, 1929—Partie C.

Dept. of the Interior, Northwest Territories and Yukon Branch, Canada:

- Keewatin and Northeastern Mackenzie—A General Survey of the Life, Activities and Natural Resources....1930.

Dept. of the Interior, National Development Bureau, Canada:

- Building Insulation in Canada, 1930, and Low Temperature Heat Insulation Industry in Canada, 1929.

National Research Council of Canada:

- Thirteenth Annual Report, Containing the Report of the President and Financial Statement, 1929-30.
- Report on the Aeronautical Laboratories and Plants of England and the Continent, Seen During July, August and September, 1930, by J. H. Parkin, M.E.I.C.

Dept. of Labour, Canada:

- Twentieth Annual Report on Labour Organization in Canada (for the Calendar Year 1930).

Special International Niagara Board, Canada:

- Final Report—The Preservation of Niagara Falls, 1930.

Quebec Harbour Commissioners:

- Report for the Year 1930.

St. John Harbour Commissioners:

- Report for the Year 1930.

The Nova Scotia Power Commission:
Eleventh Annual Report, 1930.

Bureau of Standards, United States:
Commercial Standard CS27-30: Plate Glass Mirrors.
Circular No. 391: Standard Thicknesses, Weights, and Tolerances of Sheet Metal (Customary Practice).
Building and Housing Publication BH15: Care and Repair of the House.
[Supplement to Building and Housing Publication BH6]: Modifications in Recommended Minimum Requirements for Masonry Wall Construction.

Bureau of Mines, United States:
Secondary Metals in 1929.
Chromite in 1929.
Lead in 1929.
Gold, Silver, Copper and Lead in South Dakota and Wyoming in 1929.
Technical Paper 489: Coal-Mine Safety Organizations in Alabama.
490: Separation and Size Distribution of Microscopic Particles.
491: Analyses of Washington Coals.
492: Deoxidation of Steel with Silicon.
493: Bibliography of United States Bureau of Mines Investigations on Coal and its Products, 1910-30.
494: Copper and Zinc in Cyanidation Sulphide Acid Precipitation.
496: Accuracy of Manometry of Explosions.
497: Electromagnetic Absorption by Rocks.
Economic Paper 11: The Economics of Strip Coal Mining.
12: Economics of Crushed-Stone Production.
Bulletin 279: Limits of Inflammability of Gases and Vapors.
326: Explosives Accidents in the Anthracite Mines of Pennsylvania, 1923-27.

Geological Survey, United States:
Professional Paper 165-D: Geology of the Big Snowy Mountains, Montana.
Bulletin 820: Nitrate Deposits in Southeastern California.
Water-Supply Paper 637-C: Water-Power Resources of the McKenzie River and its Tributaries, Oregon.
645: Surface Water Supply of the United States, 1927: Part 5: Hudson Bay and Upper Mississippi River Basins.

Public Health Service, United States:
Supplement No. 90: Detailed Instructions for the Performance of the Dissolved Oxygen and Biochemical Oxygen Demand Tests.

The Port of New York Authority:
Fourth Progress Report on Hudson River Bridge, March, 1931.

University of California, Dept. of Geological Sciences:
Bulletin: An Auklet from the Eocene of Oregon.
A New Genus of the Family Vespertilionidae from the San Pedro Pliocene of Arizona.

University of Minnesota, Engineering Experiment Station:
Bulletin No. 7: Manifold Phenomena in Internal Combustion Engines.

National Electric Light Association:
Prime Movers' Committee, Engineering National Section: Station Piping.
Foreign Systems Co-ordination Committee, Engineering National Section: The Technical Theory of Inductive Co-ordination.
Hydraulic Power Committee, Engineering National Section: Mechanical Reliability of Hydro-Electric Units, 1929.

The John Crerar Library:
Thirty-Sixth Annual Report for the Year 1930.

Technical Books, etc.

Presented by American Institute of Steel Construction:
The Skyscraper—Reprint from "Fortune," [1930], 40 pages.

Presented by International Illumination Congress:
[Bulletin]: The Origin, Organization and Work of the International Commission on Illumination.

Presented by National Business Publications:
Canadian Fisheries Manual, 1931.

Presented by E. & F. N. Spon, Ltd.:
High Speed Diesel Engines, by A. H. Goldingham.
Pocket-Book of Useful Formulae and Memoranda for Civil and Mechanical Engineers, by G. L. Molesworth.

Presented by Sir Isaac Pitman & Sons:
Textile Mechanics and Heat Engines, by A. Ripley and E. Dunkerley.

Purchased:
Canadian Periodical Index, Vol. 4, 1931. [Quarterly]. Published by Windsor Public Library, Windsor, Ont.
Underground Systems Reference Book, 1931. Published by National Electric Light Association.

Catalogues

Peacock Brothers, Ltd.:
Differential Pressure Control by Copes, 16 pp.

Canadian Westinghouse Company, Ltd.:
Circular 1737-F: Advance Guards,—Auto-valve Arresters, 24 pp.

National Airoil Burner Company, Inc.:
Oil Burning in Power Plants, 8th ed., 1931. 35 pp. [Also six bulletins on Oil Burners and Gas Burners for Commercial and Industrial type of furnace, 4 to 8 pages in length, issued Jan. 1931 to March 1931.]

The Steel Company of Canada, Limited:
Stelco Products: General Catalogue, 1931, 226 pp.

ELECTIONS AND TRANSFERS

At the meeting of Council held on May 19th, 1931, the following elections and transfers were effected:

Member

JACOBS, Milton, B.S. in C.E. (Norwich Univ.), associate engineer and member of firm, H. S. Taylor and Company, Consulting Engineers, Montreal, Que.

Associate Members

ANSON, Clement Matthew, B.Sc., (McGill Univ.), asst. gen. manager, Dominion Steel and Coal Corpn., Dominion Iron and Steel Divn., Sydney, N.S.

DUNN, Harold Stewart, res. engr., C.N.R., New Glasgow, N.S.

*KERSON, Morris William, designer and dftsman., T. Pringle & Son, Ltd., Montreal, Que.

*MILLAR, Peter, squad leader, Dominion Bridge Company, Limited, Lachine, Que.

STOREY, Gilbert Calder, B.A.Sc., (Univ. of Toronto), secretary-manager, City of Windsor Water Commissioners, Windsor, Ont.

Juniors

*CYR, Séraphin Adélard, asst. to supt., Eastern Steel Products, Limited, Montreal, Que.

DWYER, Thomas Edward, B.Sc., (N.S. Tech. Coll.), Masson, Que.

FERGUSON, John Henry, B.Sc., (Univ. of Man.), Flying Officer, R.C.A.F., Ottawa, Ont.

McFARLAND, Walter Irving, B.Sc., (Univ. of Alta.), engr., elect'l. engrg. dept., Beauharnois Construction Company, Beauharnois, Que.

McPHERSON, Alexander Ferrier, B.Sc., (Univ. of Alta.), engrg. dftsman., Canadian Westinghouse Company, Limited, Hamilton, Ont.

STEWART, Charles John Raphael Barnewall, B.A. (Eng.), (Cambridge Univ.), dftsman., Dominion Construction Company, Ltd., Fraserdale, Ont.

YOUNG, John Douglas, B.Sc., (Queen's Univ.), sales service engr., Bailey Meter Company, Montreal, Que.

Transferred from the class of Associate Member to that of Member

HALL, John G., B.Sc., (McGill Univ.), vice-president and gen. mgr., Combustion Engineering Corporation, Ltd., Montreal, Que.

HOLE, John, (Finsbury Tech. Coll., London), consltg. engr. and architect, Toronto, Ont.

MacAFEE, Ralph Evans, B.Sc., (McGill Univ.), mgr., Eastern Branch, Babcock-Wilcox and Goldie-McCulloch Ltd., Montreal, Que.

Transferred from the class of Junior to that of Associate Member

KINGSTON, Thomas M. S., B.A.Sc., (Univ. of Toronto), city engr. and supt. of waterworks, City of Chatham, Ont.

LAURIE, William Little, B.A.Sc., (Univ. of Toronto), Capt., Royal Canadian Signals, in charge Air Mail Radio Stations, Ottawa, Ont.

Transferred from the class of Student to that of Junior

BELL, Harry Heartz, B.Sc., (N.S. Tech. Coll.), engr., Calgary Power Company, Calgary, Alta.

EVANS, John Maurice, B.Sc., (McGill Univ.), industrial engr., Shawinigan Water and Power Company, Montreal, Que.

GOBY, Thomas, B.Sc. in C.E., (Tri-State Engrg. Coll.), sales engr., W. Q. O'Neall Co., Crawfordsville, Indiana.

WARDLEWORTH, Theophilus Hatton, B.Sc., (McGill Univ.), 168 Cote St. Antoine Road, Westmount, Que.

Students Admitted

MacDONALD, Murray Vickers, (Univ. of Sask.), Swift Current, Sask.

ST. JACQUES, Jean, C.E., (Ecole Polytech.), (McGill Univ.), 386 St. Catherine Road, Outremont, Que.

SCOTT, Edward Beresford, (Grad., R.M.C.), ap'tice, Canadian Westinghouse Company, Limited, Hamilton, Ont.

KETELSEN, Carsten, 1431 Metcalfe Street, Montreal, Que.

*Has passed Institute's examinations.

BRANCH NEWS

Border Cities Branch

Harold J. A. Chambers, A.M.E.I.C., Secretary-Treasurer.

Cyanamid and its Derivatives

The regular monthly meeting of the Border Cities Branch was held on April 10th. The speaker of the evening was S. R. Frost, A.M.E.I.C., of the American Cyanamid Company, Niagara Falls, Ont. The subject of Mr. Frost's address was "Cyanamid and its Derivatives."

Limestone for the manufacture of cyanamid is obtained from Beachville, Ont., where the company own and operate their own limestone quarry. A year ago a plant was built to take care of the fine screenings from the limestone from which agricultural limestone, mineral fillers and calcium carbonate as an ingredient for stock foods are produced.

The limestone is shipped to Niagara Falls where it is burnt in seven or eight large rotary kilns to form lime. This lime is then mixed with coke of a special grade and the two materials are processed in electric furnaces at 4,000 degrees F. Calcium carbide is formed. The nitrogen for cyanamid is obtained from the air by the liquid air process and fractional distillation. This nitrogen is placed in contact with the carbide which has been pulverized and the reaction is started by the application of intense local heat, the carbide burns actively in the atmosphere of nitrogen, with the result that calcium cyanamid is formed.

Cyanamid is lifted from the retort in which the reaction takes place in the form of an ingot, weighing approximately five tons; it is cooled, pulverized, treated with water and oil and packed in bags for shipment. This cyanamid is about 23 per cent nitrogen.

Cyanamid is exported for a great many purposes. It is used as a fertilizer for sugar cane, cotton, corn and fruits, as an ingredient to mix fertilizers, and also as a neutralizing agent and a conditioner.

A large percentage of cyanamid manufactured at Niagara Falls is used to make cyanide. This cyanide is used in the reduction of gold and silver ores in what is known as the "Cyanide Process" and is shipped to South Africa, Mexico, Australia, United States, Formosa, Nicaragua and Honduras.

A large amount of this material is shipped as cyanogas, which is powdered cyanide, and is used for rodent extermination.

Cyanamid has a very great number of derivatives which are practically all made at the American Cyanamid Company's plant at Warners, N.J. Aqua ammonia is produced from cyanamid by autoclaving, or treating under high pressure steam in a closed vessel. Some of this ammonia is sold direct and some is combined with phosphoric acid brought from Florida in the form of phosphate rock. These two chemicals properly combined make ammonia phosphate, the trade name of which is "Ammo-Phos." This is a comparatively new high analysis fertilizer and because of its high analysis it can be shipped long distances. Ammo-Phos has about 50 per cent plant food in it, ordinary fertilizer having only about 15 per cent. This product is used to fertilize bananas in Central America, mulberry trees in Japan, coffee in Java, olives and oranges in Greece and Spain, cocoanuts in the Philippines, pineapples in Hawaii, tea in China, in addition to numerous uses on this continent. In the process of manufacturing this high analysis fertilizer, there are two by-products derived from the waste black sludge. These are gypsum, which is made into structural gypsum blocks, and graphite. Some of the other derivatives of cyanamid are rubber accelerators used in automobile tires to increase the mileage, also rezyls, which are used in lacquers and modern quick drying paints.

The address was illustrated by motion pictures showing the manufacture of cyanamid and ammo-phos.

A hearty vote of thanks for the very interesting address was conveyed to Mr. Frost by the chairman, R. J. Desmarais, A.M.E.I.C., on behalf of the members of the Branch.

Calgary Branch

A. W. P. Lowrie, A.M.E.I.C., Secretary-Treasurer.
W. H. Broughton, A.M.E.I.C., Branch News Editor.

Annual Meeting

The annual meeting and election of officers was held in the Board of Trade rooms on the afternoon of Saturday, March 14th, 1931, when the following officers were elected to carry on the business of the Branch for the year 1931-1932.

Chairman	R. C. Harris, M.E.I.C.
Vice-Chairman	F. M. Steel, M.E.I.C.
Secretary-Treasurer	A. W. P. Lowrie, A.M.E.I.C.
Executive Committee	F. N. Rhodes, A.M.E.I.C.
	L. A. B. Hutton, A.M.E.I.C.
	H. J. McLean, A.M.E.I.C.
	S. G. Porter, M.E.I.C.
	B. Russell, M.E.I.C.
	R. S. Trowsdale, A.M.E.I.C.
	T. Lees, M.E.I.C.
Auditors	K. Moodie, M.E.I.C.
	W. H. Broughton, A.M.E.I.C.

The Secretary-Treasurer reported a net increase of six corporate members and two affiliates since the last annual meeting, made up of the gain of eleven by transfer and two by affiliation and the loss of three members by transfer, two by resignation and one by death. There are a number of applications for membership now in the hands of Headquarters or of the Application committee and a further number of application forms in the hands of prospective members.

During the year, ten meetings were held at which the average attendance was forty-nine. In addition there were four hundred and five present at the annual ball and eighty-seven at the annual dinner.

The Branch had somewhat over-expended its income during the year because of two annual dinners falling in one financial year but had just about broken even when this expenditure was allowed for.

Before vacating the chair, Mr. Russell thanked the officers and the members of the various committees, particularly the Secretary-Treasurer and attendance committee, for their cooperation throughout the year. After congratulating the incoming officers, he retired in favour of the newly-elected chairman, R. C. Harris, M.E.I.C.

Mr. Harris thanked the members for electing him as chairman and felt sure he could look forward to the same spirit of co-operation and support that had always been accorded to his predecessors in that office. He strongly endorsed a recommendation that the Programme committee should set up small committees of experts to consider and prepare papers on individual technical subjects, especially those which are matters of live interest to the city or province. This recommendation had previously been referred to the incoming Executive and Programme committees with instructions that it be given very careful consideration.

On a motion by Messrs. R. S. Trowsdale, A.M.E.I.C., and J. J. Hanna, A.M.E.I.C., a very hearty vote of thanks was accorded the retiring officers for the excellent work they had done for the Branch.

Annual Dinner

The annual dinner was held in the Palliser hotel on the evening of Saturday, March 7th, 1931, with Ben Russell, M.E.I.C., in the chair. Invitations had been sent to all professional engineers in the city who were not also members of The Institute and about ninety attended the dinner.

Mr. Andrew Halkett, general superintendent, Canadian Pacific Railway, in proposing a toast to the "City," pointed out that Calgary citizens had taken high honours in the life of the Dominion during the past year: R. B. Bennett as Premier of Canada, R. G. Hutchings as president of the Canadian Manufacturers Association, Col. J. H. Woods as President of the Associated Boards of Trade, and S. G. Porter, M.E.I.C., as president of The Engineering Institute. Andy Davison, Mayor of Calgary, replied in lighter vein and paid tribute to the loyal service given by the professional employees of the city.

"The Institute" was proposed by H. S. Patterson, K.C., with reminiscences of college and city life, and was replied to by the newly-elected president of The Institute, S. G. Porter, M.E.I.C. Before calling on Mr. Porter for his response, Mr. Russell rose to perform a very pleasing, and judging by the prolonged applause, a very popular duty, to present to him an illuminated address on behalf of the members of the Calgary Branch on his election as president of The Engineering Institute of Canada.

The president gracefully expressed his appreciation of the honour done him. In addition to the honour, said the president, he felt it was a call to a wider field of service. His election, he thought, might be taken as a request by the members to finish the work of unifying the various engineering organizations in the Dominion and so enable the members of the profession to give better service to the public and perhaps receive more adequate recognition for their share in the development of the Dominion. It is but natural, he said, that men with similar aims should get together for the advancement of the practical application of scientific attainments and to advance the standing of the profession.

While the advancement of civilization, continued the speaker, is largely due to the engineer, far too often he shrinks from taking his proper place in the councils of the city, the province or the Dominion. One half of all scientific advance has occurred during the past twenty-five years, the engineer is the man who applies this scientific knowledge to industry and he should take a larger share in the manner of its application because he understands better the problems involved in the development of the country than does the member of any other class in the community.

The engineer's duties are patriotic as well as professional, they are not wholly for material gain but for the development of the Dominion and the conservation of its natural resources.

Mr. Porter briefly reviewed the inception of The Engineering Institute of Canada and its expansion to include all branches of engineering, and voiced its present hope to be the means of bringing about closer union between the professional bodies of the various provinces during his term of office.

T. Lees, M.E.I.C., proposed the toast of "Our Guests," which was responded to by R. S. L. Wilson, M.E.I.C., Dean of Applied Science, University of Alberta, and John Allan, D.Sc., Professor of Mining and Geology, University of Alberta.

Dr. Allan very strongly asserted the intention of the Council of the Professional Engineer's Association and of the senate of the university to maintain the standards set for admission to the Association of Professional Engineers of Alberta and to prevent unqualified people practising as professional engineers within the province. He hoped that, in the near future, there would be one act governing the practice of engineering from coast to coast and the Association of Professional Engineers of Alberta is out to see that all qualified engineers become registered under the Alberta Act. There were in our ranks the material and the brains to take a leading part in the government of the city, the province, and the nation, and he agreed with Mr. Porter that it is time for professional engineers to take their proper places in public affairs.

Musical numbers between the toasts, by Messrs. Plesner, Lydiatt, Walrod and G. H. Patrick, M.E.I.C., under the direction of the latter, were very much appreciated.

The Tar Sands of Alberta

A general meeting of the Calgary Branch was held in the Board of Trade rooms, Calgary, at 8.00 p.m. on Saturday, March 21st, when about forty members and friends gathered to hear Dr. K. A. Clarke, chief engineer, Roads Materials Division of the Research Council of Alberta, speak on "The Tar Sands of Alberta."

Dr. Clarke reviewed the early development and experiment carried out jointly by the federal and provincial governments and independently by various commercial interests. Interest in the field and its possibilities, he said, seemed to receive renewed vigour in cycles of about ten years duration.

When the Research Council of Alberta entered the field they concentrated on the separation of the oil from the sand—the sand being too far from all possible fields of utilization to be able to carry transportation costs. Their experiments were at first confined to shipments brought down to Edmonton, but in 1929 a plant of small commercial size was erected at the field in order to test the results of the experiments on a larger scale.

The principal difficulties encountered were to separate the oil from the water used, to remove the oil from the sand; to separate the last residue of the sand; and to separate large flat stones from the mixture so as to avoid damage to pumps and machinery. These have all, except the last, been overcome on a small scale and the provincial government now feels that further development should be left as a commercial project while the energies of the department should be concentrated in finding uses for the products after recovery.

Some experimental stretches of road, he continued, have been laid down and have proven very satisfactory but the amount required for road building and oiling is small and the cost of mining prohibits its use for this purpose in competition with petroleum refinery products.

Dr. Clarke illustrated his talk by a number of slides of the district and of the separation plant.

The very interesting nature of the subject was proven by the lively discussion that ensued and by the hearty manner in which the vote of thanks, moved by Messrs. A. S. Chapman, A.M.E.I.C., and Graves, was received by the assembled company.

Cape Breton Branch

S. C. Mifflen, M.E.I.C., Secretary-Treasurer
Louis Frost, Branch Affiliate, Branch News Editor

Geological Exploration Work on the Labrador

An interesting lecture describing a number of years of geological exploration work on the Labrador was given by John Wightman, A.M.E.I.C., before a large gathering of members of the Cape Breton Branch at their regular meeting held in Sydney on Friday, April 16th; A. P. Theuerkauf, M.E.I.C., chairman of the Branch, presided.

The lecturer, following a short review of the history and early settlement of the Labrador, referred to the many disputes between the companies operating in that country, and to the territorial argument between Canada and Newfoundland, the culmination of which was the now famous Labrador boundary question settled in 1927, wherein the Dominion of Canada claimed the whole of the Labrador with the exception of a narrow strip on the coast line.

The Privy Council, to whom the matter was referred, rendered a decision in favour of Newfoundland and confirmed Newfoundland's charter of 1763. The boundary line between the Labrador and Quebec, the lecturer indicated, was now a line drawn due north from the eastern boundary of the Bay of Blanc Sablon as far as the fifty-second degree north latitude and from thence westward along that parallel until it reaches the Romaine river and then northward along the east bank of that river and its headwaters to their source, and from thence due north to the crest of the watershed or the height of land there, and from thence westward and northward along the crest of the watershed of the rivers flowing into the Atlantic ocean until it reaches Cape Chidley.

The superficial area of Labrador has been computed at about 110,000 square miles, or approximately three times the area of Newfoundland, and having a population of less than 5,000 people.

Speaking of the geological formation, the lecturer stated that the southern part of the coast from the strait of Belle Isle to Nain, is low-lying and indented with numerous fiords wherein are innumerable islands. There is everywhere evidence of profound glaciation, and in sheltered places and on high land snow lies throughout the year. Most prominent along the coast are the raised beaches, black intrusive trap dykes cutting through the older gneiss formation, and boulder barricades, that is to say large accumulations of glacial boulders lying between half and low tides.

The northern part of the coast is mountainous. Mountains rising to elevations of two and three thousand feet directly from the ocean, while inland some of the peaks are in the vicinity of 6,000 feet high.

The economic minerals found are pyrites, magnetic iron, labradorite, molybdenite, copper, and some limestone. There have been reports of gold findings, but to date no deposit of commercial value has been located.

Timber lands alone aggregate roughly twenty million acres, with an estimated coverage of 100,000,000 cords of pulpwood, sufficient to produce one million tons of paper per year for all time. The water power available for the entire country has been estimated by experts at about ten million horsepower.

The population of Labrador comprises the permanent settlers and livyeres, the Moravian and Grenfell missionaries, officers and employees of the Hudson's Bay Company individual fur traders, the Eskimos and Indians, and the floating population of fishermen and their families who come to the Labrador from Newfoundland each summer and return in the autumn.

The livyere, the lecturer indicated, is usually a person of a high moral code and strong family instinct. Having provided food and fuel for the winter months for his family, the livyere makes his way into the interior each fall, and does not return to his family until the following spring, being content to spend the winter alone trapping furs while his family remains in comparative comfort and within reasonable distance of hospital and mission schools.

Mr. Wightman had a good deal of praise for the Moravian and Grenfell missionaries who are content to spend their lives in that hard country in order to bring spiritual light to the Eskimo and Indian.

The Eskimos of Labrador are easy going and good natured, with quite a reputation for honesty. They mix freely with the white settlers and spend their time principally in fishing for cod, salmon and seals which they sell to the Hudson's Bay Company.

The Indians on the other hand do not readily mix with the white people and do not care to learn English. They are of two tribes, the Nascopie and the Montagnais. In the fall about September the Indians gather all their supplies together and leave 'en bloc' for their hunting grounds in the interior, taking their women and children and old as well as sick with them. They do not return to the coast until June when the ice breaks up.

The lecturer concluded his interesting talk with the information that Canadians as British subjects enjoyed equal rights in the Labrador with the natives of Newfoundland, timber rights and mineral licences being granted to Canadians in the same way and with no greater difficulty than to citizens of Newfoundland.

The meeting concluded with a hearty vote of thanks to the speaker, proposed by M. Dwyer, A.M.E.I.C., mayor of Sydney Mines, seconded by J. C. Nicholson, general superintendent of the Dominion Coal Company, Ltd.

Hamilton Branch

John R. Dunbar, A.M.E.I.C., Secretary-Treasurer.
J. A. M. Galilee, Affiliate E.I.C., Branch News Editor.

Problems in Central Station Engineering

The annual joint meeting of the Hamilton Branch of The Engineering Institute of Canada and the Toronto section, American Institute of Electrical Engineers, took place in the auditorium of the Canadian Westinghouse Company on Friday, April 24th. W. F. MacLaren, M.E.I.C., chairman of the Hamilton Branch, welcomed the Toronto visitors. He turned the meeting over to D. A. MacKenzie, of Toronto, who introduced the speaker of the evening, R. E. Powers, of the Westinghouse Electric and Manufacturing Company, the subject of whose address was "Problems in Central Station Engineering."

Mr. Powers introduced his subject by stating that the problem in large metropolitan areas, such as New York, is to provide a system of distribution of energy that is flexible and suited to the varying demands made on it in different sections. Four systems of generating station connections were discussed. The first of these was the close linked system. This system, used largely in metropolitan areas, consists of linking all the low tension distributing lines together so that they are all interconnected. However, should a short circuit occur a considerable amount of damage would be done in all the areas connected in the system. Also when extensions in this system are undertaken a complete new set of circuit breakers would be needed and the old ones would become useless in the central station owing to their lower ratings.

The second method, the loose linked system, involves a number of separate distribution low tension lines. This system is for use in areas which are not so thickly populated but where communities are scattered. A short in one distribution line will not have any effect on other distribution lines.

Synchronizing at the load is another method of connecting the generator stations. This method involves less trouble if generators become out of phase, has increased reliability, a minimum fault current concentration and a maximum service voltage distribution.

Still another method, and perhaps the most modern method, is by double winding the generators. This reduces the effect of a short circuit to half the effect a single winding generator would have. The interrupting capacity of the circuit breakers is also only half that of a single winding generator. When a short circuit does occur, the generator affected is shut down. The busses are so arranged that when a generator is shut down the winding on that generator which was not short circuited is supplied with energy from the other generators. This method gives a minimum amount of service interruption and the fault may be remedied immediately.

The speaker said "In our large cities the task of supplying energy to large office buildings has become quite a problem. If all energy could be considered as concentrated in the base of a large building its supply would not be difficult. However, office buildings covering an acre of ground with 65 acres of floor space extending high up offer quite a problem, especially when considering distribution at 120 to 208 volts.

"Elevator motors, 100 to 150 h.p., mounted on the upper floors require considerable copper to prevent the flicker of lights during periods of motor starting. It becomes obvious that the same practice so popular in horizontal distribution can be employed to advantage in vertical distribution, that is, distribute at high voltage to the load centre and step down to service voltage directly at the point of utilization. Thus a large office building will be served from transformer vaults in the basement and on various floors where the load is concentrated, such as at the end of elevator shafts."

As an example, Mr. Powers took the Chrysler building, which has seventy-seven storeys and a tower and 1,160,000 square feet of floor space. There are transformer vaults on the first, thirtieth, sixtieth and seventy-fourth floors, which step down the network voltage to distribution voltage. Such a 4,000-volt vertical network system offers distinct economies in buildings of forty storeys or more.

Among its advantages are improved copper economy, reduced duty on oil circuit breakers, better regulation, small and standardized transformer units, capacity installed in small units, investment for load growth in small increments, reduced system losses, area of outage reduced, and no high tension breakers needed.

Mr. Powers stressed the need for construction units, which were becoming more and more important. Among these he mentioned transformers and reactors combined so as to obtain the correct reactance and reduce the scope of short circuits. Network switches, metering panels and movable disconnecting switches were more of these units.

The meeting was then thrown open to discussion, and the opportunity of joining in this was taken by a large number of visiting engineers. S. E. M. Henderson, M.E.I.C., moved a hearty vote of thanks to the speaker for his interesting address, coupling with it also the thanks of the meeting to the Canadian Westinghouse Company for their hospitality. There were 240 present.

Kingston Branch

L. F. Grant, M.E.I.C., Secretary-Treasurer.

The annual dinner of the Kingston Branch was held at the Badminton Club on Tuesday, April 7th. The Branch chairman, Professor A. Jackson, A.M.E.I.C., presided and there were about fourteen members present.

India

The speaker was Major G. R. Turner, A.M.E.I.C., and the subject of his address was India. Major Turner has recently returned from a two-years course at the Staff College, Quetta, and gave a very interesting and informative address.

The leading authority on the present state of India is Volume One of the famous Simon Report, which should be studied by those who wish to become familiar with the factors which affect the situation.

India has an area of about 1,800,000 square miles and a population of some 320,000,000 people. There are 222 vernaculars spoken, and about 2,500,000 people are literate in English.

The races of India are numerous as a result of some thirty major invasions of the country from the northwest. Among the more important of these invasions may be mentioned those of the Assyrians, Persians, Greeks, Arabs, Afghans, and Tartars.

About 71 per cent of the population is engaged in agriculture, 12 per cent in industry, 5 per cent in trade, 2 per cent in domestic service, and 3 per cent in professions, government service, and the Army, combined. The main products are jute, grain, rice, cotton, tea, sugar and tobacco.

The religions are almost as numerous as the racial origins of the people. The largest groups are the Hindus with 217,000,000; Mohamedans with 70,000,000; Buddhists 12,000,000; Christians 5,000,000 and Sikhs 3,000,000. One of the great difficulties of the situation arises from the fact that the two great religious bodies, Hindus and Mohamedans,—who are particularly antagonistic to each other—are not confined to any particular part of the country, but are widely scattered. In consequence the inter-religious strife is serious.

The depressed classes form about 30 per cent of the Hindu population. They are for the most part quite uneducated, and at the bottom of the economic scale. The origin of these classes is partly occupational and partly tribal. It is from these lower castes that Christianity makes most of its converts since it brings to them a hope of higher standards.

There are some 600 Indian states, varying in size from over 80,000 square miles to a few acres. The British government, by treaties and agreements, is responsible for the territorial integrity and external relations of all of these, but they manage their own internal affairs. There is practically no communal strife in these states.

The central government is charged with matters such as defence, external affairs, and relations with the native states. There are provincial governments in the nine major provinces. The legislative assembly in the central government and the legislative councils in the provinces consist mainly of elected members. About 10 per cent of the adult male population is entitled to vote, the franchise being based largely upon property qualifications.

The difficulties in connection with self-government arise from the Hindu-Mohamedan strife; the question of the native states; the wide diversity of peoples in many respects without common ground; the question of affording adequate protection to the rights of minorities, and the menace of attack from the northwest. The safeguards which have been pronounced essential at present by the British government deal with finance, defence, external affairs, and the protection of minorities.

At the conclusion of his remarks Major Turner showed some very interesting slides of India especially of industrial and engineering work.

London Branch

Frank C. Ball, A.M.E.I.C., Secretary-Treasurer.
John R. Rostron, A.M.E.I.C., Branch News Editor.

The regular monthly meeting of the Branch was held on the 22nd of April in the County Council chamber, the chair being occupied by the Branch chairman, W. R. Smith, A.M.E.I.C.

Engineering of the Ancients

The speaker of the evening was Colonel W. P. Wilgar, B.Sc., M.E.I.C., Professor of Civil Engineering, Queen's University, and his subject was "Engineering of the Ancients." He was introduced by H. B. Craig, M.E.I.C.

In his address, Colonel Wilgar pointed out that the profession of engineering is so old as to reach far beyond the age of accurate history. Man as an animal capable of thinking and fashioning tools and weapons has inhabited the earth for at least 350,000 years, but our accurate knowledge of his activities is, so far, restricted to about 8,000 years, and the caves and sepulchres, the temples and monuments which have perpetuated the skill and wisdom of our professional ancestors are the only trophies which have safeguarded through the ages traces of the culture and magnificence of ancient civilization that, otherwise, would have been completely lost.

The Bible is the oldest of our histories and in the last ten years the flood and the Tower of Babel have been definitely established by excavation of the city of Ur of the Chaldees, settled about 8,000 years ago by the Sumerians, who possessed a knowledge of engineering which enabled them to build the first city of the land on the fertile flats opposite the Tigris and the Euphrates. The Tower of Babel or Zigurat was supposedly built as a temple to the Moon God.

The Sumerians were dwellers of the hills and worshipped from high places. The bricks of the Tower were well burned and bound together by asphalt from the pools of Hit. Each brick was stamped with the name of the Emperor Ur-Nama. Bricks used in the city of Babylon had also been found bearing the name of "Nebuchadnezzar."

These Chaldees at Ur used gold, silver, copper and tin 6,000 years ago, and the art of the goldsmith, the armourer and the potter of that day is unsurpassed by any period of history.

The civic engineer of Ur designed and built brick arches 6,000 years ago. He understood canalization and irrigation and also the principles of hydraulics concerning stream flow and pressure. The great reservoirs built 3,000 years ago in the hills of Judah, designed as a water supply for the city of Jerusalem, are amongst the greatest of the technical achievements of the ancients. Drains and sewers existed 5,000 years ago and the gymnasium of Pergamon (2,000 years ago) had shower baths and flushing toilets.

The earliest arched bridge, a semi-circular brick arch, was built across the Tigris in Mesopotamia.

The people of India were mining, forging and fabricating metals more than 5,000 years ago. Near Delhi there is a shaft of wrought iron of 17 tons weight. It bears an inscription proving its age as 3,000 years and in all its length there is no mark of seam or weld and no spot of rust.

So far as we know the ancients had no knowledge of explosives for mining purposes although the Chinese used gunpowder for pyrotechnics. Herodotus, an historian of 2,000 years ago, said they broke the rocks by lighting fires on them and then throwing on vinegar. The miners of those days were all slaves and criminals.

Among the wonders of the world the Cheops pyramid occupies first place—not only as an engineering achievement but as a monument to the amazing knowledge its designers possessed in mathematics and astronomy and as a proof that instruments of precision must have been used in its erection. It is supposed to have been started as a tomb for Cheops, though no body was ever found in the sepulchres. It contains about 3,000,000 cubic yards of cut stone, many of the blocks weighing 70 tons. The stone was quarried on the banks of the Nile about a quarter of a mile away. So far as we know the only mechanical devices available at that time were the pulley, the lever, and the inclined plane.

It is a perfect square on plan with 775 feet to the side and was originally covered with a veneer of polished marble. The Egyptians used the plug and feather method of quarrying their limestone, but no one knows how they managed to secure such precision of finishing, that it is impossible to insert a knife blade between the courses of the stone.

These points are generally known, but the wonder of the pyramid is not in its size but in the theories that have been deduced by mathematicians and astronomers who have studied it.

The sides of the pyramid coincide precisely with the cardinal points of the compass. The exit to the lower sepulchre is so inclined that the pole star of that time shone at lower culmination directly on the sarcophagus of the dead Pharaoh. The star Sirius, worshipped by the Egyptians, and from which their time was calculated, culminated at an angle of 38 degrees and the faces of the pyramid have exactly an angle of 52 degrees, the complement of 38 degrees; and the ventilating shaft of the upper sepulchre is cut exactly at right angles to the southern face so that the star Sirius shines directly at culmination on the sleeping god of the upper sepulchre. Again as a result of the 52 degree angle of the faces, the pyramid casts no shadow at midday from the 1st of February until the middle of October, so that from Nature's awakening in the spring until her August decline "the Sun pours the full lustre of her rays on the resting place of Pharaoh." The indeterminate ratio π was calculated by a Dutchman in the Sixteenth century—or so it was believed until a few years ago, when Flammarion, the great French mathematician, discovered that the height of the pyramid bears to the perimeter of the base, the exact ratio π. This astounding fact can scarcely be an accident.

After referring to ancient road making and drainage, textile industries, architecture, building, town planning, water supplies and purification, etc., the speaker quoted from the writings of Vitruvius who was the first engineer who tried to leave a record of the technical sciences of his age and about 2,000 years ago wrote what might be called an encyclopædia of engineering. This author deals with most of the subjects mentioned above and also has a chapter on professional ethics which applies to the present as well as the ancient days. One paragraph under the heading of practice and theory is well worth repeating, "He who has aimed at acquiring manual skill without scholarship can "never reach a position of authority to correspond with his pains, and "he who relies on scholarship alone is hunting the shadow and not the "substance. He who has a thorough knowledge of both—like a man "armed at all points—soon attains his object and carries authority with him."

In closing, Colonel Wilgar remarked that the engineer of ancient days does not appear in history as a man of great wealth. Then, as now, he was an advisor to capital, and he was listened to with respect at the councils of his state in war and in peace. He built up for the profession, which he loved, a reputation for honesty and integrity which has lasted through the ages.

An interesting discussion followed the address. W. C. Miller, M.E.I.C., said that with regard to the excavation of rock without the facility of explosives he believed that some of this excavation was probably achieved by forming cavities or fissures in the rock and packing these with lime which was confined and afterwards slaked with water.

E. V. Buchanan, M.E.I.C., remarked that in the ancient days much was accomplished by a little at a time and the pay (if any, for slaves and criminals were employed) was so low that the economics of a job did not matter whereas in the present days the work was much more complicated and was often sacrificed to the question of cost.

A hearty vote of thanks proposed by T. Y. Harcourt, M.E.I.C., and seconded by W. C. Miller, M.E.I.C., was unanimously carried.

About thirty-eight members and guests were present.

Niagara Peninsula Branch

Paul E. Buss, A.M.E.I.C., Secretary-Treasurer.

Remuneration of Engineers

On March 26th the Branch held a dinner meeting at Welland to hear J. L. Busfield, M.E.I.C., explain the results of the recent questionnaire on remuneration. The meeting was poorly attended which might indicate that the engineers in this district feel that their remuneration is quite adequate, or again it might indicate that they consider their lot to be hopeless.

Mr. Busfield gave a clear and concise explanation of the various steps which had been taken and of the charts and diagrams which accompanied his talk. This report was published in the May issue of the Engineering Journal.

C. K. McLeod, A.M.E.I.C., had travelled with Mr. Busfield from Montreal and, in a few well chosen remarks, he metaphorically pulled the leg of the Branch by introducing an enlarged version of the Engineering Journal diametrically opposed to the principle for which our membership has expressed a preference.

The gesture was properly appreciated as indicating that at least a few of the Montreal members are alive to the necessity of making some modification to the present size.

About sixteen members from this Branch motored to Hamilton on March 2nd to participate in an inspection trip, dinner and evening meeting arranged by the Hamilton Branch.

The party split into three sections, going respectively to the plants of the Firestone Tire, the Westinghouse and the Steel Company of Canada. At 4.30 p.m. they all met at the Dominion Glass Works and from thence they went to the Hotel Connaught. After dinner some excellent motion pictures were shown through the courtesy of the Buffalo Section A.S.M.E. These pictures were taken at the almost incredible speed of 10,000 to 40,000 exposures per second. Professors Harrington, Hector and Taylor of the University of Buffalo explained something of the method used and the value of the pictures in the study of aero-dynamics.

Steam Storage

Mr. J. P. Wys then read an interesting paper on steam storage accompanied by lantern slides showing modern installations of accumulators and charts of the consequent flattening in the peak load curves. The Hamilton Branch may be congratulated upon providing a highly instructive programme with items of such varied interest.

Inspection Trip

A well attended meeting was held on April 30th at Niagara Falls to inspect the plants of the Canadian-Ohio Brass Company, the Ontario Power Company (H.E.P.), and the new filtration plant. The "Brass Company" is labouring under a misnomer because nothing but porcelain insulators are manufactured at this plant. The ball clay and kaolin are obtained from England in air-tight drums, mixed in exact proportions with the proper quantity of moisture—any variation in these proportions would affect the shrinkage and consequent dimensions of the finished product. This shrinkage is quite large, about 10 per cent in the initial drying stages and a further 8½ per cent in the final baking.

The soft clay is moulded to rough form on a modern electrically-driven potter's wheel and is then passed through the drying ovens to the finishers who bore any necessary holes and dip the insulators in a salt glaze solution. Packed in fire clay tubes the insulators are next stacked in one of the two immense kilns and fired at a temperature of 2,642 degrees F. The final step is to test every insulator with a flash-over voltage which will determine the actual resistance and which is severe enough to crack or fuse any but perfect specimens. A noticeable feature of the plant was the cleanliness and perfect order which prevailed.

The Niagara Falls filtration plant, which is situated near the village of Chippawa, is described by Mayor Swayze as being the most modern on the North American continent. The designing firm is H. G. Acres and Company, and Mr. S. W. Andrews of that firm described the plans and mechanical features. The visitors had a good opportunity of following the process from start to finish as the water had not yet been let in and they were therefore able to enter the intake well, coagulation basins and filter beds. A much appreciated buffet supper was served at the plant through the courtesy of the Board of Water Commissioners.

Harold Buck, M.E.I.C., proposed a vote of thanks, which was seconded by Alex. Milne, A.M.E.I.C.. Mr. Milne is responsible for a filtration plant at St. Catharines and stated that of the total filtered water he used but 3½ per cent for cleaning, whereas Mr. Andrews had suggested a possible 10 per cent as the requirements for the new plant.

Ottawa Branch

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

Petroleum and Present-Day Civilization

At the noon luncheon held on the 23rd of April, A. W. Sime, technical engineer with the Imperial Oil Limited of Toronto, was the speaker, his subject being "Petroleum and its Relation to our Present-Day Civilization." Mr. Sime was introduced by G. J. Desbarats, C.M.G., M.E.I.C., chairman of the local Branch, and, in addition to the chairman and speaker, head table guests included the following: R. M. Stewart, M.E.I.C., E. Viens, M.E.I.C., W. S. Van Scoyoc, M.E.I.C., A. E. MacRae, A.M.E.I.C., C. W. Barber of the British American Oil Company; T. G. Madgwick, Petroleum Engineer of the Department of the Interior; G. M. Thomas of the Imperial Oil Company; H. Woods of the McColl-Frontenac Oil Company; F. H. Peters, M.E.I.C., G. O. Johnson, A.M.E.I.C., C. R. Coutlee, M.E.I.C.

Mr. Sime remarked that the story of petroleum in Canada had its birth about seventy years ago when J. H. Williams of Hamilton drilled the first wells on this continent for oil in Lambton county, antedating those of Colonel Drake in Pennsylvania.

Discovery of oil wells originally was by surface indications, seepages, etc. Today discovery follows upon the expert investigations of the trained petroleum geologist. To his aid he has recently summoned the aeroplane and from aerial photographs, together with maps compiled therefrom, he may study the general characteristics of the terrain—its outcrops, folds, etc. Also the geophysicist and the palaeontologist have assisted to reduce the number of profitless and dry holes. He stated that today we were better able to estimate available resources than we were ten years ago, and also a great advancement had been made in drilling methods and machinery.

In the matter of fuel transportation there are great engineering difficulties involved, and the construction of pipe lines for this purpose is the work of specialists.

At the refining end the engineer also plays a most important part and many interesting problems arise, also there is the manufacture and utilization of the so-called by-products which is a most fertile field for the chemical engineer. Again there is natural gas and its utilization and transportation.

Petroleum, stated the speaker in conclusion, is destined to play a more important part in our daily life than ever before. Its potentialities have barely been touched upon. Engines today are from 25 per cent to 30 per cent thermally efficient; and a greater efficiency will result from a development of increasingly better fuels, all to be brought about by further efforts of the engineer.

The Diesel Electric Drive Dredge "General Brock"

At the last noon luncheon of the Ottawa Branch for the 1930-31 season held at the Chateau Laurier on May 7th, the speaker was B. G. Flaherty, chief engineer of General Dredging Contractors, Limited. This firm has been engaged in dredging projects on the St. Lawrence and Saguenay rivers, one of which is the deepening of the ship channel to 35 feet for the Federal Department of Marine. Mr. Flaherty's address dealt with the new Diesel electric suction dredge "General Brock," the major features of which were designed by himself. This dredge is the last word in suction dredges and embodies a number of features which are entirely new.

G. J. Desbarats, C.M.G., M.E.I.C., chairman of the Ottawa Branch, presided at the luncheon, and at the head table in addition to the chairman and the speaker were the following: George E. Bell, M.E.I.C.; V. Meek, M.E.I.C.; S. Bray, M.E.I.C.; J. L. Rannie, M.E.I.C.; D. W. McLachlan, M.E.I.C.; K. M. Cameron, M.E.I.C.; A. T. Phillips, M.E.I.C.; Commodore W. Hose; E. Hawken; Col. A. E. Dubuc, M.E.I.C.; John McLeish, M.E.I.C.; Dr. R. M. Stewart, M.E.I.C.; and L. L. Bolton, M.E.I.C.

Mr. Flaherty, at the commencement of his address, stated that a controlling feature in the design of dredges is the velocity of water possible in the pipe line carrying away the dredged materials, as this has a bearing upon the kinds of material which may be moved. The power required for maintaining this velocity varies greatly, as a matter of fact, as the cube of the velocity. The suction dredge which he described may be considered as an ultimate development from the original sand or mud sucker type. It could handle almost any kind of material, excepting bed rock, and transport it through its pipe line for distances as far as three miles away from the scene of operations.

In working out the design of the dredge, the type of power to be used came in for early consideration, whether such power should be purchased from the shore and brought to the dredge by means of transmission lines, or whether it shold be produced on the dredge itself. The extra cost of building transmission lines, erecting transformers and inconveniences in connection with moving the dredge, together with the fact that purchased power uses almost altogether a constant speed motor which is very wasteful, early decided the question, so that this dredge had its power self-contained.

At this point the question arose as to whether the primary power should be from steam or from Diesel engines. The steam turbine was not as efficient in fuel economy for smaller sizes and there was really a dividing line at about 5,000 h.p. below which it could compete with the Diesel engine. In the "General Brock" the Diesel electric drive was chosen operating a 24-inch dredge. The usual amount of power required for the operation of this dredge was from 1,600 to 2,000 h.p., and the power plant accordingly consisted of four 700 h.p. Diesel engines running at 350 r.p.m., each connected to an individual generator.

The dredge had a vertical spud which could be let down so that the shoe at the bottom came in contact with the bed of the river, thus allowing the spud to act as an anchor around which the dredge would swing in carrying on its operations at any one particular point.

The dredge had been designed for work in fairly hard material. In fact, the cutting machinery was one of the main problems in the construction in that it was necessary to have it strong enough to withstand considerable shocks. It was estimated that the thrust at the edge of the cutter knives amounted to from 200,000 to 250,000 pounds. The dredge was well lighted with flood lights for use in carrying on the work at night.

After the speaker had given his address and before the close of the luncheon meeting, the chairman made a brief reference to the retirement from the government service and consequent removal from the city of Ottawa of one of the members who had been most active in the affairs of the local branch. The thanks of the branch, stated the chairman, were due to T. H. G. Clunn, A.M.E.I.C., who had been most assiduous in his work upon the Reception committee and in effecting arrangements for adequately carrying on the regular luncheon and other meetings of The Institute.

Peterborough Branch

F. G. A. Tarr, S.E.I.C., Secretary.
B. Ottewell, A.M.E.I.C., Branch News Editor.

Metal Enclosed Switchgear

At the April 9th meeting of the Peterborough Branch of The Engineering Institute of Canada, F. Kunst, S.E.I.C., of the Switchboard Engineering Department of the Canadian General Electric Company, read a paper entitled "Metal Enclosed Switchgear."

The subject pertains to those forms of switching equipments in which the current carrying parts, such as oil circuit breakers, disconnecting switches, buses, current and potential transformers etc., are enclosed by metal.

Among the subjects included under this heading are found the following: indoor metal clad switchgear, outdoor metal clad switchgear, truck panel type equipments, truck breaker type equipments, cubicle type equipments, outdoor switch house equipment.

Each type of equipment was considered from the viewpoints of fields of application and advantages peculiar to each type.

In order to cover a number of design and construction problems encountered during the course of development one type was selected and analysed.

Comparative costs of a typical installation were offered to assist the hearers in obtaining the proper perspective of these types of equipment.

A number of lantern slides materially assisted in supplementing the written material.

In order to provide material for further consideration of this subject which at present is a very vital one in the electrical industry, a bibliography was included as a supplement to the paper.

E. R. Shirley, M.E.I.C., occupied the chair. F. G. A. Tarr, S.E.I.C., Branch Secretary, assisted at the lantern.

The Manufacture of Refractories

This interesting paper was presented on April 23, 1931, by E. Rigby, superintendent of the Porcelain department, Canadian General Electric Company, Ltd., Peterborough.

A. B. Gates, A.M.E.I.C., presided, and introduced Mr. Rigby as a man with lengthy experience in refractories, both in Canada and in Great Britain.

The presentation of a purely technical subject was considerably aided with moving pictures, which were loaned for the occasion through the courtesy of the Harbison-Walker Company of Pittsburg, while J. R. Stirling, the company's Canadian representative, was also present and contributed to the very instructive and interesting programme.

The series of films showed the complete process of the manufacture of refractories, of fire resisting materials, from the mining of the raw materials to the shipping of the final product, refractories having become a highly specialized branch of the porcelain and electrical industries.

The tunnel kiln has now come to be largely adopted by manufacturers of refractories, who have an exceedingly large volume of business, but the more common type of kiln is the periodic kiln.

Refractories play an important part in modern industry, in providing furnace linings, where it is essential that such structures must be capable of withstanding high temperatures. Unusual care is taken to make every brick perfect, and many of the more intricate shapes are made entirely by hand, instead of being moulded in the hydraulic presses, which are in common use for the less complicated moulds.

The address was followed by an interesting discussion, and the meeting concluded with a hearty vote of thanks to Mr. Rigby for his address.

Saint John Branch

G. H. Thurber, A.M.E.I.C., Secretary-Treasurer.

Visit to New Power Plant of N.B. Electric Power Commission

A joint inspection trip by the Saint John Branch members of The Engineering Institute of Canada and the Engineering Society of the University of New Brunswick was made to the power plant now under construction for the New Brunswick Electric Power Commission at Newcastle Creek, Queens County, N.B., on April 16th, 1931.

Members of the Saint John Branch joined the students of the University at Fredericton and left by special train for Newcastle Creek.

The Grand Lake power station of the New Brunswick Electric Power Commission is located at Newcastle Creek, on the shore of a lake, within four miles of the centre of the Grand Lake coal fields. The plant had to be located on the shore of the lake in order to obtain sufficient condensing water for the present installation and future extensions.

The Commission have taken over or built about one and one-half miles of railway line to connect the plant with the Fredericton and Grand Lake coal and railway system, and the railway has put in effect a freight rate on coal which will be the same from all mines in the district. It is expected that about 20,000 tons of coal will be used initially.

The plant is one of the most up-to-date and complete units of its kind in Canada, all equipment being in duplicate. The most modern features are incorporated in the design, including mechanical equipment for handling coal and disposing of ashes.

The power station is to have an initial capacity of 5,000 kw. It is anticipated that this plant will produce power, for the purposes required, at a lower cost than could be obtained from any undeveloped water power site in the province.

The design and construction of the plant has been supervised by the United Engineers and Constructors (Canada) Ltd., and Dr. John Stephens, M.E.I.C., of the University of New Brunswick, has been consulting engineer to the Commission.

The Commission is under contract to supply power to the Maritime Electric Company at Fredericton, and to the Canadian Cottons Ltd., at Marysville, beginning September 1st next. They anticipate no difficulty in having the plant in operation before that date. Their transmission lines are now being built to Fredericton. A transmission line is also to be built to Moncton which will link up with the transmission line from Saint John and the Musquash Hydro-Electric Plant to provide a reserve capacity to take care of possible low water conditions at Musquash and to supply sufficient power for rapidly growing system demand.

The New Brunswick Electric Power Commission held a luncheon on completion of the trip of inspection. Speakers at this luncheon included Hon. C. D. Richards, Minister of Lands and Mines of the Province of New Brunswick; F. J. Robidoux of Shediac, member of the New Brunswick Electric Power Commission; S. R. Weston, M.E.I.C., Chief Engineer of the Commission; J. M. Woodman of Saint John, Superintendent of the New Brunswick District, Canadian Pacific Railway; C. C. Kirby, M.E.I.C., District Engineer of the Canadian Pacific Railway; Stewart Bull, President of the Engineering Society of the University of New Brunswick, and W. R. Johnston, A.M.E.I.C., Chairman of the Saint John Branch of The Institute.

Annual Dinner Meeting

The annual dinner meeting of the Saint John Branch was held at the Riverside Golf and Country Club on May 5th, 1931.

The meeting, which was largely attended by members and their guests. was presided over by the chairman, W. J. Johnston, A.M.E.I.C.

After the toast to the King, the toast to the City of Saint John was proposed by C. G. Clark, S.E.I.C., and responded to by His Worship Mayor W. W. White, M.L.A. His Worship recalled the early days of the city and in comparing them with the city of today declared that members of the engineering profession have been responsible for the great change which has taken place. He wished the Branch every success.

The toast to Our Guests was proposed by R. D. H. Wigmore, A.M.E.I.C., and responded to by Dr. W. J. Wright, Provincial Mineralogist and Professor of Mineralogy at the University of New Brunswick, and R. Hugh Bruce.

The toast to The Engineering Institute of Canada was proposed by Geoffrey Stead, M.E.I.C., and responded to by G. G. Murdoch, M.E.I.C. In replying to this toast, Mr. Murdoch told of the founding of the organization 40 years ago and something of its history.

During the business meeting held directly after the dinner, the reports of the various committees were received and adopted. The report of the Natural Resources and Engineering Industries committee, prepared by F. P. Vaughan, M.E.I.C., the chairman, and read by J. L. Feeney, A.M.E.I.C., in the absence of Mr. Vaughan, showed in part a closer accord between the Department of Lands and Mines and the provincial university and expressed the opinion that much could be accomplished in the application of these resources to industry if the services of the chemical and mining engineer be fully utilized. The tourist industry offers as good an opportunity as any to our people, and to this end our public services must not only be maintained but improved.

A. R. Crookshank, M.E.I.C., chairman of the Town Planning committee, said that he was glad to report that the town planning scheme for the city of Saint John was now in the last stages and only needed to be proclaimed by the Lieutenant-Governor-in-Council. He said that those interested looked forward to seeing it put in operation this year, as they had been assured that it would be dealt with by the provincial government at an early meeting.

Votes of thanks were extended to W. J. Johnston, A.M.E.I.C., the retiring chairman, A. A. Turnbull, A.M.E.I.C., the retiring secretary-treasurer, last year's executive, the Saint John Board of Trade and the Press.

The election of officers for the ensuing year resulted as follows:

Chairman	J. N. Flood, A.M.E.I.C.
Vice-Chairman	A. A. Turnbull, A.M.E.I.C.
Secretary-Treasurer	G. H. Thurber, A.M.E.I.C.
Executive	V. S. Chestnut, A.M.E.I.C.
	J. T. Turnbull, A.M.E.I.C.

Following the business meeting a social evening of cards and music was enjoyed.

Mr. Johnston, in his address as retiring chairman, thanked the Branch executive and chairmen of the committees, also Mr. Turnbull, the efficient Branch secretary, and noted with pleasure the interest in The Institute's affairs which had been maintained in the Branch.

Inauguration of the Saint John Branch

On March 7th, 1918, a paragraph appeared in the Saint John *Times* as follows: "Civil Engineers to have Society in City—A meeting of the local members of the Canadian Society of Civil Engineers was held today for the purpose of meeting Fraser S. Keith, M.E.I.C., Secretary of the Society, and of forming themselves into the Saint John Branch of the Society." Those present at this meeting were as follows: E. T. P. Shewen, M.E.I.C., A. Gray, M.E.I.C., C. C. Kirby, M.E.I.C., W. Colin Ewing, A.M.E.I.C., J. K. Seammell, M.E.I.C., H. H. Donnelly, A.M.E.I.C., G. N. Hatfield, A.M.E.I.C., R. H. Cushing, M.E.I.C., A. B. Blanchard, M.E.I.C., G. G. Murdoch, M.E.I.C., G. G. Hare, M.E.I.C., A. R. Crookshank, M.E.I.C.

Shortly after this, the name of the Society was changed to "The Engineering Institute of Canada" and on May 7th, 1918, the first officers of this Branch were elected as follows:

Chairman	A. Gray, M.E.I.C.
Secretary-Treasurer	A. R. Crookshank, M.E.I.C.
Executive Committee	J. A. Grant, A.M.E.I.C.
	C. C. Kirby, M.E.I.C.
	G. G. Murdoch, M.E.I.C.

At this time, the total membership of the Branch was 23.

Engineering Conditions in New Brunswick, 1931

Motor traffic originating beyond the boundaries of the province, namely tourist traffic, has created a business which surpasses even that of the development of most of its natural resources. Power facilities of the province are being greatly developed. One should note not only an increase in hydro-electric power development, but also the increase in the number of steam plants, the two most recently built steam plants being located within the city of Saint John and at Grand Lake to utilize Minto coal. This development is lessening the drudgery of farm life and other industries, and in this way the engineer is helping industry and his assistance is a distinct benefit to the province.

The harbour of Saint John is to a great extent being further improved by channel dredging and a large port development is in progress at Carleton.

In the municipal field one notes further mileage of paved streets year by year, improvements in water supply, extensions of sewerage systems and other municipal improvements in the cities and towns of the province of New Brunswick.

In the railway field, heavier rolling stock and greater speeds demand further improvements and betterments to the various railway systems.

Vancouver Branch

W. O. Scott, Jr.E.I.C., Secretary-Treasurer.

At the meeting of March 25th, 1931, J. P. Hodgson, M.E.I.C., gave a brief talk on "The Addition to the Jordan River Power Plant of the British Columbia Electric Railway Company, Limited, on Vancouver Island." This was accompanied by moving pictures which showed the detail of field operations in connection with the erection of pipe line No. 4.

This pipe line was fabricated locally and enumerated below are a few of the details:—

1. Head in feet, 1,150.
2. Length in feet, 9,482, composed of the following units:—
   a. 60 inch diameter—4,809 feet
      54 " " —1,990 "
      48 " " —2,683 "
   b. From the forebay 3,500 feet was lap-riveted and remainder down to power house, 5,982 feet, was butt-riveted.
   c. Plate varied in thickness from 3/8-inch at upper end to 1-1/16-inch at lower end.
3. There were 20 expansion joints, generally about midway between anchors.
4. The pipe is entirely above ground and supported on concrete piers, in general about 18 inches high and numbering approximately 360.
5. At vertical bends reinforced concrete anchors were placed numbering 21 in all.

Messrs. Hodgson, King and Marble of Vancouver, B.C., were the general contractors and the field erection of the pipe line was sub-let to the Vancouver Engineering Works.

An additional film was shown after the above of the installation of the Ladner, B.C., distribution system and the construction of a reinforced concrete reservoir.

Among those taking part in the discussion were Messrs. A. C. R. Yuill, M.E.I.C., C. Brakenridge, M.E.I.C., P. H. Buchan, A.M.E.I.C., J. Oliver, Jr.E.I.C. and W. O. Scott, Jr.E.I.C.

A joint luncheon meeting of the Vancouver Branch of The Engineering Institute of Canada and the Association of Professional Engineers of British Columbia was held in honour of the visit of tthe Institute President, S. G. Porter, M.E.I.C., on April 16th, 1931, at 12.15 p.m., in the Hudson's Bay dining room. There were sixty present.

H. B. Muckleston, M.E.I.C., occupied the chair and introduced the speaker.

THE ENGINEERING PROFESSION

S. G. Porter, M.E.I.C., expressed himself as pleasurably surprised to be able to speak to such a luncheon gathering during his short stay, as his trip was entirely unofficial.

Mr. Porter chose as his topic "The Engineering Profession," and a summary of his remarks follows:—

"The engineer's place in our social structure is particularly important because of the newness of our country and the vastness of its resources.

"The engineer is by nature a pioneer. He makes ready the way for civilization. He it is that combines the forces of nature, the discoveries of science and applies them to the needs of luxury-loving civilization.

"Present conditions afford a great opportunity and at the same time impose a great responsibility on the engineer. You occasionally hear the complaint voiced by engineers that they do not receive the recognition to which they are entitled from the public. This is no doubt true. The debt of civilization to the engineer is indeed beyond measure. He is human and vain enough to want some recognition and credit for that which he has done. After all is it not largely his own fault? Is he assuming his due share of the responsibility of shaping public policies and bearing the burdens of citizenship in his community? If his training fits him for the task of supplying to the public the utilities and the industrial facilities which it demands, does it not also qualify him for a voice in formulating the policies and directing the course of the activities of these bodies which govern and control us? The obligations of citizenship demand that we capitalize our engineering skill and the influence of our personality for the benefit of the community of which we are a member.

"Also, we owe a duty to our profession. The engineer who selfishly sticks to his own narrow job without regard to the welfare of his fellow-engineers is not meeting his full responsibility. He should be as keenly interested in the development of high ethical standards and of professional pride and loyalty as in his own personal success. A greater unity and solidarity in the profession are outstanding needs of the engineers of Canada today. How can we expect our voice to be heard and heeded unless it has behind it the force that can only come out of unity and solidarity. If all the engineers of Canada, working in harmony and professional loyalty, could provide a Dominion-wide medium for expressing the viewpoint of the engineering profession they would exert an influence otherwise unattainable both on public opinions and on legislature which affects, not merely the welfare of the engineers themselves, but the safety and welfare of the public where construction operation or control of engineering works and public service utilities are governed by legislative enactment. Such a condition would also result in greater public recognition and more favourable publicity which would create greater confidence in Canadian engineers and enable them to compete more successfully with outside engineers. All this would result in a reflex influence on the profession itself in creating a stronger professional consciousness and esprit de corps among engineers comparable to that existing in other professions."

At the conclusion of the speaker's remarks G. A. Walkem, M.E.I.C., M.L.A., very ably moved a vote of thanks, and was seconded by A. S. Gentles, M.E.I.C.

STUDENT SECTION

R. V. Anderson, S.E.I.C., Secretary.

The activities of the Student section of the Vancouver Branch for the second half of the University year are summarized as follows:—

Jan. 7.—Maj. W. G. Swan, M.E.I.C. "Engineering Aspects of Vancouver Harbour."

Jan. 14.—J. W. Kelly, Portland Cement Association. "Research Applied to Concrete."

Jan. 21.—Mr. Perry. "Motion pictures of the blasting into place of the Obelisk at Chute-à-Caron."

Jan. 21.—Annual Dinner.

Feb. 11.—Maj. J. C. MacDonald, M.E.I.C., President of the Professional Engineers of B.C., 1931. An illustrated lecture on "Water Power in B.C."

Feb. 18.—Dr. Perry Barr. "Forest Research."

Feb. 25.—H. B. Muckleston, M.E.I.C., Vice-President of The Engineering Institute, 1931. "Relativity, its Meaning and Consequences."

Feb. 25.—Student Night.

Mar. 4.—W. H. Powell, M.E.I.C. Illustrated lecture on "Vancouver's Water Supply."

The following field trips were taken since the beginning of the new year:—

Feb. 7.—Inspection of C.P. S.S. "Empress of Japan," holder of world's record for crossing the Pacific, Yokohama to Vancouver, in eight days, 3 hours, 18 minutes.

Mar. 14.—Trip to C.P.R. tunnel being built under the business section of Vancouver for steam railway traffic.

STATEMENT—1930-1931

	Debits	*Credits*
Dec. 20, 1930—Received from Vancouver Branch		$ 5.00
Jan. 21, 1931—Sale of tickets, 32 at $1.00......		32.00
Acct. Love's Cafe—32 dinners at $1.00....................	$32.00	
Gratuity, cigarettes, etc........	3.00	
Complimentary tickets.........	2.00	
Acct. Gehrke's — 50 banquet tickets.....................	2.40	
Feb. 25, 1931—Received from Vancouver Branch		6.00
Acct. R. Anderson — stamps, phones, transportation, slides for student night............	3.50	
	$43.00	$43.00

Coal

Raw Material for Chemical Manufacture

Science is just beginning to reveal coal as destined to become the foundation for vast industrial chemical operations. Its first use was as fuel. Of the 600,000,000 tons produced yearly in the United States, five-sixths is still used raw.

Far from being a simple substance, coal is a complex mixture of chemical compounds, largely hydrocarbons, together with such impurities as ash, moisture, and sulphur. Very little carbon as such exists in coal. This complex nature makes it easier to understand the transformations that occur when coal is distilled in coke ovens, such distillation being historically the second important step in the utilization of coal.

When distilled, coal yields coke, an essential raw material in blast furnace operations and in production of water-gas; coal gas or coke oven gas, valuable as a fuel and as a source of hydrogen for the synthesis of ammonia; ammonia, recovered as a water solution or combined with sulphuric acid to form sulphate of ammonia, the second most important nitrogenous fertilizer; benzol, raw material for various organic syntheses, also a motor fuel of valuable anti-knock properties; and coal tars, well known as raw material for synthetic organic chemical manufacture. About 15 per cent of the United States coal production is distilled, mostly in by-product coke ovens of efficient design.

There are under development uses for coal certain to be of vast importance to civilization, since they will assure indefinitely certain essential commodities, the chief being gasoline and lubricating oils, heretofore obtained solely from petroleum. Coal is destined to be the most important raw material ever available to chemical industry. Starting with coal, proceeding thence to water-gas (largely hydrogen and carbon monoxide), we have a material that is the immediate starting point in the synthesis of ammonia, of alcohols, and of motor fuels. Under suitable conditions of heat and pressure we can combine the hydrogen derived from water-gas with coal itself thus obtaining synthetic gasoline and other hydrocarbon oils comparable in utility with the present products from petroleum.

Use of coal as a raw material for chemical manufacture is the direct result of research, principally in Germany and to lesser extent in France, Great Britain, and the United States. The initial coal hydrogenation studies specifically should be credited to the Kaiser Wilhelm Institute for Coal Research in Mulheim-Ruhr, Germany. In these laboratories was conceived the idea of adding hydrogen molecules to the solid hydrocarbons of coal, thus obtaining liquid hydro-carbons similar to the fractions of petroleum. Hydrogen is combined with the powdered coal at elevated temperatures and at a pressure of several hundred atmospheres. The inherent mechanical problems are extremely difficult. The coal is introduced into the pressure or reaction chamber in the form of paste, made by incorporating the powdered coal with some of the heavy oil produced in the reaction. This paste is actually pumped into the system and in similar manner the ash and heavy oils resulting from the reaction are removed.

Separation of this crude oil into its constituents is accomplished in the same manner as in the treatment of petroleum. This process of hydrogenating coal has not yet been exploited generally because of the present surplus of petroleum in nearly all parts of the world. However, the Interessen Gemeinschaft Farbenindustrie (commonly known as the German Dye Trust) has expended millions of dollars on the process, which is now in production on a large factory scale.

Little imagination is required to forecast the economic and political significance of coal hydrogenation. Countries that do not possess adequate supplies of petroleum and gas, as for example, Germany, will be enabled to become self-sufficient in motor fuels and oils. Most important of all, however, future generations in all countries need not fear that the possible eventual decline of petroleum resources will cause difficulties and inconvenience. Relative to petroleum, coal appears to exist in virtually inexhaustible quantities widely distributed, and therefore is the logical economic basis of all fuel supplies whether solid, liquid, or gaseous. These new and large possibilities for the utilization of coal have come about with comparative suddenness and are attributable directly and entirely to the vision and genius of the research chemist.—Chaplin Tyler, B.Ch.E., B.B.A., M.S., in Research Narratives of The Engineering Foundation, New York, N.Y.

Civil Aircraft Accident Report on Miscellaneous Flying in the United States for the Last Six Months of 1930

A decrease in the number of passenger fatalities and an increase in the number of miles flown per passenger fatality in miscellaneous flying operations for the period July to December, 1930, is shown in the semi-annual report of the Aeronautics Branch on accidents to civil aircraft. The number of passenger fatalities was 104 and as the miles flown totaled 56,502,560, the miles flown per passenger fatality were 543,294.

While there was an improvement in the passenger fatality phase of miscellaneous flying, the number of accidents both fatal and non-fatal increased, bringing about a decrease in the number of miles flown per accident over the corresponding previous period. There were 1,116 accidents involving 2,021 persons, including pilots, members of crews, passengers and persons on the ground. Of this total 258 were fatally injured, 145 were severely injured, 277 received minor injuries and 1,341 were not injured in any way.

Miscellaneous flying for the purposes of this report, is divided into four classes: Miscellaneous commercial, pleasure, student instruction and experimental flying. Miscellaneous commercial includes such operations as charter flights, aerial photography, sightseeing, crop dusting and exhibition flying. Pleasure flying means operation of planes privately owned for pleasure only. Student instruction and experimental flying include operations implied by those terms.

The number of accidents in miscellaneous operations is more than twenty times greater than those reported for scheduled air transportation for the same period, but this is due primarily to the fact that there are more miscellaneous planes in operation; and they fly a greater total mileage and engage in a wider variety of operations.

Aircraft in miscellaneous operations are flying only about one-eighth as many miles per accident (including accidents of all kinds) as are those employed in scheduled air transportation. The total number of miles flown by aircraft in non-scheduled operations was nearly three times as great as the number of miles flown by air line craft in the last half of 1930, but there were 1,116 miscellaneous flying accidents as against 47 in scheduled operations. A comparison of the trend in scheduled flying, taken from the accident report on scheduled air transport operations in the Air Commerce Bulletin of April 1st, 1931, volume 2, No. 19, with that for miscellaneous operations follows:

	Miles Flown per Accident		
	July-December 1928	July-December 1929	July-December 1930
Scheduled Operations.......	121,350	209,739	426,436
Miscellaneous Operations...	74,883	72,165	50,630

NOTE:—Direct comparisons are made for corresponding periods because weather conditions during the last 6 months of the calendar year usually are more favourable for flying than during the first 6 months.

Of the total number of accidents occurring in miscellaneous operations during the 3-year period, it was found that the largest percentage—42.23—occurred in pleasure flying, and the next largest 38.45, in miscellaneous commercial flying. Student instruction was charged with 15.83 per cent of the accidents and experimental flying with 3.49 per cent.—*U.S. Air Commerce Bulletin.*

Neon Signs

The Neon sign is simply a gas-filled glass tube through which a high voltage current of electricity is passed, producing a luminous glow.

Neon gas was discovered by Messrs. Ramsay and Travers, English scientists, in 1898, but it was not put to practical use until several years later, when Professor Claude of France perfected a method of obtaining the gas in commercial quantities. It is of the same family as helium and argon, and is present in the atmosphere in the proportion of one part of Neon to 66,000 parts of air. It is colourless, odourless and tasteless, and is secured by means of the distillation of liquefied air. The supply of gas comes from France and Germany and is shipped in glass litre containers at atmospheric pressure costing in the neighbourhood of $24. per litre, which is sufficient for about 700 feet of 15 mm. tubing. The glass used in the tubing is a high grade, specially produced for this particular application. The popular sizes are 3, 12 and 15 mm. in diameter or approximately ⅛, ½, and ⅝ inches, the ½-inch tubing being used in the majority of signs in Ontario.

The glass tubing is formed into letters or designs with sections averaging perhaps 6 to 8 feet and invariably limited to 12 feet, on account of the difficulty of producing a suitable vacuum in greater lengths. The electrodes, usually copper and in one of several patented forms, are then attached and the section evacuated. When a proper vacuum is obtained the tube is "bombarded" by the application of high voltage (usually 6,600 volts) which heats up the glass and burns out any impurities, following which the gas is admitted through an ingenious arrangement of traps and filters, and the tube is tested and sealed.

The natural colour of the Neon tube is orange red, but practically any colour can be obtained by the introduction of other gases combined with coloured tubing. Blue is obtained from a combination of argon and Neon, known to the trade as B10 gas, with a small quantity of mercury added to give density. This gas, when used in yellow tubing, produces a green colour. The tube gives off practically no heat which accounts largely for its economy of operation. The gas does not burn up, and the tube has a life of from 15 to 20 thousand hours, although difficulties are encountered in the way of fading, due principally to leakage with a resultant reduction in the original vacuum. Experiments are being conducted in an effort to produce a white light, and if successful, it is claimed that interior lighting will be radically changed. The natural red Neon colour, having a long wave length, possesses high penetrating power which makes it especially attractive in daylight or fog, and it is being applied quite extensively to beacon lights for airports.

The tubes require an extremely high voltage, and the 110-volt supply is stepped up as high as 15,000 volts, the present day Ontario practice being confined to the use of three transformers with secondary voltages of five, twelve and fifteen thousand volts, and with respective volt-ampere ratings of 150, 350 and 450. With secondary operating current of only 25 milliamperes the signs cannot be considered as particularly dangerous, and the life and fire hazard is reduced to a minimum in Ontario due to our rigid standards.

The size and number of transformers to be used is determined from the length of the various sections of tubing in the sign, on the basis of the following approximate figures for ½-inch tubing operating at 25 cycles:

5,000-volt transformer, 9 to 11 feet.
12,000-volt transformer, 25 to 27 feet.
15,000-volt transformer, 35 to 40 feet.

For 60 cycles the lengths may be increased by approximately 20 per cent, and increased or decreased for the ⅝-inch or ⅛-inch tubing in the direct ratio of the diameters. The loading is approximately 8 watts per foot of tubing for the ½-inch size and 6 watts for ⅝-inch. A sign having a total of 160 feet of ½-inch tubing and operating at 25 cycles would require the equivalent of at least four 15,000-volt transformers, but the design of the sign, or the combination of the small 6-and 8-foot sections might necessitate one or more additional transformers. The sections of tubing are connected in series across each individual transformer, and the various transformers are paralleled on the low voltage supply. A 25-cycle transformer with a 15,000-volt rating weighs approximately 40 pounds, and costs the sign manufacturer about $19.

A Neon sign is decidedly heavier than an equivalent incandescent sign, and the capital cost is perhaps double. They are invariably sold at a price computed on the total length of tubing, ranging in the neighbourhood of $7 per foot, which covers the complete sign including transformers and erection. It is very difficult to get a definite basis of comparison as regards operation and maintenance, but it is a generally accepted fact that the cost of a Neon sign over a period of five years will be only about 25 per cent of the cost of an incandescent sign.

The transformers used for Neon signs have an inherently high reactance with a resultant low power factor. Tests recently conducted by an American power company on 611 straight Neon signs showed total volt amperes approximately 2¼ times total watts, giving a power factor of 44 per cent, with an average loading of 642 watts per sign. On another group of 330 Neon signs containing one or more incandescent lamps, the average power factor was 68 per cent. On the total of 941 signs the average power factor was 52 per cent. This naturally imposes a serious burden on the distribution system, and if billing is solely on the basis of kilowatt-hours, the consumer does not take his proper share of the cost. The regulations in Ontario call for a volt-ampere rating on the sign equivalent to the total rating of the individual transformers, so that as far as demand or installed capacity on a straight Neon sign is concerned, the power company is probably protected, and, even though the energy is measured in watt-hours, the apportioning on the basis of a volt-ampere demand seems reasonably fair.

The Neon sign may be classed as a commercial commodity with almost unlimited possibilities and the number is rapidly increasing from day to day.

—*The Bulletin of the Hydro-Electric Power Commission of Ontario*

"Advance Guards," recently issued by the Canadian Westinghouse Company, is a bulletin which is of great interest to every engineer connected with the transmission and distribution of electric power. It discusses fully the subject of lightning hazards on various types of systems and the many methods of eliminating them. The manufacturer will be pleased to send you a copy; ask for Circular 1737-F.

An interesting shipment of concrete reinforcing 1¼-inch square bars, 87 feet 6 inches long, was recently made from the Hamilton works of the Steel Company of Canada, Ltd., to the Stanley Construction Company of Hamilton, for use in connection with the erection of a new low level bridge at Hamilton.

Preliminary Notice

of Applications for Admission and for Transfer

May 20th, 1931.

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 July, 1931.

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

ABRAMSON—ISAAC ALBERT, of Seebe, Alta., Born at Winnipeg, Man., Feb. 12th, 1908; Educ., B.Sc. (E.E.), Univ. of Alta., 1929; 1929, mtce., Ghost River development; 1929-30, floorman, and 1930 to date, operator, Calgary Power Company, Seebe, Alta.

References: G. H. Thompson, H. J. McLean, C. A. Robb, R. S. L. Wilson, H. B. Sherman, W. R. Mount, H. J. MacLeod.

BLAKE—WILLIAM HENRY, Capt., R.C.E., of 81 Orange St., Saint John, N.B., Born at Pontefract, England, July 17th, 1890; Educ., 1920-22, complete course, School of Military Engineering, Chatham, England. All military qualifications by exam. up to the rank of Major of Engineers, including technical subjects; 1906 to date, with the Royal Canadian Engineers, as follows: 1906-09, at Halifax, N.S.; 1909-15, at Kingston, Ont.; 1915-19, overseas; 1922-27, works officers, M.D. No. 2, Toronto; 1927-31, district engineer officer, M.D. No. 12, Regina, Sask.; at present, district engineer officer, M.D. No. 7, Saint John, N.B.; (1918, Lieut., C.E., 1920, Lieut., R.C.E., 1927, Capt., R.C.E.)

References: W. B. Lindsay, A. C. Caldwell, H. T. Hughes, J. L. H. Bogart, A. C. Garner, J. W. D. Farrell, A. P. Linton, G. R. Turner.

BROWN—THOMAS, of 630 Byng Road, Walkerville, Ont., Born at Barrow-in-Furness, England, May 16th, 1885; 1910-12, shop clerk, American Bridge Co., Ambridge; 1912-18, Canadian Bridge Co. Ltd., Walkerville, Ont., Bundling, shipping, testing of acids, etc., later in charge of galvanizing shop. 1914, storekeeper and shipper, in charge of Govt. supplies for shell making and attendant reports; 1918-22, Ford Motor Company, Walkerville, Ont., mech'l. dftsman.; 1922-23, mech'l. dftsman., General Motors, Walkerville, Ont.; 1923-26, inspr. in tool room, Ford Motor Company, Highland Park, Detroit; 1926 to date, estimator and dftsman., T. J. Eansor and Sons Limited, (Structural Steel and Misc. Iron Work), Windsor, Ont.

References: L. M. Allan, A. E. West, F. H. Kester, R. A. Spencer, H. J. A. Chambers, M. E. Brian, H. C. McMordie, W. A. Messenger.

CAREY—CYRIL JOSEPH, of St. John's, Nfld., Born at Halifax, N.S., Oct. 22nd, 1905; Educ., 1925-29, night and part day classes, Memorial University College, St. John's, Nfld.; Passed Sections A (1929) and B (1930) of the Inst. of Civil Engrs. (London, Eng.) Associate Membership examinations. 1925 to date, with Nfld. Highroads Commission in the office of the Government Engineer, as follows: 1925-28, pupil to T. A. Hall, M.Inst.C.E., design and constrn. of engrg. works; 1928-30, gen. drawing and office work, testing of materials, setting out and supervision of works, installn. of heating systems and sewage disposal works, gen. arch'l. work; 1930 to date, engrg. (civil) asst., in charge of all survey and levelling work, Govt. Engr's. Dept., and chief dftsman., Nfld. Highroads Commn., St. John's, Nfld.

References: E. W. Neelands, J. W. Morris, F. W. Angel, J. B. Baird, A. Vatcher.

CARPENTER—EDWARD STANLEY CAMERON, of 198 Leopold Crescent, Regina, Sask., Born at Gamebridge, Ont., June 2nd, 1904; Educ., B.Eng., Univ. of Sask., 1929; Summer work: 1921-22, rodman with highway constrn. party; 1924-25, dftsman., with topog'l survey party; 1926, instr'man., with highway constrn. party; 1927, timekpr., waterworks dept., City of Regina; 1928, engr., Montreal Engineering Company; June 1929 to Mar. 1930, instr'man. on C.P.R. constrn.; April 1930 to date, res. engr., Dept. of Highways, Prov. of Sask., Regina, Sask.

References: H. S. Carpenter, H. R. MacKenzie, W. W. Perrie, O. Inkster, C. J. Mackenzie.

EASTWOOD—DONALD ROSS, of Toronto, Ont., Born at Marmora, Ont., March 26th, 1897; Educ., B.A.Sc., Univ. of Toronto, 1927; Mar. 1921 to July 1922, assembling and repairing meters, Lincoln Meter Co.; 1925 (May-Sept.), installing telephone exchanges, Northern Electric Co.; 1927-28, student course, Can. Gen. Elec. Co.; 1926 (May-Sept.), foreman on installn. of converters and transformers, Aluminum Co. of Canada; 1928-29, asst. to erecting engr., and Feb. 1929 to date, erecting engr., Can. Gen. Elec. Co., in charge of contracts for substations, generators, elevator equipments and all movable bridge equipments, Toronto, Ont.

References: G. N. Thomas, W. A. Bucke, W. E. Ross, A. B. Gates, M. B. Atkinson.

FENNIS—ALBERT M., of 468 John St., Niagara Falls, Ont., Born at Hilversum, Holland, June 4th, 1900; Educ., 1920-23, Ingenieur Schule, Zwickau, Saxony. Elect'l. Engr., March 1923; 1918-20, layout and installation of transmission lines and substations, Provincial Power Company, of the Province of North Holland, Hilversum, Holland; 1923 (Apr.-July), volunteer, Zwickau Electric Motors Co. of Zwickau, Saxony; 1923-25, with the Control Commission of the Ruhr Occupation, Cologne, Germany, in charge of elect'l. equipment and repair shop at the Liblar Mine, during the occupation by the Control Commission; 1925-26, installation of hydro-electric plants in Southern France for the General Electric Co. of Lyons, France; 1927-28, design of radio apparatus, Northern Electric Co. Ltd., Montreal; Jan. 1928 to date, plant layout, conveying and elevating machinery layout, struct'l. steel design, American Cyanamid Company, Niagara Falls, Ont.

References: S. R. Frost, G. M. Hamilton, A. W. F. McQueen, R. L. Hearn, C. G. Cline, W. S. Orr, W. Jackson.

FOWLER—JAMES, of Calgary, Alta., Born at Hawick, Scotland, Dec. 19th, 1887; Educ., M.A., B.Sc., Edinburgh Univ., 1910. 1921 to date, head of Science Dept., and at present, vice-principal, Institute of Technology and Art, Calgary; Part time work: 1923-29, frequent gas analyses for Canadian Western Power Light & Heat Co.; 1924, Research work for Imperial Oil Limited, Calgary; 1925 and 1927, chemical analysis of shales for Canada Cement Co., Exshaw, Alta.; 1928-30, testing of gasoline for Regal Oil Co., Calgary; 1923-28, analysis of coals for Mohawk Coal Co., Calgary; 1925-28, analysis of coal for Wilson Coal & Coke Co., Calgary; 1922-31, analysis of many samples of oil and motor fuel for tractor firms, farmers, and others, throughout Alberta; 1924-29, analysis of various samples of anti-freeze for Motor Car Supply Co., Calgary; 1929-31, in charges of laboratory and running tests in connection with Provincial Oil Survey.

References: W. D. Armstrong, W. Anderson, C. C. Richards, W. H. Broughton, F. N. Rhodes, J. J. Hanna.

HAY—CHARLES CECIL, of Lumsden, Sask., Born at Kingston, Ont., June 28th, 1902; Educ., B.Sc. (C.E.), Univ. of Sask., 1925; With C.P.R., Saskatoon, as follows: 1923 (5 mos), rodman; 1924 (5 mos.), transitman; 1925 (7 mos.), B. & B. Dept.; 1926 (6 mos.), transitman, Moose Jaw; 1926-27, instructor in engrg. classes, Univ. of Sask.; 1927 (8 mos.), Gibb Bros., contractor; 1928 (4 mos.), transitman, C.N.R. water supply dept.; Manager of Gibbs Bros., & Hay Ltd., Contractors and Engineers, since company was formed in May 1928, to date. Work consists of constrn. of water supplies for C.N.R., railway branch lines and provincial highways. Company is also qualified to act in the capacity of consulting engineers.

References: J. L. Charles, T. C. Main, J. M. Campbell, C. J. Mackenzie, J. J. White.

NOBLE—GEORGE, of Sarnia, Ont., Born at Wednesbury, Staffs., England, Feb. 3rd, 1901; Educ., B.Sc., (Hons.), (Civil Eng.), Univ. of Birmingham, 1926; (Assoc. M.I.Struct.E.); With Patent Shaft & Axletree Co. Ltd., Wednesbury, England, as follows: 1914-17, jr. dftsman. in bridge dfting room; 1917-22, plant dftsman., gen. mtce., plant layouts, levelling, pegging out sites, etc.; 1923-24-25 (summers), design and details of plate girder and lattice bridges; 1926-1930, with Rendel, Palmer & Tritton, consltg. engrs., London, England, as follows: 1926-27, asst. in bridge and struct'l. dept., calculations and design of loco. shops for Indian State Rlys.; 1927-28, inspr. of steelwork and bridgework in Glasgow and district; 1928-30, preparation of estimates and erection schemes for bridge over Meglina River, India, analyses of stresses in various bridges, strengthening schemes for bridges for increased train loading, design of piers and well curbs, design of foundry bldg. complete with charging platform, sand bunks, etc., estimating design for floating bridge, etc., in India; May 1930 to date, dftsman., Imperial Oil Refineries, Ltd., Sarnia, Ont., plant layouts, steel structures, docks, design of refinery equipment, etc.

References: T. Montgomery, C. B. Leaver, J. W. MacDonald, L. S. MacDonald, H. A. McKay.

SAMUEL—MYRON, of 118 Spadina Road, Toronto, Ont., Born at Liban, Latvia, Nov. 8th, 1898; Educ., Engrg. Diploma, Engineering College of Danzig, 1924; 1919-20, ap'ticeship, with V. F. Matisons Machine Works, Liban, and Danziger Shipbldg. and Engrg. Corpn.; 1923 (Apr.-Aug.), Sawmill and Lumber Transport and Shipping Co., Danzig, consltg. work in connection with installn. of new equipment, etc.; 1926-27, S. Bahr & Mathew, Shanghai, China, in charge of frozen egg dept., mixing, filling, freezing, and tin box making plant; May 1927 to date, Canadian representative of J. I. Bernitz (machinery importers) of New York and Toronto (conducting negotiations leading to sale of equipment, making estimates and giving engrg. advice, appraising used equipment, conducting acceptance tests, demonstrating machinery, etc.).

References: N. M. Hay, W. F. McLaren, H. A. Ricker, H. M. Jaquays, W. G. Milne, E. Maybee.

VARLEY—PERCY, of 1464 Leclaire Ave., Montreal, Que., Born at Leeds, Yorks, England, Oct. 11th, 1900; Educ., Evening classes, Montreal Technical School. I.C.S. Diploma in Elec. Engrg.; 1915-21, 4 years ap'ticeship and 2 years dftsman., naval electr'l. dfting., design and detailing installns. and equipment at Canadian Vickers Limited; 1922-23, mech'l. dfting., refrigerating plant layouts and detailing ammonia compressors, Linde Canadian Refrigeration; 1923-24, locomotive dfting., design and detail of locomotive boilers, Montreal Locomotive Works, Ltd.; 1924-26, arch'l. dfting (principally tracing), Canadian Benedict Stone Co. Ltd.; 1926-28, locomotive dfting., standardizing locomotive parts, C.N.R.; Sept. 1928 to date, elect'l. dftsman., industrial plant elect'l. layout and design, Canadian Industries Limited. (First year at Sandwich, Ont., as asst. engr. and dftsman, installing extension to power plant, under H. A. Wilson, tech. engr.)

References: L. deB. McCrady, I. R. Tait, H. C. Karn, A. B. McEwen, W. H. DeBlois, L. H. Birkett.

WILHJELM—FRITS ERIK, of Cape Tormentine, N.B., Born at Odense, Denmark, Aug. 10th, 1896; Educ., Diploma, Royal Technical College, Copenhagen, 1920; 1920-22, asst. engr., Danish National Rlys.; 1922-25, asst. engr., to G. Mengel, consulting engr., Odense. Municipal and elect'l. work; 1929-30, land surveying, and 1930 to date, constrn. work for C.N.R.

References: A. F. Stewart, F. B. Fripp, C. S. G. Rogers, F. F. Clarke, V. C. Blackett.

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

SMYTH—CHARLES McDOWALL, of Sydney, N.S., Born at Woking, Surrey, England, April 24th, 1890; Educ., 1906-09, The Polytechnic Institute, London, England. Senior Diploma Elect'l. Engrg. and silver medal; 1910-13, electrn., Dominion Iron & Steel Co., Sydney, N.S.; 1914, electrn., Dominion Coal Co., New Waterford, N.S.; 1915, night foreman, shell mfg. plant, Starr Mfg. Co., Dartmouth, N.S.; 1915-19, overseas., Can. Engrs., Lieut., M.M.; 1919, instructor, garage mechanics, D.S.C.R., Halifax; 1919-21, foreman in line dept. and asst. to light and power supt., N.S.Tramways & Power Co., Halifax, N.S.; 1921 to date, light and power supt., Cape Bretou Electric Co. Ltd., Sydney, N.S. (*Jr. 1920, A.M. 1921.*)

References: A. P. Theuerkauf, S. C. Mifflen, W. E. Clarke, P. A. Freeman, A. L. Hay, I. P. Macnab.

THOMSON—CLARENCE, of Montreal, Que., Born at Philadelphia, Pa., Jan. 1st, 1876; Educ., B.A.Sc., McGill Univ., 1897; 1895-97 (summers), with Fred Thomson Co., elect'l. engrs.; 1897-1902, examiner in charge of application for patents (elect'l) in the Patent Office, Ottawa; 1902 to date with Fred Thomson Co. Limited, elec'l. engrs., Montreal, from 1918 to date as manager (Design and manufacture of electric motors, generators, transformers and special elect'l. equipment, and planning and installn. of industrial power plants. Also engaged as consltg. elect'l. engrs. by a number of firms). (*A.M. 1899.*)

References: F. Thomson, J. H. Hunter, G. R. MacLeod, G. D. MacKinnon, A. H. Milne.

EMPLOYMENT SERVICE BUREAU

This Service is operated for the benefit of members of the Engineering Profession and Industrial and other organizations employing technically trained men—without charge to either party.

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2050 Mansfield Street, Montreal

All notices intended for publication must be received not later than the Tuesday of the week preceding the date of the issue in which they are to be inserted.

Capital to Invest

BUILDING CONSTRUCTION EXECUTIVE located in New York city, Canadian born, graduate McGill University, wishes to locate in Canada, preferably Vancouver, B.C. Will invest $20,000 and services in established construction concern where capital is needed for expansion. Fifteen years' field and office experience. Past three years general manager of construction. Apply to Box No. 230-W.

ELECTRICAL ENGINEER. College graduate with about seven years designing experience with large manufacturer of electrical apparatus; would consider junior partnership with electrical contractor or electrical repair firm. Could invest several thousand dollars. Correspondence invited. Apply to Box No. 579-W.

Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., R.P.E. (Ont.), 15 years experience, available on short notice. Experienced surveys, draughting, reinforced concrete design, municipal engineering, construction work, inspection, estimating. Apply to Box No. 107-W.

CIVIL ENGINEER, university graduate 1926, desires employment as junior engineer or instrumentman on construction work. Experience, resident engineer on railway construction, miscellaneous surveys. References. Available any time. Apply to Box No. 149-W.

ELECTRICAL ENGINEER, B.Sc., McGill 1926. Five years experience in the design of switchboards, layouts and wiring diagrams. Considerable experience in high and low tension switchgear design. Fifteen months experience in switchboard estimating. At present employed; available on short notice. Correspondence invited. Apply to Box No. 247-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.

ELECTRICAL ENGINEER. Graduate '25, wide experience in hydro-electric power stations, desires position on power plant design or related work. Apply to Box No. 278-W.

CIVIL ENGINEER, A.M.E.I.C., Canadian, R.P.E., Nova Scotia, 21 years engineering experience, both field and office, in railway, highways, foundations, concrete structures, water power and conservation, electric transmission lines, etc., experience comprising both surveys and construction, desires employment. Single. Will go anywhere. Working knowledge of French and Spanish. Available immediately. Apply to Box No. 327-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. Also some experience in ventilating and heating work and calculators. Accustomed to structural design and details. Good references. Present location Montreal. For interview apply to Box No. 329-W.

ENGINEERING REPRESENTATIVE. Experienced civil and mechanical engineer wishes to communicate with engineering or equipment manufacturing firm with a view to becoming Ontario or Quebec representative. Apply to Box No. 334-W.

CIVIL ENGINEER; age 48; married; A.M.E.I.C., R.P.E., Ontario and New Brunswick; 32 years experience in municipal engineering, on roadways, sewers, waterworks and buildings, desires position with either municipality or as engineer superintendent with contractor. Ten years with City of Toronto, construction engineer on roadway work; four years consulting engineer; three years engineer in charge of construction work; one year resident engineer, Dept. of Public Highways. Available immediately. Maritimes or Ontario preferred. Apply to Box No. 336-W.

CIVIL ENGINEER, S.E.I.C., graduate '29, desires engineering position with possibilities of advancement. Past experience consists chiefly of survey work and municipal construction. Location in western provinces preferred. Apply to Box No. 338-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., R.P.E. Ont., with twenty-four years experience embracing dams, wharves, grain elevators, foundations, pile driving, highways, municipal engineering, water power surveys, road locations, inspections and estimating is open for engagement as engineer or superintendent in construction, operation or maintenance. Location immaterial. Apply to Box No. 358-W.

CIVIL ENGINEER, graduate, age 32, A.M.E.I.C. Ten years experience; seven years on design, construction, erection work and maintenance of paper mill and mine buildings and machinery. Three years on hydro-electric work in charge of surveys and field investigations; associate hydro-electric engineer, U.S. Engineers, on office investigation, design and estimates; desires permanent position in Canada. Apply to Box No. 362-W.

STRUCTURAL AND CIVIL ENGINEER, Jr.E.I.C., age 31, married, Was instrumentman and structural engineer on erection of Royal York hotel, and asst. resident engineer on James Bay Extesnion, T. & N.O. Rly. Experience includes structural, civil and mechanical draughting and all kinds of instrument work and special work. Qualified as captain in military engineering, R.M.C., Kingston. Available anywhere in Canada, preferably Toronto, for any kind of work. Apply to Box No. 377-W.

SCOTS ENGINEER, 28 years old, desires situation as junior executive or some similar situation. Wide experience in mechanical, civil and hydraulic fields and four years as junior executive; A.M.E.I.C. exam., Jr.E.I.C. Will go anywhere. Apply to Box No. 381-W.

ENGINEER ADJUSTER, MANAGER, desires to connect with an industrial concern or department which is not showing a proper return with a view to suggesting more efficient methods and eliminating bad debts. Apply to box No. 411-W.

Situations Wanted

CIVIL ENGINEER, s.E.I.C., 1930 graduate of Nova Scotia Tech. with experience as plane table topographer, instrumentman and draughtsman and particularly interested in hydro-electric power development and reinforced concrete design, desires position. Willing to go to foreign fields. Available at a few weeks notice. Apply to Box No. 431-W.

CIVIL ENGINEER, s.E.I.C., 1930 graduate. Experience as instrumentman on city and railroad construction, desires to enter structural or hydraulic field. Available at once. Will go anywhere. Apply to Box No. 467-W.

CIVIL ENGINEER, experienced in road construction, mine surveying, transmission line survey and construction; paper mill construction; age 27. Available on short notice. Apply to Box No. 468-W.

CIVIL ENGINEER, A.M.E.I.C., age 39, with wide experience on design and construction of reinforced concrete structures, desires position. Apply to Box No. 475-W.

CIVIL ENGINEER, B.Sc., six years experience in paper mill and hydro-electric work, desires position with paper or power company. Paper mill experience covers design, layout, some estimating, and construction. Hydro experience covers preliminary and flowage surveys, transmission line location, design, and six months as resident engineer on construction. Available at once. Apply to Box No. 482-W.

STRUCTURAL ENGINEER, technical graduate, age 40, married, seeks position with architect or contractor. Fully experienced in design and supervision of all types of office and industrial buildings, structural steel or reinforced concrete. Available on short notice. Apply to Box No. 501-W.

ELECTRICAL ENGINEER, B.Sc., McGill University, Jr.E.I.C., age 32. Five years practical experience before graduating. Since graduation two years course with International Paper Co., including six months as electrical foreman, engineer in charge of installation of electrical equipment for two 28,000-h.p. units. Also electrical equipment for large coal-fired boiler house, designing some of the features. Apply to Box No. 506-W.

MECHANICAL ENGINEER, Jr.E.I.C., B.Sc., '26. Ten months experience in pulp and paper steam control. Four years experience in detail and design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

CIVIL ENGINEER, B.A.Sc., '29, with experience in supervision of construction and general office engineering, desires permanent position with contractor or engineer. Available at once. Apply to Box No. 524-W.

CIVIL ENGINEER, A.M.E.I.C., with twelve years experience embracing survey and construction, railway, hydro-electric and highways foundations, pile driving, municipal engineering, water power surveys, road location, inspection and estimating, is open for engagement as resident engineer on construction or other responsible position. Experience comprises both office and outside work. Available immediately. Apply to Box No. 527-W.

MECHANICAL, CONSTRUCTION, AND DESIGNING ENGINEER, with special training in hydro-electric power development, underground steam distribution systems, and the operation of large electrical machinery. Active work desired. Apply to Box No. 528-W.

ELECTRICAL ENGINEER, s.E.I.C., B.Sc., E.E., 1931, desires to become associated with some branch of electrical engineering offering good opportunity for advancement. Sixteen months experience in draughting of electrical apparatus with large manufacturing concern; including layout work, and making of detail working drawings. Bulk of experience with industrial control apparatus. Location immaterial. Available on short notice. Apply to Box No. 532-W.

ELECTRICAL ENGINEER, married, graduate of McGill University, desires position in Ottawa, Montreal or Toronto. Experience includes four summers with a building concern as instrumentman and assistant engineer, two and one-half years with the Canadian Westinghouse Co., this time being distributed between tests, design and sales. At present employed but available on short notice. Apply to Box No. 533-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C., age 32. Seven years general experience in hydro-electric power investigations and construction. Has been in charge of high power transmission lines location, also in charge extension surveys. Experience in office and field. Thorough knowledge of French. Best of references from former employers. Apply to Box No. 537-W.

STRUCTURAL ENGINEER, A.M.E.I.C., B.A.Sc. Wishes to join established firm of consulting engineers. Age 37. Married. Ten years experience design of reinforced concrete and steel on buildings. Two years practical contracting experience. Apply to Box No. 540-W.

CIVIL ENGINEER, McGill '20, A.M.E.I.C., P.E.G., age 31, single. Experience includes general engineering, especially reinforced concrete work, and eight years of pulp and paper mill construction and layout. Best of references. Available on short notice. Apply to Box No. 547-W.

UNDERGRADUATE ENGINEER, s.E.I.C., junior year standing (Sask.), desires work to complete course. Electrical or mechanical work preferred. Apply to Box No. 553-W.

ELECTRICAL ENGINEER, s.E.I.C., graduating 1931, desires employment in electrical engineering. Sixteen months draughting experience on electrical machines with a large manufacturing company. Work included making layouts and detail working drawings. Available immediately. Location immaterial. Apply to Box No. 555-W.

A.M.E.I.C., graduate of University of Toronto, 1915. Building engineer and superintendent, with considerable experience as installation, sales and promotion engineer. Present connection, four years in responsible position with large utility corporation. Open for immediate connection where he can use his past experience. Location immaterial. Apply to Box No. 560-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, s.E.I.C., graduating this year. Experience in railway maintenance, and instrumentman on location and construction. Desires to enter any branch of civil engineering or industrial work affording technical experience and an opportunity for increasing responsibility. Will go anywhere. Apply to Box No. 567-W.

CIVIL ENGINEER, A.M.E.I.C., ten years experience as mining engineer of a colliery, six years railway construction, including location, construction, bridge construction, and maintenance. Also one year on hydro transmission lines; one year government land surveys. Would consider position in any branch of construction, as resident engineer or instrumentman. Apply to Box No. 569-W.

CIVIL ENGINEER, B.Sc. McGill Univ., Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

YOUNG ENGINEER, Jr.E.I.C., experienced in design, details and erection of steel and concrete structures. Also a good theoretical and practical knowledge of steam, hydraulic and I.C. engine power plant. Good practical mechanical and electrical engineer, able to operate and maintain any type of machinery or power plant. Location immaterial. Apply to Box No. 572-W.

MECHANICAL ENGINEER, s.E.I.C., B.A.Sc., (Univ. of B.C., '30), Undergraduate experience in pulp mill. One year's experience, Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

TEMPORARY EMPLOYMENT wanted by an engineer with wide experience in the design and operation of steam power plants and heating system. Apply to Box No. 584-W.

CIVIL ENGINEER, s.E.I.C., 1931 graduate, age 26. Experience in draughting, designing and estimating in structural engineering. Desires to enter structural, hydraulic (including hydrographic) or municipal field affording technical experience. Location immaterial. Available at once. Apply to Box No. 593-W.

ELECTRICAL ENGINEER, graduate Univ. of Alberta, '31, with excellent record, desires connection with electrical manufacturing firm, power or communication company. Good general experience includes one summer railway construction, two summers geological surveys in oil fields of Alberta, planetable topographer and asst. geologist. Available immediately. Apply to Box No. 596-W.

MECHANICAL ENGINEER, age 22, graduate '31, Univ. of Alberta, experience as draughtsman and instrumentman-inspector, is open for a position. Location immaterial. Apply to Box No. 598-W.

MECHANICAL ENGINEER, s.E.I.C., age 21, four years mechanical engineering, Queen's University, desires permanent employment. Experience in wood work, machine shop work, draughting and surveying. Location immaterial. Available at once. Apply to Box No. 600-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building, desires change. Location immaterial. Available on one month's notice. Apply to Box No. 601-W.

ELECTRICAL OR MECHANICAL ENGINEER, B.Sc.'31, s.E.I.C., desires employment which will give experience and lead to advancement. Two summers in a large communication company, including draughting, switchboard and surveying. Available on short notice. Will go anywhere. Apply to Box No. 606-W.

CHEMICAL ENGINEER, s.E.I.C., University of Alberta '30, desires a position in any industry with chemical control. Experience includes three summer vacation periods of five months each as assistant chemist, and ten months as chief chemist with a cement company. Age 29. Single. Available at once. Apply to Box No. 609-W.

For Sale

TROUGHTON & SIMS 8" geodetic transit, with 8" vertical circle reading to 10 seconds. Three levelling screws and three verniers. New and in beautiful condition. Packed in two mahogany cases. Complete with framed mahogany tripod (half price), $400.00. Apply to Box No. 10-S.

GRAFLEX CAMERA, post card size, in good condition. May be seen at Institute headquarters. Price $75.00. Apply to Box No. 11-S.

Canadian Sheet Piling Co., Limited

An announcement of interest to the engineering profession in Canada is made by the recently formed Canadian Sheet Piling Co. Limited.

This Company will distribute in Canada the Larssen section of steel sheet piling. The new Company has its head office at Suite 1106 Castle Building, Montreal, with suitable sales and engineering representation throughout the Dominion.

The Board of Directors includes Mr. D. G. Macpherson, President of Watson Jack & Co. Limited, who is President of the new Company; Mr. H. T. Garvie, M.I.Mech.E., M.I.Struct.E., who is Managing Director of The British Steel Piling Co. Limited of London; Mr. M. J. McCarthy, A.M.Inst.C.E., M.I.Struct.E., A.M.I.Mech.E., who is also a Director of The British Steel Piling Co. Limited, and Mr. B. C. Talbot of Cargo Fleet Iron Co. Limited, who roll Larssen piling at Middlesbrough, England.

Both Mr. Garvie and Mr. McCarthy have had a long experience in the furnishing of Larssen section of steel piling in important engineering works all over the world. Mr. Macpherson is well known for his connection with the contracting and engineering trades throughout Canada, while Watson Jack & Co. Limited have been acting as sales representatives for The British Steel Piling Co. Limited for some time past. This combination, therefore, places the new company in a sound position in the Canadian market.

Steel sheet piling is a product that is not manufactured in Canada, and for many years the importation of this material has been exclusively from United States sources. Canadian contractors, engineers and architects will therefore welcome the possibility of now obtaining a British rolled steel piling.

Arrangements have been made for the carrying of representative stocks of piling at convenient localities in Canada to take care of urgent requirements and give the Canadian trade prompt and satisfactory service.

The Canadian government have recognized the desirability of showing preference for British products, and have placed a favorable preferential duty on steel piling rolled in Great Britain.

The users of this Larssen piling will be assured of having the assistance of structural engineers specializing in piling, and 27 years of proven design, in the planning of their various projects, as a competent staff of engineers will be maintained by the new company.

Some of the features of Larssen section of steel piling are the following:—

(a) Its patented interlock is truly rolled and water tight, and at the same time offers a minimum resistance to driving.

(b) The flanges of the Larssen section are subject to a minimum of live pressure due to the shape of the section approaching the rectangular.

(c) The Larssen section has maximum section modulus for a minimum of material, as it is rolled to furnish the greatest amount of metal at the point of greatest stress.

(d) The published section modulus of the Larssen section is the result of laboratory tests, and proven by twenty-seven years of field practice.

The use of Larssen section of steel piling is becoming more and more widely known as a method of construction, not only for temporary cofferdam work but also for the more permanent structures such as docks, seawalls etc., where its economical and sea-resisting properties make it ideal for this type of structure, and in the majority of cases a substantial saving over ordinary forms of construction can be demonstrated.

Amongst some of the important works carried out with Larssen piling in Canada are the following:—

Quebec Harbour Commission dock at Quebec.
Pier work at Kincardine, Ont.
Banc Brule Lighthouse foundations.
Ste. Anne Bridge Piers foundations.
Abitibi Canyon Power Development, Fraserdale, Ont.
Halifax Harbour Commission new docks.

Gliding

Interesting data regarding the various aspects of gliding are contained in a year book published by the Dorset Gliding Club, Weymouth, England, of which a copy has been received. The progress made in this sport during the past year in England has been extraordinary. While the achievements in Germany are, of course, outstanding, it must be remembered that gliding was taken up and developed in that country immediately after the War.

The booklet, besides full information as to the gliding clubs in Great Britain, has a series of articles on the theory of gliding flight; how gliding can be taught; the construction and design of gliders; materials used in glider construction, and the organization and possibilities of gliding clubs.

Historically, continuous progress is reported, commencing with the brief twenty-six minute gliding flight of the Wright brothers at Kitty Hawk in 1902, up to the engineless flight of Barstow in 1929, when he remained in the air for fifteen hours and thirteen minutes. In the same year Kronfeld in Germany succeeded in reaching a height of 8,514 feet, depending only on the motive power of the wind.

Copies of "Gliding" can be obtained from "Gliding," 10 Victoria Street, Weymouth, Dorset, England, at a cost of 2s. 6d. per copy.

Electrical Eyes

Television

Part I

One original invention is credited to Nipkow, a German; fifty years ago he explained scanning, line after line with a spot of light, the object of which an image was to be made visible at a distance. He lacked several essentials, particularly amplifiers and other devices made familiar since then through radio.

How far can a picture be "televised"? Experimenters of General Electric Company sent television waves from Schenectady, New York, to Australia and had them come back. After travelling 20,000 miles a rectangle still had four corners, although broken into pieces most of the time.

In 1927 a picture three inches square on the screen was achieved by Alexanderson; in the fall of 1929, a picture fourteen inches square, not simply black and white like a silhouette; all the gray shades were reproduced, registering every shadow and giving depth and detail. In May, 1930, television first appeared as part of a regular performance at a theatre. It was in Schenectady, and the image was six feet square.

Antenna radiation is modulated by a succession of impulses supplied by the beam of light scanning the object of which a picture is being transmitted. The subject stands before an incandescent lamp. Between subject and light is a metal disc the size of a bicycle wheel, drilled with forty-eight holes. The revolving disc covers the complete subject twenty times per second; that is, there are twenty complete pictures made up of light and shade. A frame contains four photoelectric tubes, sensitive to light. The tubes respond 40,000 times per second to impulses reflected back from the subject.

At the receiver the electrical impulses are passed on to a light valve, in the middle of an intricate lens system, in front of a high-intensity arc lamp similar to those used for projection of motion pictures. The light valve operates delicately and accurately to permit passage of light in correspondence to impulses received from the television transmitter. These light emissions are passed to a rotating disc supporting lenses in places corresponding to the holes of the disc at the originating point. Additional lenses pass the light forward to the screen, where these light impulses, at the rate of 40,000 per second, become the living, active image.

Part II

April 7, 1927, one-way systems for television over telephone circuits by radio were demonstrated in Bell Telephone Laboratories, New York, permitting an individual to see as well as to hear a person in Washington. On a large television screen the audience observed the person at Washington while hearing his words over the loud-speaker. This receiver was used also to demonstrate television by radio, at which time there was presented to an audience the first radio broadcast programme of sound and scene.

With photoelectric cells of greater sensitivity it became possible, in July, 1928, to illumine the subject broadly by daylight, and allow the photoelectric cell to "behold" only one small area of the picture at a time. This "direct scanning" lends itself particularly to action at a distance from the lens. Improvement of photoelectric cells sensitive at the red end of the spectrum, and glow-discharge tubes whose light is rich in blue and green rays, made possible in June, 1929, an image in colour, using beam-scanning and superposing three one-colour images.

Experimental two-way television service between American Telephone and Telegraph Company building at 195 Broadway and Bell Telephone Laboratories at 463 West street, nearly two miles apart, was demonstrated to representatives of the press on 9 April, 1930. Special telephone booths were equipped with television transmitters and receivers, designed by the Laboratories. A person seats himself in a booth before a frame in which he will see the face of the person with whom he is talking. His own face is rapidly scanned by a mild beam of blue light which reflects from his face to the photoelectric cells and gives rise to the current which transmits his image. There is no fierce glare to the scanning beam; one is not annoyed by its presence and may even gaze directly at it without inconvenience.

The first thing that strikes the observer when he steps into the booth, lighted with a dim orange light to which the photoelectric cells are insensitive, is the absence of the usual telephone. Special telephone transmitters and receivers are concealed in the booths. One talks face to face to the distant person and a hidden receiver speaks the words, which seem to issue from his mouth. An ordinary telephone is not used because it would hide part of the speaker's face. This novel arrangement adds naturalness to the conversation. The other party appears with sufficient detail for recognition of facial expression but the effect is like looking at an animated cabinet-size photograph, because the image is produced in monochrome. What one sees is like an instantaneous moving picture done in black on a pink background due to the colour of the neon tube, whose flashing light through the synchronized scanning disc forms the image.—*From Research Narratives of The Engineering Foundation.*

The Canadian General Electric Co. Ltd., announces a new pendant type push button for controlling small floor operated cranes. This is designed to supersede the present rope and chain types of control, with the advantages of greater safety to the operator, a saving in time (only one man being necessary to operate the crane) and less aisle space required on the factory floor.

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Seven Sisters Hydro-Electric Development

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Presented before the Winnipeg Branch of The Engineering Institute of Canada, April 16th, 1931, and before the Montreal Branch of The Institute on April 30th, 1931.

SUMMARY.—The initial stage of the Seven Sisters development of the Northwestern Power Company is nearing completion, and will be delivering power this summer. This is the third hydro-electric development undertaken by the Winnipeg Electric Company, or a subsidiary, and is situated on the Winnipeg river, about 63 miles distant from Winnipeg. The initial development will produce 60,000 shaft horsepower, and the final installation will have a total installed capacity of 225,000 h.p. under a 66-foot head. Interesting features in this project include the dykes, which extend up river from the dam for several miles on both sides of the river; also the tailrace cut, which involves an excavation of about 1,000,000 cubic yards of granite rock, which will be used for railroad ballast.

The power house adjoins the main dam, which is of the solid gravity spillway type. Three high specific speed propeller turbine units of different manufacture are being installed, each of 37,500 h.p. rated capacity. The completed project calls for six such units. Special provision has been made for dewatering the power house substructure for the addition of future units. The generators are of welded structural steel design, each rated at 32,500 kv.a., 11,000 volts, 3-phase, 60 cycles, and 138½ r.p.m.

Power is transmitted by a double circuit 110 kv. line direct to Winnipeg, and a tie line also has been constructed to interconnect with the Great Falls development, further down the river.

General

The era of low price hydro-electric power for industrial use in Winnipeg dates from the time the 30,000 h.p. Pinawa plant of the Winnipeg Electric Company on the Lee channel of the Winnipeg river was placed in operation on June 11th, 1906. This was supplemented by a 12,000 h.p. steam turbo-electric plant in Winnipeg in 1912. Other developments on the Winnipeg river are the 105,000 h.p. Pointe du Bois plant of the city of Winnipeg, placed in service in 1911; and the 168,000 h.p. Great Falls plant of the Manitoba Power Company, Ltd., which started operating on January 3rd, 1923.

Two plants are now under construction, the Slave Falls plant of the city of Winnipeg, and the Seven Sisters plant of the Northwestern Power Company, Ltd. The ultimate installation of these plants will be 100,000 h.p. and 225,000 h.p., respectively.

The Manitoba Power Company Ltd., and the Northwestern Power Company Ltd., are subsidiaries of the Winnipeg Electric Company.

Geographical

The Winnipeg river possesses exceptional power and storage advantages, having a total drainage area of over 53,000 square miles; with regular and well distributed precipitation resulting in remarkably uniform natural run-off annually. In a normal year the maximum flow seldom exceeds four times the minimum.

The topography of the catchment basin has the typical characteristics of the Laurentian country, being rough, hilly, well forested, with numerous lakes and muskegs, which exercise a strong influence upon the natural flow of the river. In addition, several large lakes provide natural advantages for securing maximum uniformity in the flow by means of mechanical regulation. It is interesting to note that there are over 100 lakes varying from a few square miles up to 1,500 square miles in area, having a combined surface of 4,400 square miles or about 10 per cent of the drainage area above the power reach in Manitoba.

The Winnipeg river proper, having its source in the Lake of the Woods, flows northwesterly for a distance of 160 miles and empties into Lake Winnipeg, the total drop in that distance being 347 feet. The English river, 120 miles in length, having its source in Lac Seul, is the principal tributary and joins the Winnipeg some 50 miles below the outlet of the Lake of the Woods. The two main basins in the watershed regulated by storage dams are the Lake of the Woods with a surface area of 1,500 square miles, and a drainage area of 26,400 square miles, and Lac Seul which has a surface of about 420 and a drainage area of 11,700 square miles. The maximum and minimum regulated levels of the Lake of the Woods provide for a storage depth of 5 feet, equivalent to 7,500 square mile-feet of water, while at Lac Seul a depth of 5½ feet can be stored at present, with an ultimate depth of 16½ feet equivalent to 6,930 square mile-feet of water. Tributary to the Lake of the Woods are two other storage basins, Rainy lake and Lake Namakan with areas of 300 and 100 square miles respectively and together capable of storing 2,850 square mile-feet of water. The total storage at present available therefore amounts to more than 17,000 square mile-feet, equivalent to 470 billion cubic feet or a flow of 20,000 c.f.s. for 274 days. In other words storage facilities are available for 75 per cent of the dependable flow.

Hydrographic records available from 1907 to 1928 show a mean discharge of 25,800 c.f.s., the maximum flow being 86,600 c.f.s. in July, 1927, and the minimum of 9,440 c.f.s. as recorded in July, 1925. This excessive variation in a period of two years was due to manipulation before existing control methods were effective. Extensive studies by the engineers of the Dominion Water Power and Reclamation Service in 1915, indicate that a dependable flow of 20,000 c.f.s. can be maintained. More recent investigations which include the Lac Seul regulation lead to the conclusion that a regulated flow of 22,000 c.f.s. may be obtained with reasonable assurance except during very exceptional seasons.

Pinawa-Seven Sisters Reach

The Seven Sisters reach of the river, shown in Fig. 1, extends approximately 8 miles downstream from the point at which the Pinawa channel leaves the main river, and derives its name from the seven rapids encountered in this section, originally known as the Seven Portages. The total fall in the Pinawa and Seven Sisters reach is 72 feet, the effective head on the Pinawa channel is 60 feet, while on the main channel 66 feet can be utilized. The original plan submitted by the Dominion Water Power Department, contemplated four developments. The existing Pinawa plant and the Upper Pinawa plant, 3½ miles above, would both use the flow diverted down the Pinawa channel under heads of 42 and 18 feet respectively. The remaining flow would be utilized in the Seven Sisters reach in two stages; the lower Seven Sisters plant, situated at the foot of the reach developing the five lower falls, and the second plant situated 4½ miles upstream developing the two upper falls.

There were several reasons for this proposal. Firstly, the interests of the Winnipeg Electric Company, in respect to the diversion of water down the Pinawa channel, had to be fully considered in fixing the head water elevation. These interests involved the Pinawa power concession granted in perpetuity in 1902, based upon the diversion of 540,000 c.f.m., the unit in effect in those days, or 9,000 c.f.s. via the Pinawa channel to Lac du Bonnet. This diversion was effected by means of a rock fill diversion dam across the main river and two auxiliary dams across the secondary channels, thus reducing the dependable flow in the main river to 11,000 c.f.s. Secondly, the company had owned lands abutting on the river in the vicinity of the lower Seven Sisters falls since September 23rd, 1903, prior to the passing of the Dominion Water Powers act. The title to this land, which had been acquired by the company in order that it might construct the above mentioned diversion dam, carried with it certain rights to the power on this section of the river. Finally, the contours of the river banks were considered unfavourable to a development in one stage. Subsequent studies carried out by the company indicated that the full head could be utilized in one plant by placing the power house at some point in the Seven Sisters reach, between the two sites proposed by the government.

Experience in operating hydro-electric plants indicates that it is impossible to utilize water as effectively in four plants with divided flow, as it is in one plant, especially when such plants are operated independently. By abandoning the Pinawa plant, concentrating the head at one plant in the Seven Sisters reach, and utilizing the full flow in a single stage development, instead of in four separate plants, an increase of 50,000 commercial horsepower could be obtained with much less capital investment and less operating cost, as only one operating staff would be required. After due consideration of the above facts the government in 1928 granted the company a lease to develop this section of the river, thus removing the difficulties encountered by the government engineers.

After a single stage development had been decided on, four alternative arrangements (see Fig. 1) were studied. Due to their excessive cost the two long canal schemes were eliminated; but little difference in cost was found between the short canal and the tailrace cut scheme. However, the latter presented less hazard in construction and operation, and lent itself more readily to a partial initial development, so that this scheme was finally adopted. The full head of 66 feet will be obtained by constructing dykes to impound the water up to elevation 899, and excavating the tailrace to give a tailwater elevation of 833.

Seven Sisters Development

The capacity of the Seven Sisters plant when completed will be 225,000 h.p. Such a large block of power could not be absorbed immediately, consequently it was decided that the development should be carried on in progressive stages according to power demands. The initial stage, now practically completed, enables 60,000 h.p. to be developed from three units, operating under partial head. When further power is required the effective head on the plant will be raised, firstly by raising the dykes, and secondly by excavating the tailrace. Concurrently with

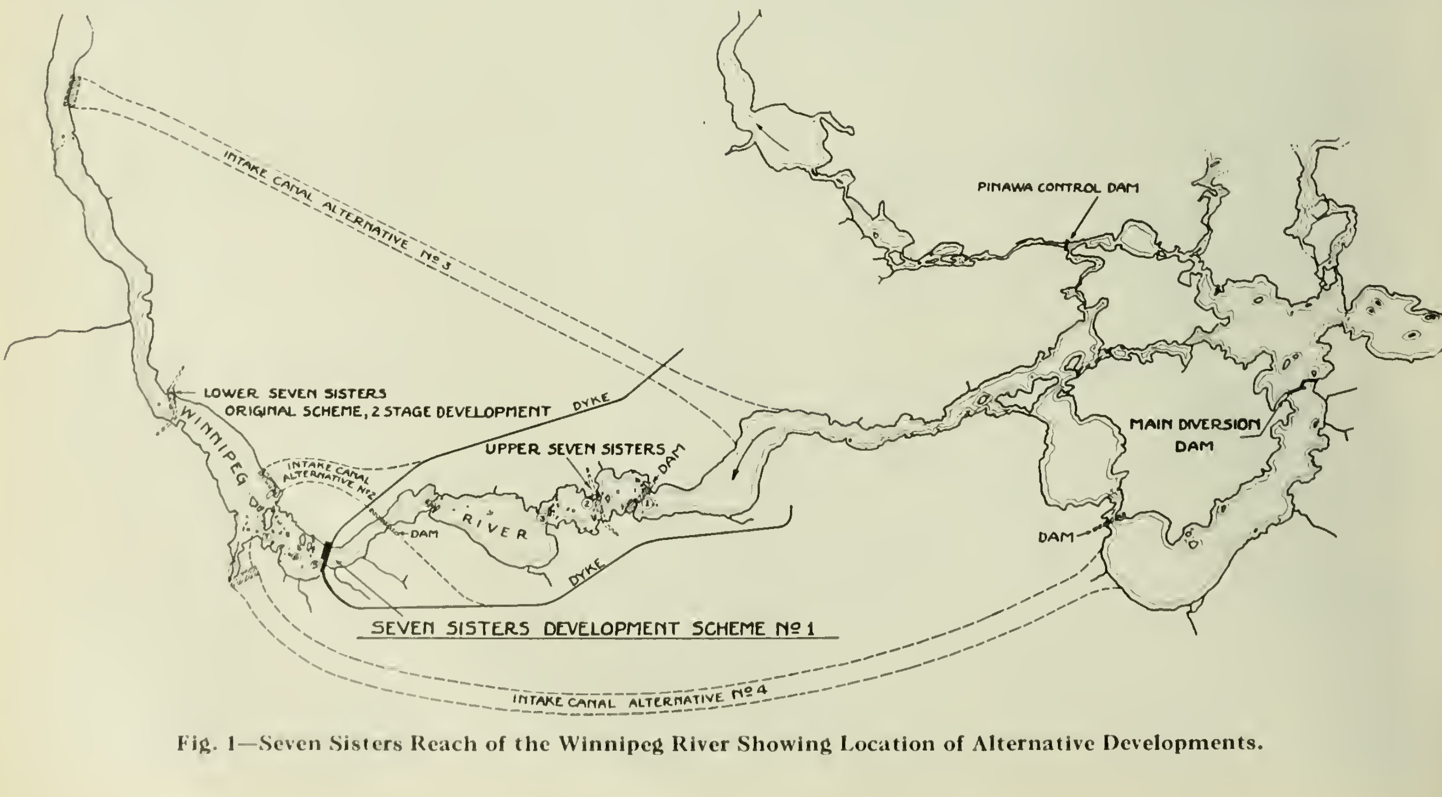


Fig. 1—Seven Sisters Reach of the Winnipeg River Showing Location of Alternative Developments.

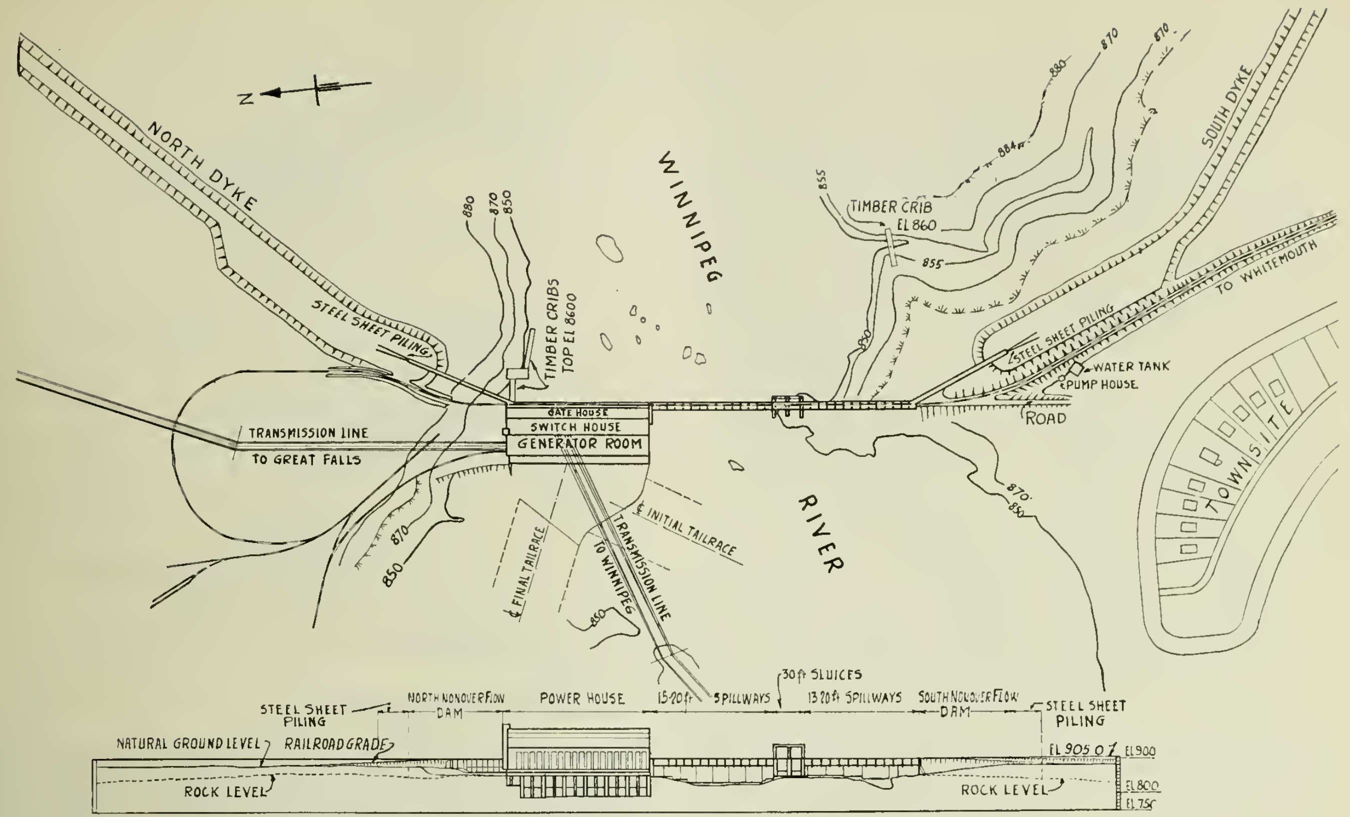


Fig. 2—General Plan Showing Power House and Dyke Location.

these procedures additional units will be installed until the full complement of six, operating under a head of 66 feet, will enable the whole of the effective power in this reach of the river to be developed.

The general arrangement of the development is shown on Fig. 2. Railroad connection is provided by a spur line 14 miles long which connects with the main line of the Canadian Pacific Railway at Whitemouth. The dam, of which the power house intake structure forms an integral part, is located at the fifth fall, where the river was relatively narrow and shallow and where advantage could be taken of an island in midstream. Due to the fact that the final forebay elevation would be above the natural ground level in this locality, dykes were constructed which extend upstream 3½ miles on the north and 4½ miles on the south shore, creating a lake 25 miles long, varying in width from one half to one and one half miles. The final tailrace excavation will extend downstream about seven-eighths of a mile.

A typical dyke section (Fig. 3) consists of a clay core 16 feet wide at the top with upstream slopes of 3½ to 1 and downstream slopes of 3 to 1. The core material is a colloidal clay and in order to protect the upstream slope from wave action, 4 inches of crushed rock is rolled into the surface and a 3-foot thick layer of 3-inch crusher run riprap is then deposited. The top is crowned and covered with crushed rock. The downstream slope is covered with stripping and seeded. In locations where the subsoil is porous but otherwise stable for a foundation, a core trench 10 feet wide is excavated and backfilled with compacted clay. Drainage ditches parallel the dykes and are provided with off-takes at suitable intervals.

Dam and Substructure

The dam is of gravity type spillway section, flanked to the south by a non-overflow concrete wingwall and to the north by the power house intake structure terminating in a non-overflow wingwall. Two sluiceways were provided in the middle of the spillway since it was considered desirable to have the discharge from the sluices remote from the tailrace, especially at the final stage of the development, when the tailwater will be about 12 feet below the water level in the natural channel. Each sluiceway has a clear width of 30 feet with sills at elevation 870, and a normal depth of 29 feet of water over the crest of the rollways. Provision has been made for placing stoplogs on both the upstream and downstream side of the sluicegates. The downstream logs can be placed by the stoplog winch, forming slack water between the two sets of stoplogs, thus equalizing the water pressure on the gates or upstream stoplogs, in case of emergency.

The spillway section has a total of 28 openings, each 20 feet wide, with sills at elevation 885, or a normal depth of 14 feet over the crest of the rollway, one of which is reserved for a log chute and a fish ladder. The spillway discharge is controlled by stoplogs handled by a winch operated from the spillway deck. For the initial development the crest elevation of the rollways was left at 874, to provide adequate flood discharge.

The spillways and sluiceways have a total discharge capacity of 126,000 c.f.s., with the normal forebay water level at elevation 899. The maximum discharge capacity under conditions of extreme high water is 185,000 c.f.s., including the Pinawa channel.

The design of the different structures is based on the following assumptions and data:

Water level....................Elevation 900.
Weight of concrete.............145 pounds per cubic foot.
Coefficient of friction...........0.65.
Uplift.........................75 per cent of static head at heel decreasing to zero at toe.
Ice pressure:
Against each spillway pier.....100,000 pounds at elevation 900.
Against each sluiceway pier....225,000 pounds at elevation 900.
Against each non-overflow section....................No ice pressure: these are protected by air bubbler system.

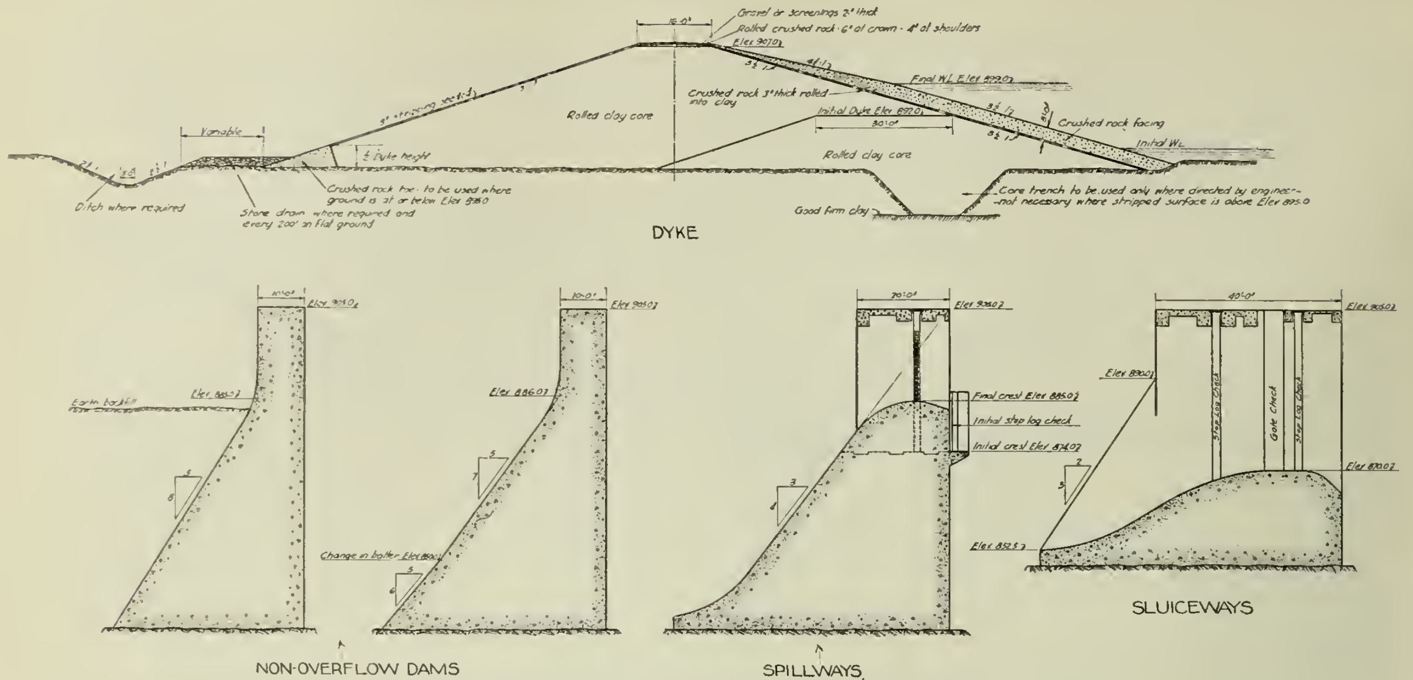


Fig. 3—Typical Sections of Dykes, Dams, Spillways and Sluiceways.

Ice apron, power house intake	25,000 pounds per linear foot at elevation 900.
Scroll case roof	Full static head plus 15 per cent for surge.
Live load on generator room floor	500 pounds per square foot.

The piers of the spillways and sluiceways are designed as reinforced concrete cantilevers carrying the ice thrust and reaction from the stoplogs and gates to the mass concrete below.

As the scroll cases and draft tubes for units 4, 5 and 6 were not built, the intake structure had to be designed to withstand full hydrostatic pressure and uplift without any assistance from these parts. The weight of the concrete not being sufficient to counteract the overturning moment, and the area of the intake piers not great enough to provide space for a sufficient number of dowel anchors into the rock, it was decided to make use of the weight of the water upstream from the emergency gates. The horizontal thrust which is exerted by the water on the head wall was transferred through the piers into the floor slab, the weight of water on the floor slab thus giving the necessary stability to the head wall. The latter was doubly reinforced (see Fig. 5), firstly by horizontal steel on the downstream side enabling the wall to take the load by beam action, and secondly by extending vertical steel from the roof of the intake flume up into the stream side of the wall, providing a cantilever action, and thus partly transferring the load into the roof.

All piers were considered fixed at the top and supported at the bottom with one adjacent water passage full and the other empty. A horizontal diaphragm was placed across the centre opening of each turbine intake at about half the height of the piers to give additional stiffness to the intermediate piers.

The bed rock being sound and remarkably free from fissures, it was not necessary to provide a cut-off wall or drainage for the intake structure foundation.

The hoop reinforcing of the scroll case was carried back to, and bonded with the reinforcing in the intake piers. In designing this reinforcing the volume of the concrete in the power house on the downstream side of the centre line of units and above the scroll case floor was assumed as a dam with a coefficient of sliding of 0.50. The walls of the scroll case and entrance were designed for water pressure only, the roof being considered as simply supported on the walls and producing no bending stresses in them. The construction joints were not assumed to be fully watertight, and dowels were provided to counteract the water pressure. In considering anchorage for the scroll case roof against water pressure, uplift was considered as full static head plus 15 per cent surge. Half the span between the stay vanes and vertical walls was considered as contributing to uplift on the stay vanes and the remainder assumed as anchored by the wall.

The reinforcement of the central part of the draft tube roof was arranged in beam-like strips which were assumed as taking part of the generator room floor load together with the weight of the generator, water wheel and hydraulic thrust. The pressure in the scroll case in excess of that due

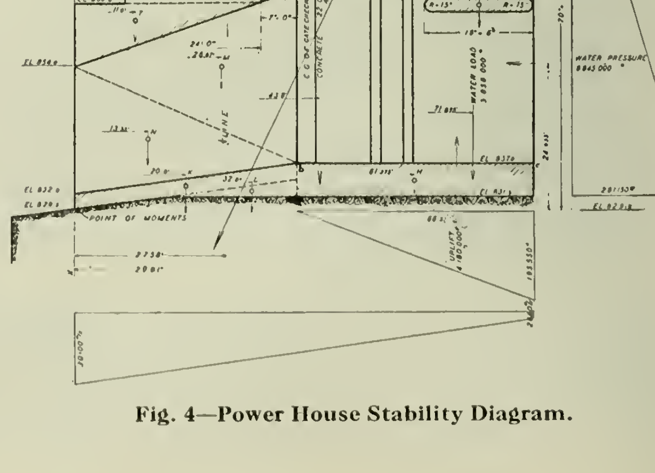


Fig. 4—Power House Stability Diagram.

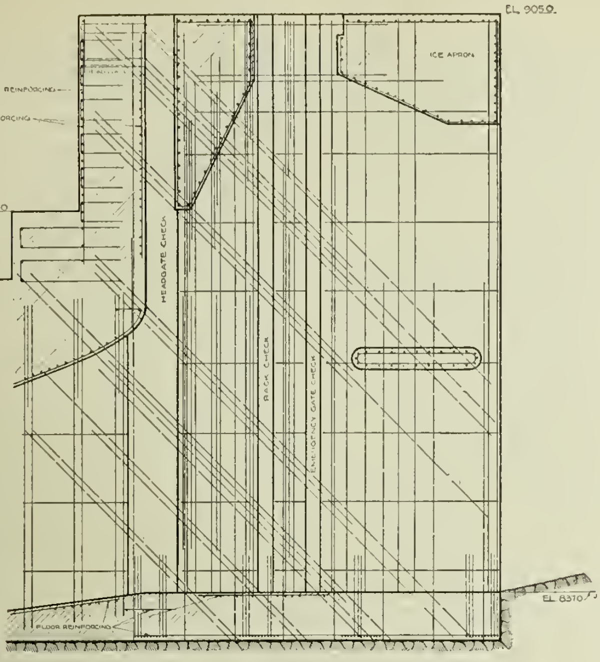


Fig. 5—Section Through Intake Showing Reinforcement.

to the weight of the water was not taken into account, since this pressure acts boths upward and downward and the speed ring stay vanes are capable of taking tension. The remainder of the draft tube roof carries the generator floor loads, the downstream wall column reactions and the water load due to tailwater on that portion of the roof outside the downstream wall. The uplift due to the tailwater head was neglected.

Superstructure

The superstructure (Figs. 7, 8 and 8a) consisting of three main sections, the generator room, transformer and switch room, and gate-house, has been completed to house the service and first three power units with a temporary end wall between units Nos. 3 and 4. It is built of concrete and structural steel throughout with walls separating the three main sections of the building. The transformers, oil switches, and high tension bus room have all been so separated by means of tile and concrete partitions, fire-doors, etc., that a fire or flashover originating in one part of the building will not be communicated to other parts. Metal sash is used throughout the building, and doors to switch pockets and transformer compartments are terne-clad or kalameine.

There are three main switch floors containing the step up transformers and 110,000-volt switching equipment, and a fourth floor is provided for the high tension bus. The control room between units Nos. 3 and 4 is situated on the level of the transformer floor and overlooks the generator room. Immediately above the control room are offices, and below a mezzanine floor for the local station service switches, control cables, transformer oil and water piping. At the north end of the generator room floor there is a machine shop, air compressors, and a room for housing the cooling water pumps. The compressors are required for the bubbler system and for pneumatic dewatering of the units. Erection pits are provided in the generator room floor for the generator shaft while erecting or handling the rotors. Railway connection is furnished by a track extending under the generator room crane. Tracks are installed on the transformer room floor for moving the transformers from their compartments to a loading platform which extends out into the generator room bay, from where they can be handled by the crane. Light tracks are also provided on other floors for moving circuit breaker tanks from the elevator to their respective locations.

Below the generator room level are located the local service turbine room, oil storage, and space for electric heating boilers. The floors of the transformer pockets slope sharply to the back and drain to the tailrace. Oil drainage is also provided for each circuit breaker compartment and each high tension breaker is enclosed in a compartment with openings at the top for the leads.

A 500-h.p. electric boiler is installed for providing steam heat during period of light load. For this purpose blower type heater units are mounted in the generator room and on the roof of the main air duct arranged to discharge heated air into the turbine pits when necessary to prevent the water, oil lubricating, and governor systems from freezing.

The generators are ventilated by air drawn from a ventilating duct below the generator room floor and continuous from end to end of the building. By means of adjustable louvres the air is supplied to this duct either from the generator room or from outside the building in any proportion. In the summer the generator room windows will be opened to get rid of the heated air, but in winter provision is made to circulate it through the switch-house and gate-house by means of exhausters installed in pockets at the level of gate-house floor. Openings are provided for free passage of the air which is drawn from the generator room at the roof trusses, through the switch-house and into the gate-house near the roof. It will be exhausted from the gate-house floor and forced back into the generator room through suitable ducts. Ventilators are installed on the switch-house roof, and in these fans will be used to clear the building of smoke in the event of a fire.

Intake Equipment

There are three headgates per unit, of the fixed roller type, 15 feet wide by 34 feet high. They were designed for a maximum head of water of 66 feet over the sill of the gate and have a normal lift of 69 feet, allowing them to be lifted completely out of the water when not in use, this feature being desirable on account of the corrosive action of the Winnipeg river water on mild steel. The headgates are designed for a maximum unit stress of 18,000 pounds per square inch. The gates are raised by individual hoists operated by a motor-driven line shaft, there being one motor reduction unit for every six gates. The gates are arranged for electrical remote control gravity lowering by means of push buttons on the gate-house floor for each individual gate, and on the switchboard for each unit, lowering the three gates for that unit simultaneously. Limit switches are provided for raising and lowering. On lowering, the tripping device applies the brake when the gate is a few inches above sill, thus preventing it from striking a heavy blow and unwinding the hoisting rope. In order to make the gates self-lowering under all conditions they are loaded with concrete weights.

The trash racks are located immediately in front of the headgates, and are made in removable panels arranged for

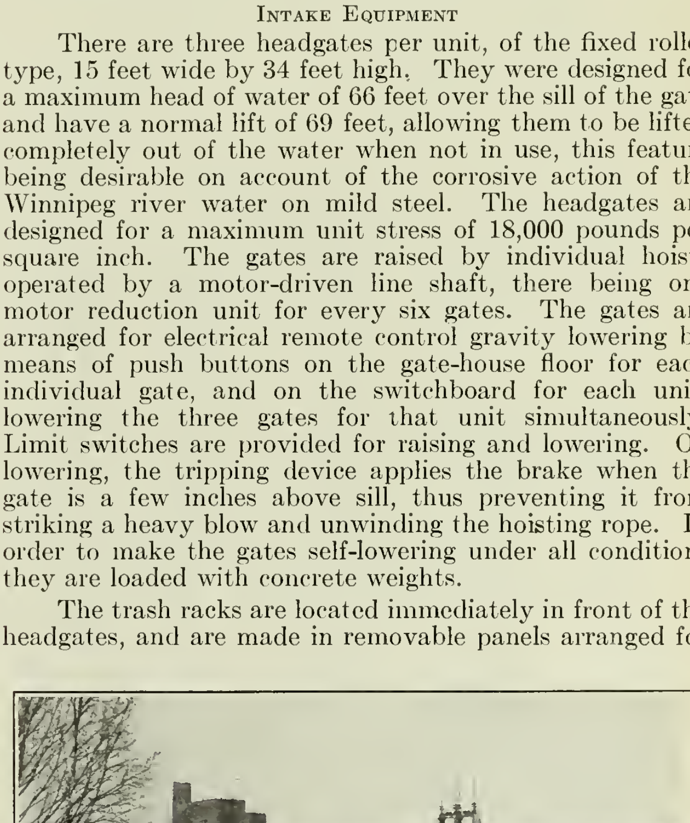
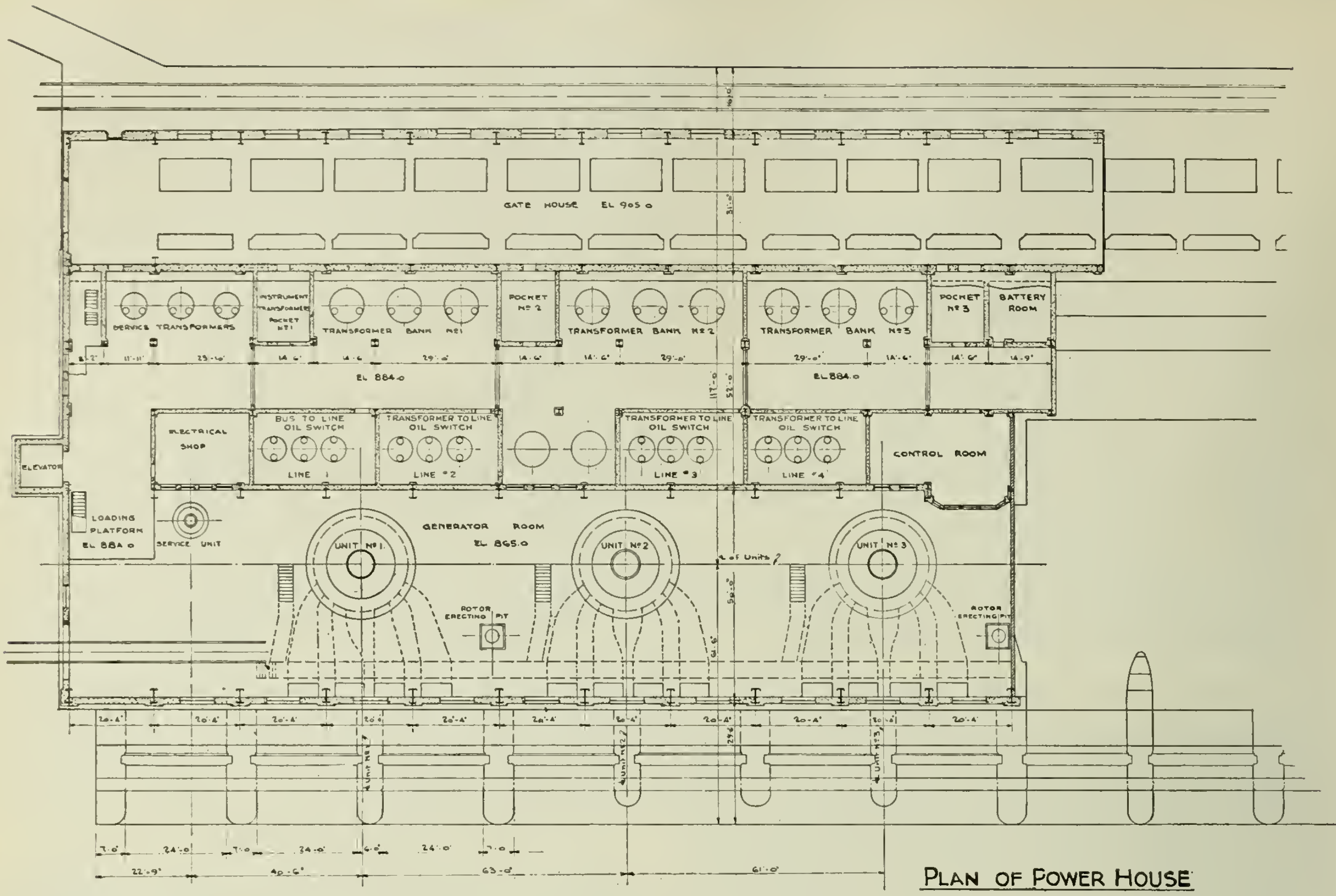


Fig. 6—General View of Power House and Spillways.



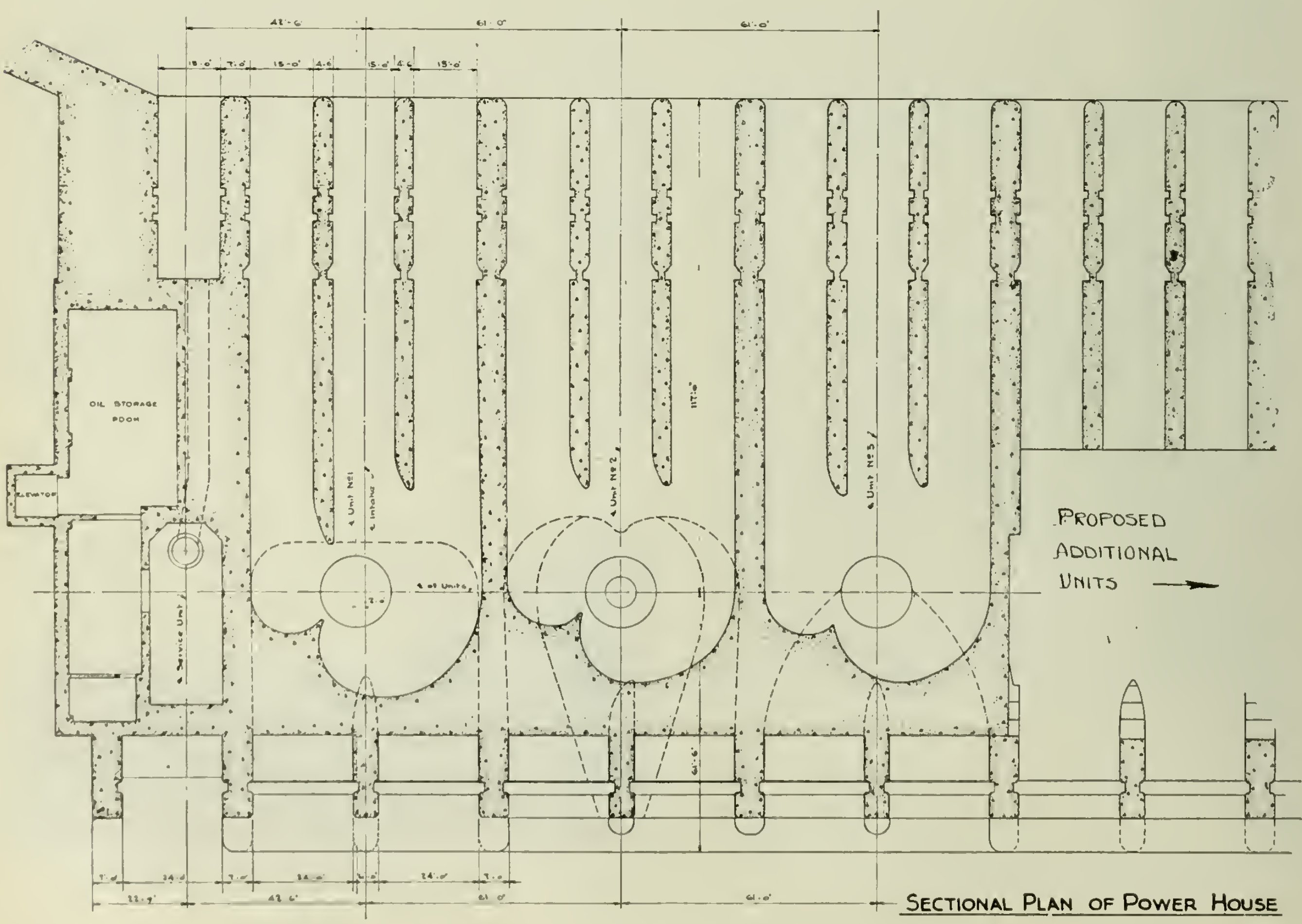


Fig. 7—General Arrangement of Power House.

hoisting by the gate-house crane. In removing the rack, the sections are lifted out one by one, by the crane, the remaining sections being supported in place by dogs engaging in bearing plates in the gate-house floor. Each section consists of a structural steel frame with the rack bars welded thereon. The racks are designed for a maximum stress of 22,000 pounds per square inch when completely blocked by debris under full head.

Four feet upstream from the racks, there is a series of steel gains for the emergency gates, of which there are three complete sets, sufficient for one unit. Sliding gates rather than those of the roller type were chosen for the reason that the flow can be shut off by either the headgates or the turbine gates, and the chances are slight of having to operate the emergency gates in swift flowing water.

The sluicegates have a height of 33 feet with a clear width of opening of 30 feet and are of the fixed roller type with individual hoists. The gates are provided with limit switches and gate position indicators and can be operated by push button control either from the hoist platform or from the deck of the dam. They are arranged for electric heating of the embedded parts and skin plate. For this purpose the backs of the gates were sheathed in, and a total of 30 kilowatts of heaters per gate are installed in the enclosed space. Bayonet heaters totalling 8 kilowatts per gain are installed in voids adjacent to the bedded parts. These gates are designed for a maximum stress of 18,000 pounds per square inch under the worst conditions.

The Winnipeg river is not subject to excessive freshets and for this reason the greater part of the flood water will be discharged by the spillway openings regulated by stoplogs. The stoplog hoist for handling and piling the stoplogs is electrically operated and travels by power drive on standard gauge track laid along the whole length of the dam. It has three speeds of operation in hoisting and lowering and is provided with a slipping clutch to guard against overloading. The frame of the hoist is adjustable in length so that it can handle the 20-foot spillway logs and also the 30-foot emergency logs for the sluiceways.

Turbines

Turbines of three different makes were purchased and this somewhat unusual policy was adopted in order to determine the most economical unit as regards first cost of machinery, concrete setting, efficiency, and operating characteristics, for installation in the final development. It was felt that a gain of a small percentage in efficiency would more than compensate for the additional cost. Piezometer tubes and facilities for applying the Gibson, Allen, and current meter efficiency tests have been installed in the intake passages.

Six units of the high speed propeller type were decided on for the complete development, and three of these have been installed in the initial development. The turbines are rated at 37,500 h.p. under a head of 66 feet and a speed of 138½ r.p.m. This gives a specific speed of 142, and a discharge at full load of about 5,500 c.f.s. for each machine, while the efficiencies at best gate opening are about 90 per cent. The WR^2 of the generators is 22,000,000 pounds feet squared, somewhat in excess of that required for good governing.

The turbines proper are somewhat of similar design but the draft tubes are quite different. The runners are cast steel and vary from 195 to 200 inches in diameter, both four- and six-blade types being used. Two of the units have ten stay vanes each, of cast iron and semi-steel respectively, while in the case of the third unit the complete speed ring is made of welded plate having twenty stay vanes. All units have steel plate throat rings and draft tube liners, the latter extending down about 16 feet below the centre of the speed ring. The scroll cases are all of the spiral formed concrete type, the draft tubes also being of formed concrete. No 1 draft tube is a modification of the hydraucone type employing a plane base; No. 2 of the Moody symmetrical spreading type with central cone; and No. 3 of the more usual elbow type. In the case of the No. 2 unit the upper 14 feet of the cone is plate covered. Each unit has 20 welded plate guide vanes, with the usual breaking links, or shearing pins. The main shaft is 27 inches diameter in all cases, and the lignum vitae water-lubricated guide bearings are all interchangeable. The runners have a low setting, the trailing tips varying from elevation 825 to 829 based on a minimum tailwater elevation of 833.

The governors are identical for the three units and are of the actuator type using oil under pressure, and with motor-driven flyballs. Each unit has its own oil pumps but these are of sufficient capacity for two units and are arranged for operation either singly or interconnected. The closing time for full stroke is from 2½ to 3 seconds, and the sensitivity ¼ to ½ per cent.

Mechanical Equipment

On account of the high tailwater of the initial development which will prevail for a considerable period, the tailwater will be above the roof of the scroll cases. It was felt that exceptionally good facilities should be available for dewatering the turbines for inspection and repairs. This can be accomplished separately in two ways; firstly by a system of air locks by which the water in the scroll cases can be depressed pneumatically; and secondly by pumping after placing gates over the draft tube outlets for which purpose a travelling gantry crane has been provided. The air lock (Fig. 9) will be used generally for inspection purposes but when any extensive work is necessary, such as the removal of a turbine head cover, the tailrace gates will have to be lowered and pumping resorted to. The draft tube dewatering pump of the bore hole type has a capacity of 3,500 gallons per minute at 70-foot head, and can be set up in each pump shaft as required. The motor and driving head are handled by a special hoisting drum on the gantry crane. However, provision has been made to handle the 60-foot length of 16-inch riser pipe, pump, and shafting by means of a jib crane attached to the downstream wall of the generator room.

An air bubbler system will be installed for preventing the formation of heavy ice in front of the dam, sluicegates, and stoplogs; and in front of the racks for the purpose of stirring up silt and debris as an aid in keeping them clear. For this purpose two 800 cubic feet per minute compressors with suitable air dryer are provided. They are also used for pneumatic dewatering of the scroll cases.

On account of high tailwater especially during the initial stages, it was necessary to provide ample sump pump capacity and for this purpose two 500 U.S. gallons per minute pumps were installed, and are arranged for automatic operation by means of float switches.

A 50-ton electric travelling crane is provided for the gate-house, and in order to cut down head room to a minimum a special spreader which can be substituted for the crane hook is used for handling the emergency gates, racks, and headgates.

The generator room is equipped with a 200-ton four-motor eletric travelling crane with a 25-ton auxiliary hoist, and in addition to serving the generators, turbines, and equipment on the generator room floor it is arranged for handling the main transformers, and switching equipment, all of which can be transferred by it from cars to a loading platform on the level of the transformer floor, from which point the switching equipment for the upper floors is handled by a freight elevator.

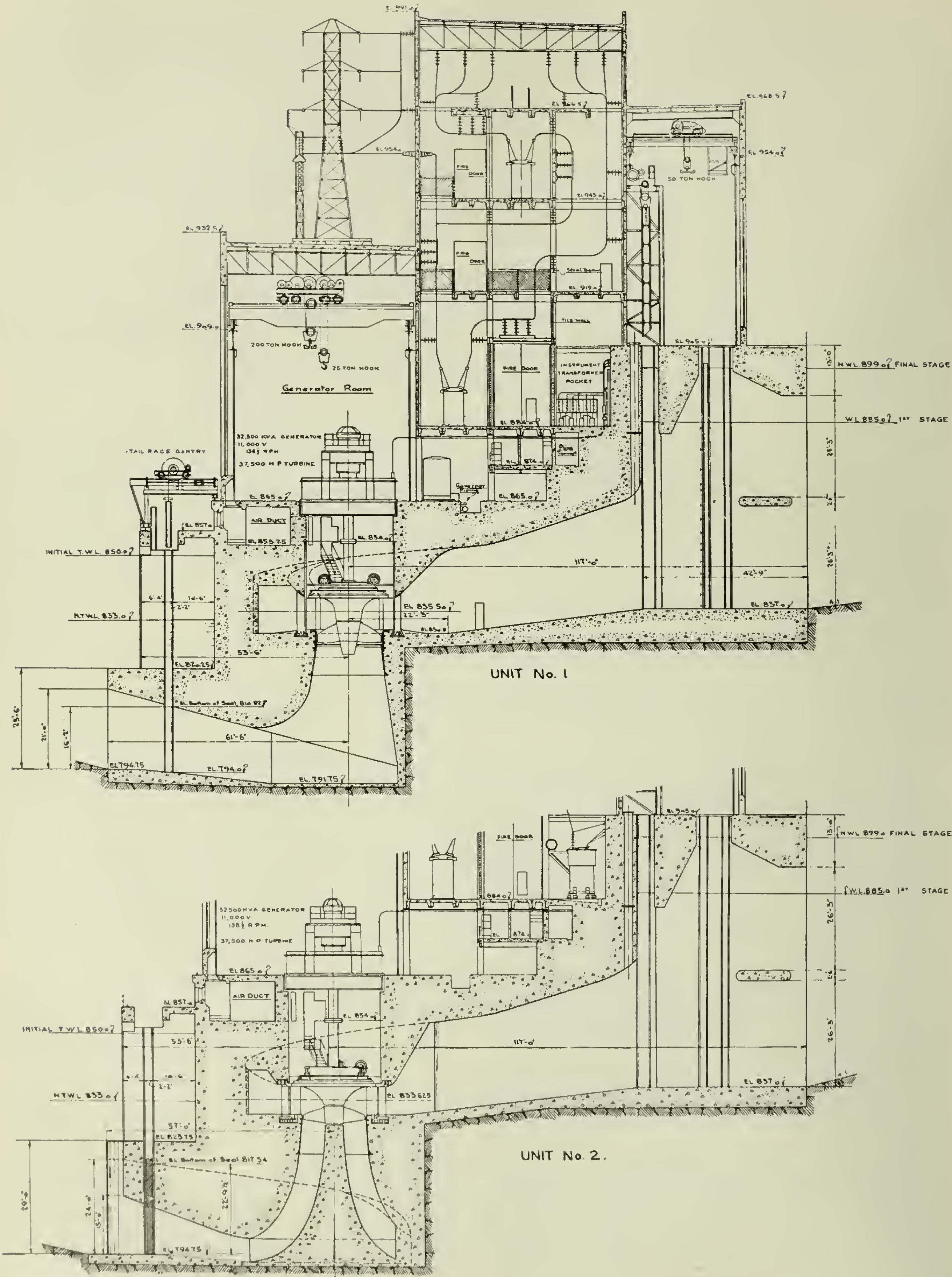


Fig. 8—Cross Section through Power House Showing Turbine Settings for Units Nos. 1 and 2.

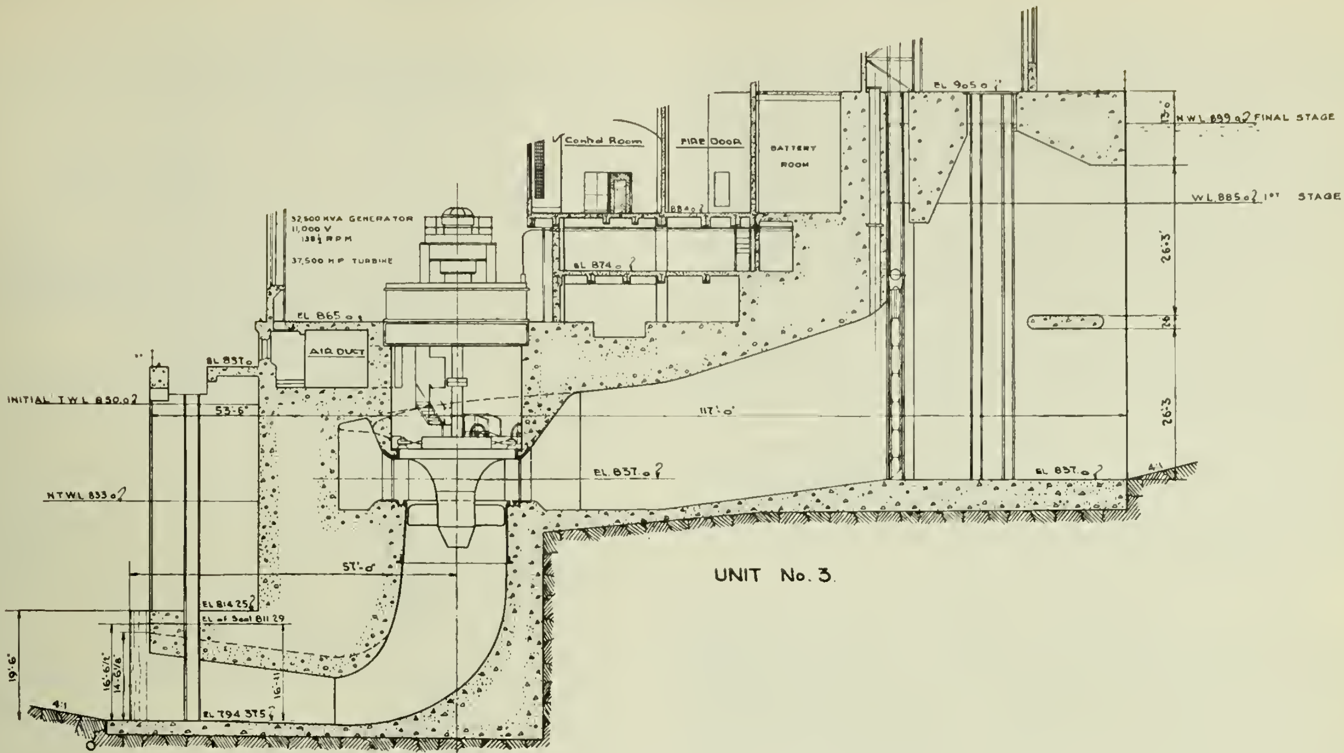


Fig. 8a—Cross Section through Power House Showing No. 3 Unit Turbine Setting.

A 5-ton freight elevator with push button control operating at 70 feet per minute serves all of the floors from the oil storage room at elevation 846 to the high tension bus room at elevation 966.5. The car is of sufficient size—9½ feet square by 13 feet high—to carry the high tension oil circuit breaker tanks. Rails are sunk in the floor of the car and line up with rails on the various floors on which oil circuit breakers are installed in order to facilitate the moving of this equipment.

Generators

As outlined above, the best size of water wheel appeared to be 37,500 h.p. and since there were no electrical features which rendered the use of such a unit undesirable, generators having a rating of 32,500 kv.a. at 85 per cent power factor were chosen. This rating is slightly in excess of that of the water wheels but additional kv.a. capacity was considered desirable. The generators are of the vertical type having a thrust bearing and two guide bearings. Each has a rating of 32,500 kv.a. at 85 per cent power factor, 11,000 volts, 3-phase, 60 cycles, at 138½ r.p.m. Full load temperature rise is 60 degrees C.; full load efficiency 97 per cent, and transient reactance 35 per cent. Temperature detector coils are supplied and each unit has a direct connected shunt wound interpole exciter rated at 165 kw. 250 volts.

The stator winding is a four parallel star. Two leads are brought out from each end of each phase winding so that split phase protection may be applied. Current transformers to give this protection on the neutral end of the winding are mounted in a sheet steel housing on top of the generator frame. The neutral lead and six main leads are brought out through the top of this housing in brass conduits. Non-automatic sprinklers are installed inside the generator frames by means of which the ends of the winding may be sprayed with water in case of fire. The individual oiling system is used, there being no connection between units and no central oil supply. A small filter and motor-driven oil pump is installed in the machine pit and a gear pump driven by the main shaft is located in the oil pan below the lower guide bearing. Under normal operation the shaft-driven pump will deliver oil to the thrust bearing and to each guide bearing independently. All three bearings drain to the filter. The motor-driven pump operates automatically in case of failure of the gear-driven pump and is also used for starting up. The generators are fabricated throughout of steel plates and structural shapes welded in place, only a few hundred pounds of cast metal being used out of a total weight of 713,000 pounds per unit. The rotor is built up on a small cast steel hub which is keyed to the shaft, the inner portion of it being a more or less open framework of heavy steel plate while the rim consists of laminated punchings which are keyed to the inner portion. A large number of fitted dowels and through bolts hold the laminations rigidly in place so that the rim takes care of all radial and tangential forces.

A centrifugal overspeed relay on the shaft will, by opening the governor safety solenoid circuit, close the turbine gates to no load position, and at the same time cut resistance into the exciter field by interconnection with the overvoltage relay. A two-pole electrically operated field circuit breaker and the field discharge resistor are mounted on the side of the top bracket thus shortening the exciter leads, and no auxiliary or emergency excitation circuit is provided.

The station service generator is rated 1,000 kv.a. at 75 per cent p.f. 2,200-volt 3-phase, 360 r.p.m. It is of the vertical type with a thrust bearing and two guide bearings, the upper one located in the same oil well as the thrust bearing. There is no forced oil circulation. The thrust bearing is water cooled. The winding is a single circuit star with both ends of each phase brought out for differential protection. The neutral is solidly grounded.

Transformers

The main transformers are oil insulated water cooled, single-phase, rated at 10,900 k.v.a., 45 degrees C. temperature rise; ratio 11,000/72,000 volts with full capacity taps for 63,500, 65,000 and 68,000 volts on the high tension winding. They will be operated delta Y connected at 110,000 to 125,000 volts with high tension neutral solidly grounded. Three banks of three transformers and one spare have been installed. They have a reactance of 10 per cent and a full load efficiency of 99.1 per cent. The cores are of the three legged type with windings on the centre leg only. The high tension bushings are of the condenser type equipped with bushing type current transformers. The low tension bushings are cemented porcelain. The transformers have conservators, no load tap changers, and all the usual accessories. The tanks are mounted on swivel bogies, which run on the previously mentioned tracks. The weight of a complete transformer is 98,000 pounds. It contains 2,400 Imp. gallons of oil; 25 gallons of cooling water per minute are required.

A bank of three 750 kv.a. transformers and a spare are provided for duplicate station service. They are oil insulated, water cooled, 50 degrees C. temperature rise, 63,500/2,200 ratio, Y delta connected with high tension taps and no load tap changers. They are equipped with conservator tanks, calcium carbide breathers, oil-filled high tension bushings and swivel rollers.

Electrical Layout

The relative advantages of indoor and outdoor switching equipment were carefully considered, and from estimates made it was felt that the installation of indoor apparatus was justified for several reasons. Considerable weight was given to the severity of the winter climate in this locality, making outdoor installation and maintenance more costly. To provide the same factor of safety as regards continuity of service, additional equipment would be required outdoors, also the cost of low tension connections and cooling system were relatively higher for the outdoor scheme. In addition to this with the building design decided upon there was considerable space available between the gate-house and the generator room; without involving great additional expense, it was found that this space could be enlarged sufficiently to house the switching apparatus.

The system of connections adopted is shown in Fig. 10 and while it has not quite the flexibility of a double high tension bus, it uses only three breakers per unit instead of four. It provides for unit operation of generator, transformer bank and line, and synchronizing at the receiver end can be conveniently carried out. A single high tension ring bus is provided so that any transformer bank may deliver power to any line and any circuit breaker may be overhauled without interrupting service. Relay connections also are simplified by this system. There is no low tension bus and no means of interconnecting units on the low tension side of the transformer banks.

The high tension breakers are rated at 138,000 volts, 1,500,000 kv.a. rupturing capacity, A.I.E.E.-2 O.C.O. duty cycle. They are operated by a D.C. motor mechanism of the fly ball type, with the mechanism auxiliary switch and control wiring completely enclosed in the mechanism housing. The circuit breakers are guaranteed to close in .9 seconds, and require approximately 90 amperes at 250 volts for operation.

All indoor high tension disconnecting switches are gang operated, remote manually controlled of the three insulator post type, the centre rotating insulator being mounted on double ball bearings. All switch handles may be locked in both open and closed positions. Insulator stacks consist of four units having a dry flashover of 330,000 volts. Line disconnecting switches are equipped with grounding blades gang operated by means of a separated handle and operating mechanism. The grounding blades and power blades are interlocked as described below.

The equipment will be interlocked throughout by Robinson interlocks, locking each circuit breaker compartment door, each oil circuit breaker, each bus section compartment, and each disconnecting switch handle.

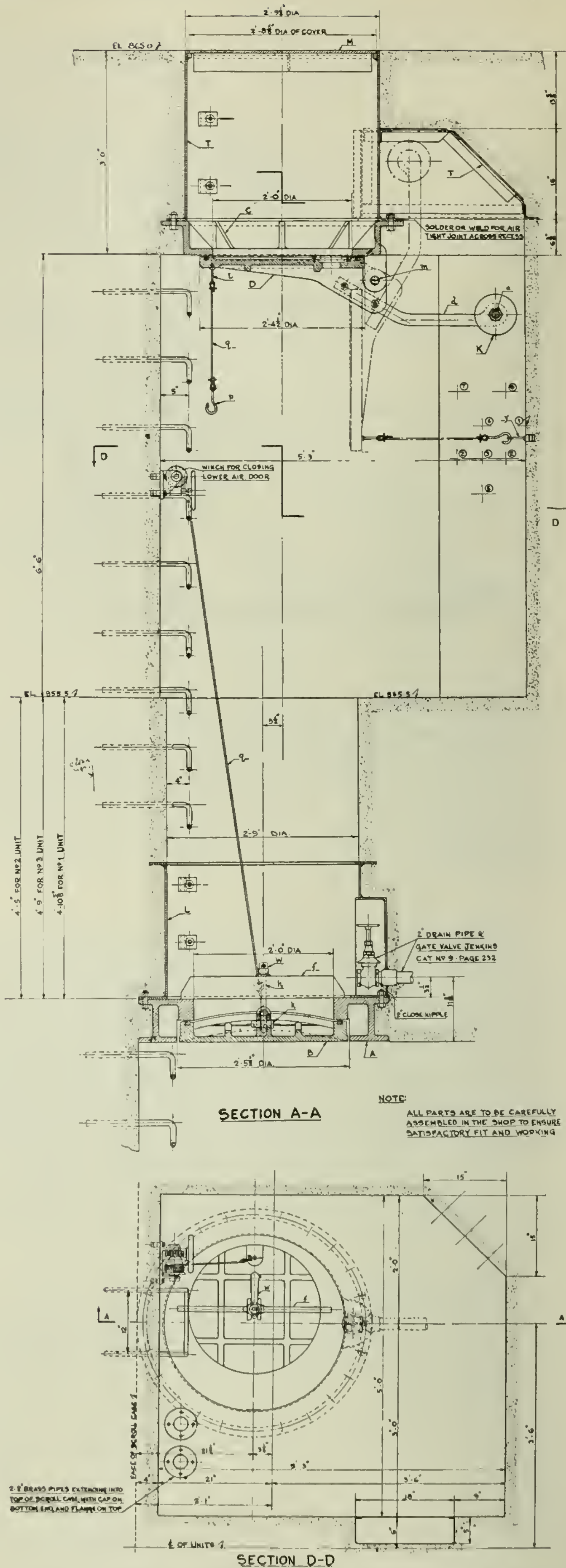


Fig. 9—General Arrangement of Air Locks for Dewatering Wheel Cases.

The circuit breaker interlock is electrical, and is essentially a key operated snap switch. With the key in the operating position, the circuit breaker can be opened and closed from the switchboard, but with the key removed from the lock the circuit breaker cannot be closed electrically. This interlock is mechanically connected to the circuit breaker operating mechanism and when the circuit breaker is closed the key is held in the lock and cannot be removed. The interlocks do not occasion the operator any additional work except the handling of the keys. They do, however, compel him to carry out all operations of clearing a piece of apparatus in a fixed sequence, which, when completed, absolutely assures him that none of the apparatus is alive. As long as he retains the clearance key none of the apparatus can be accidentally made alive, either from the control room or elsewhere. A master key will be available in the control room to give quicker access to a compartment in case of emergency.

A copper strap ground bus, bolted to the wall at a safe height, is carried the full length of each main floor. Connections are made to the building steel and to each insulator base, disconnecting switch, transformer, generator, and conduit run. Connection from apparatus to the ground bus will, in most cases, be buried in concrete, but the connections at both ends will always be open so that the condition of the ground can be checked up at any time. Three ground plates are buried in widely separated and permanently wet clay deposits, on both banks of the river.

The control switchboard is made of ebony asbestos lumber with an angle iron framework and channel iron base set on concrete pads with top four inches above the floor level. The control cables from the back of the board pass down through slots to cable trays in the room immediately below. The board is made in two sections mounted back to back. On the front section are mounted the indicating meters, control switches, test blocks and mimic bus; on the back section the relays, graphic meters, and integrating meters. Two voltmeters and two synchronoscopes are mounted on a swinging panel to the left of the front section.

The generators are protected by differential relays, split-phase balance relays, overvoltage, and overload relays. The latter, being required for protection of the high tension bus only, will be given a very high current and short time setting.

The transformers are protected by differential relays and the bus tie and line breakers by overload and ground relays. Where a relay is required to trip two or more circuit breakers simultaneously a multipole auxiliary relay is connected between the protective relay and the circuit breaker trip coils. The auxiliary relays are self-resetting except those operated by differential relays which are hand reset. If a breaker is tripped by differential relay it cannot be reclosed until the operator goes to the relay board and resets the auxiliary relay by hand, thus assuring that he will examine the apparatus involved before reclosing the breaker.

A signal equipment is provided on each generator panel and on pedestals near each governor, by means of which the floorman and the switchboard operator can exchange signals to start, stop, pick up load, drop load, and O.K. The switchboard operator controls an electric horn and a signal light adjacent to the machine which requires attention together with the standby signal on the signal pedestal. Arriving at the generator, the floorman will acknowledge the signal by turning out the standby light both at the pedestal and at the switchboard. The floorman can call the switchboard operator by means of a signal bell which may be operated from any signal pedestal. In addition to this, telephone connection is provided between the control room and signal pedestals.

By means of test blocks, any relay or meter may be calibrated in position. All work required in this connection can be done from the front of the switchboard and no connections whatever are disturbed. Circuit breaker trip circuits from relays are carried through the test blocks as well as current transformer leads, so that a cycle counter may be connected in circuit and relays accurately timed. When testing relays with test block covers removed, a tripping circuit from the control switch is maintained complete so that the circuit breaker may be tripped by the control switch if necessary.

Each generator has a voltage regulator of the exciter rheostatic type with hand-operated adjusting rheostat. Line drop compensation up to 24 per cent is provided, and cross current compensation can be used if necessary.

The station service switching is of the metal clad type, electrically operated and controlled from the main switchboard with protective relays and integrating meters mounted at the equipment. Under normal operation, essential circuits will be carried on the station service generator and non-essentials on the local service transformer bank. All services, however, can be carried on either source. By means of a transfer bus any circuit breaker may be taken out of service without causing an interruption. Power for the electric boiler, the townsite and outside construction work for future extensions will be distributed at 2,200-volt. All other circuits are carried to secondary transformer banks, 2,200/550 volt transformation ratio, and of ample capacity so that all essential service could be maintained with two transformers of any bank connected in open delta.

Racks with steel trays carrying control cables run the length of the building to the switchboard, and control conduits terminate in the tray tunnel. The control cables are multi-conductor 30 per cent rubber, and are lead-covered where subject to moisture but braid covered for the upper floors.

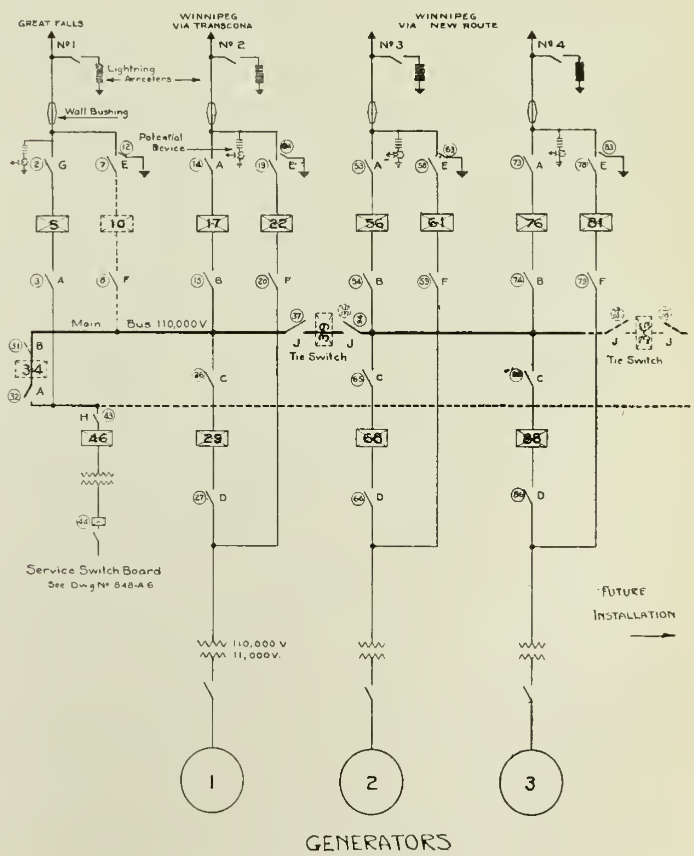


Fig. 10—Diagram of Connections.

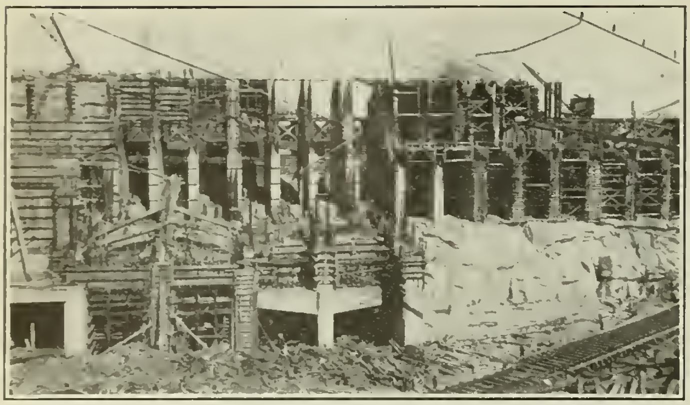


Fig. 11—South End of Power House From Downstream.

A fireproof instrument transformer pocket for current and potential transformers is provided for each main unit. There are six current transformers for split-phase protection and three others having five secondary windings each for transformer differential, generator differential, meters, relays, and voltage regulator compensation respectively. Potential transformers are isolated by concrete barriers. There are two potential transformers per unit for driving the governor speed head motor, two with double secondaries for meters and relays and one for the voltage regulator. Combination resistor type disconnecting switches and fuses are installed in the primary circuits of each.

High tension potential devices of the capacity coupled type will be used in place of the conventional potential transformers for measuring line voltage and for synchronizing. They consist essentially of a comparatively low ratio potential transformer connected to the line by means of condensers. A protective resistor is connected between the condensers and the line, voltage being measured from one phase to ground. The outgoing high tension lines are taken through the bus room wall by six wall entrance bushings of the condenser type and six of the oil-filled type. Both types are rated at 132 kv. with a wet flashover exceeding 275 kv.; they are installed with a universal wall mounting. Lightning arresters mounted on the new porous block and thyrite types will be installed. A very simple framework is required for these arresters, which occupy only a fraction of the space required for the older types.

Three 4,000-gallon tanks are provided for handling and storing transformer and switch oil. Direct connection is made to these tanks from the transformers which drain by gravity. The circuit breaker tanks are not permanently piped to the drain line. A pump delivers oil from the tank room to any transformer or circuit breaker pocket, where it will be passed through a portable filter into the transformer or breaker.

A storage battery of 120 lead-acid type cells with a rating of 240 ampere hours is provided for switch operation and emergency lighting. It has capacity to carry a lighting load of 5 kw. for three hours immediately followed by a discharge of 400 amperes while maintaining a potential of 1.75 volts per cell. It uses glass jars of the enclosed type, and will be floated on the control bus at 2.15 volts per cell.

The power house lighting is designed to eliminate shadows as far as possible and to give the following foot-candle intensities of illumination: generator room floor ten, gate-house floor five, stairway five, turbine pits ten, tunnels and passages three and control room fifteen. This latter room has a domed ceiling and totally indirect lighting is used. An emergency lighting circuit is arranged to throw over automatically on to the control battery in the event of the A.C. supply failing, and emergency lights are provided in the control room, stairways, and main passages, and at each governor.

The charging set has a rating of 7½ kw., and the control is semi-automatic, arranged to disconnect the generator on reverse power. If the A.C. supply fails the set will shut down, and start again when power is restored, in which case the generator will cut in as soon as its voltage builds up.

Transmission Line

A double-circuit 110,000-volt steel tower transmission line, 63 miles long, (see Fig. 12), was built from Seven Sisters to the Winnipeg district; this voltage having been adopted for interconnection with the existing 110,000 volt Great Falls system. The line was designed for a load of 32,500 kv.a. per circuit, with a receiver end voltage of 100,000 and a regulation of 15 per cent at 95 per cent power factor, without the use of synchronous condensers, future installation of which will increase the capacity of each circuit to 50,000 kv.a.

The conductors are 336,400 cm. A.C.S.R., spaced 10 feet vertically with the centre conductor offset 3 feet 6 inches; a 134,600 cm. A.C.S.R. ground wire is installed on the peaks of the towers and compression type joints and dead ends are used throughout. The normal spacing of towers is 1,000 feet, while the longest span is 1,620 feet, the minimum clearance of conductors to ground being 22 feet 6 inches. At railroad and important road crossings this clearance is increased to 35 feet and in the city to approximately 30 feet. Three main types of towers only are used, namely, standard suspension, dead-end, and angle type, in addition to which there are two special sectionalizing and a top-off structure. All are designed for a loading of 8 pounds per square foot wind, with half an inch of ice at 0 degrees C. and a maximum tension under this loading of 8,000 pounds per cable, which is approximately 68 per cent of the elastic limit of the conductors. They are galvanized throughout, set on steel grillages, and silicon steel is used in the heavier members to reduce weight. Fourteen towers rest on muskeg and all others on standard earth footings, there being no rock outcrops along the line. Strings of seven insulators are used on suspension towers and double strings of eight units at dead ends.

The line is completely transposed four times between Seven Sisters and Winnipeg, and in order to obtain information for use in future construction, two miles of it will be equipped with festooned cable vibration dampers.

In addition to the line to Winnipeg, a double-circuit 266,800 A.C.S.R. line will run to Lac du Bonnet where it will tie in to the Great Falls-Winnipeg system. Here spacing is 800 feet and the towers are considerably lighter than on the Winnipeg line.

Wood pole telephone lines paralleling the transmission circuits on the same right-of-way, will run to Lac du Bonnet and to Winnipeg, and will consist of a single metallic circuit of No. 8 copper except for the river spans where copper-clad steel is used. Twenty five-foot cedar poles with 6-inch top and a 150-foot span are standard.

Construction

Few power developments have been as happily situated as the Seven Sisters. Located within a convenient distance of the city, yet far enough away to avoid excessive labour turnover; served by main line train service with two trains daily each way; within two hours from Winnipeg on a gravelled highway open at least eight months of the year; and connected direct by telephone and telegraph service, there never has been a transportation or communication problem. Labour troubles have been non-existent and the number of fatal accidents less than half the ratio usually obtaining for work of this nature.

Throughout the duration of the job weather conditions exceptionally favourable to construction work have obtained, with a minimum of rainfall. River flow conditions have also been favourable; the normal flow of 10,000 c.f.s. in the main channel of the river having fallen to between 4,000 and 8,000 c.f.s. during the water-handling periods.

The permanent townsite, including staffhouse, twelve permanent cottages, hospital, general store, school, railway station, office building, and recreation hall, all connected with electric light, sewer and water service, as well as a dozen or more temporary foremen's cottages were built during the early stages of development, in addition to the usual camp buildings, and added materially to the comfort and efficiency of the employees during the construction period.

The main contract for constructing the dams, powerhouse substructure, superstructure and tailrace was awarded on a cost-plus-fixed-fee basis. The contract for earth dykes was given on a unit price basis. The contract for the transmission line erection was also awarded on a unit price basis. The Dominion Bridge Company of Winnipeg supplied and erected the structural steel. Power Corporation of Canada has co-operated with the Northwestern Power Company on design and supervision of construction.

Originally it was intended to have the plant in operation by December, 1930. By the fall of 1929, however, the impending business depression indicated that the additional power would not be required until the fall of 1931, and the schedule was consequently retarded as far as was then possible by setting back the equipment deliveries and closing down the concrete work for the winter.

Rock work was commenced in July, 1929. There were some 180,000 yards of rock to remove for power house and initial tailrace excavation. From this quarry approximately 130,000 yards of crushed stone were obtained for use as coarse aggregate and crushed stone facing for the initial dykes, the remainder being deposited in a waste pile for the sake of speed in excavating, to be reclaimed to the crusher at a later date for future dyke facing.

The spillways were built solid up to the initial crest level of 874 south of the sluiceways. The rollways of the sluices were left open between piers for carrying the flow of the river while the closure portion of the spillways were poured. When this was completed the sluices were stoplogged and the flow diverted through openings in the spillway section. These latter openings were successively closed by filling the rollways behind stoplogs, taking a 10-foot lift on from one to three openings at a time, and forcing the flow back over the completed sluice rollways.

Steel erection was commenced on the first of July, 1930, and completed on November 5th, 1930. The building was entirely closed in by November 20th, before the severe

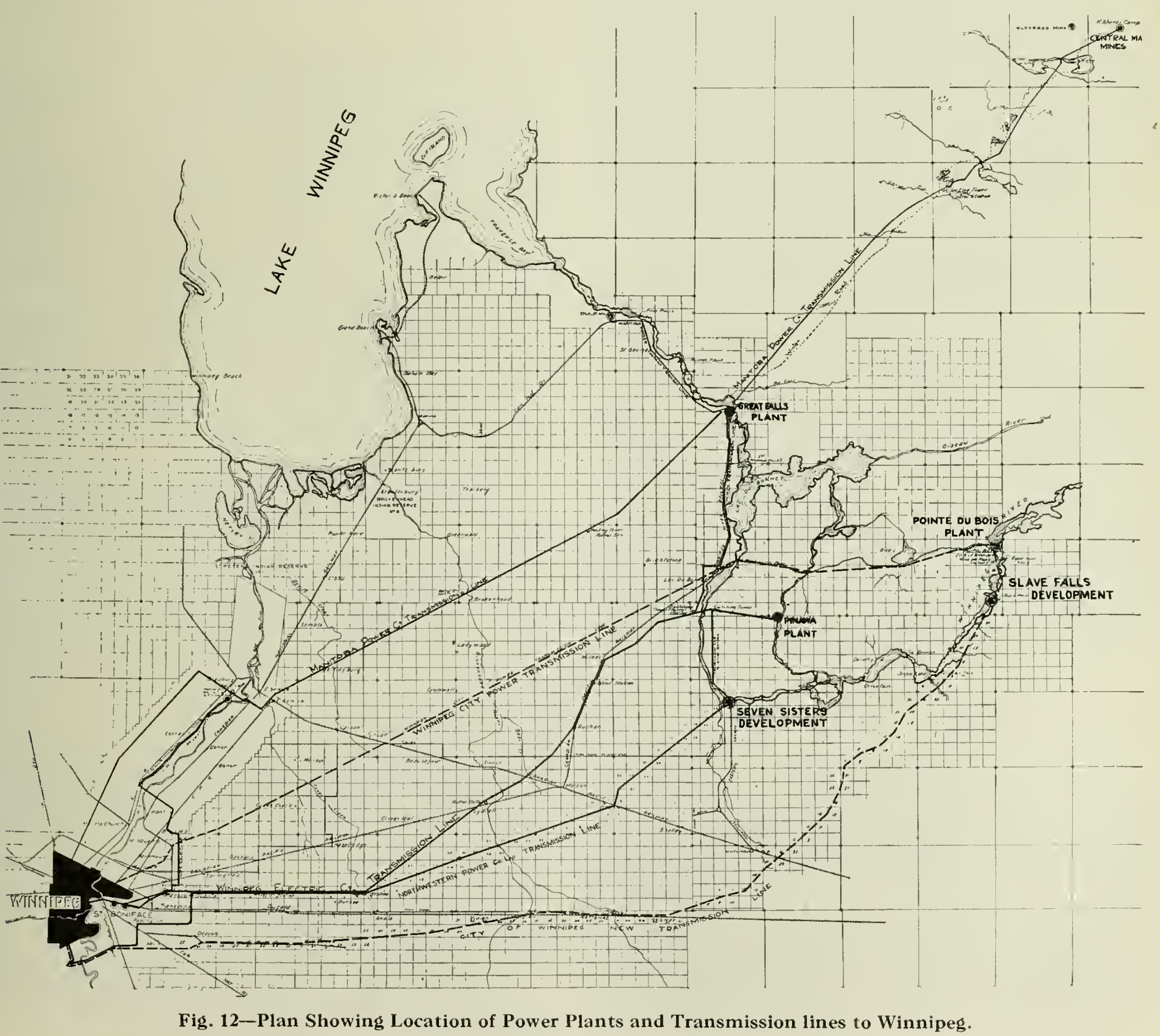


Fig. 12—Plan Showing Location of Power Plants and Transmission lines to Winnipeg.

winter weather set in, leaving the winter for pouring interior walls and floors, setting bedded parts of turbines, and completing substructure concrete around them. Generator installation was commenced in February, 1931, and the first unit is expected to be in operation by June 1st, and all three by September 1st, 1931.

The quantities involved in some of the principal features of the initial development are as follows:

Rock excavation	180,000 cu.yds. of solid rock.
Concrete	150,000 cu.yds.
Cement	650 carloads.
Reinforcing steel	3,000 tons.
Lumber	7,700,000 F.B.M.
Structural steel in power house superstructure	1,400 tons.
Machinery and equipment	300 carloads.
Earth dykes	350,000 cu.yds.
Stone facing	75,000 cu.yds.

Additional quantities for the final development include the following:

Earth Dykes	1,800,000 cu.yds.
Stone Facing	300,000 cu.yds.
Tailrace rock excavation	950,000 cu.yds.

For the initial development, it was necessary to build only the lower portion of the dykes for the first mile and three-quarters on either side of the river. Owing to the peculiar nature of the material available, great care and special equipment was required for compacting. The clay was excavated in side borrow pits with 1½-yard draglines, and hauled and deposited in 7-yard caterpillar wagons hauled by 60-h.p. caterpillar tractors. The clay was deposited in 6- to 8-inch layers, spread with a blade grader, and consolidated without sprinkling, by means of the travel of the tractors and wagons themselves, and by a heavy oil filled "Sheeps-foot" roller. The shrinkage in material averaged 10 per cent and frequent bearing tests indicated a consolidation considerably greater than the natural ground on which the dyke rested.

The first 4 inches of the crushed stone facing was spread and rolled into the surface of the clay core by means of a 30-ton roller, after which the balance of the 3-foot thick layer of crushed stone was deposited and spread with the same equipment as was used for placing the clay.

The construction plant was laid out on the north bank of the river. A No. 8 gyratory primary crusher and two No. 5 gyratory secondary crushers received the rock direct from the tailrace quarry, and the output was delivered by a belt conveyor to a stock pile, conveniently located so that a tunnel passing under the pile and containing a 30-inch conveyor belt carried the coarse aggregate direct to the mixer bins. A sand pit was opened and stripped near Whitemouth, and the sand was delivered in 2-yard dump cars to a track hopper, from which it was handled in to a storage pile by belt conveyor. Underneath the sand pile was another tunnel with a belt conveyor, loading the sand to the mixer bins. Cement was delivered in bulk and shovelled direct from the freight cars into a hopper bottom bin, from which it was drawn through weighing scales into concrete buggies which were dumped direct into mixer hoppers. The power house concrete was placed by chuting equipment from a tower 260 feet high.

A steel transmission line approximately 7½ miles long was built from the Pinawa line of the Winnipeg Electric Company to the site of the work to furnish power for construction, this line serving later as a tie line connecting the Seven Sisters plant with other plants of the Manitoba Power Company, and the Winnipeg Electric system.

Local substations containing transformer banks were located at points of load concentration and fenced in. They were connected for the most part by armoured cable and this arrangement has resulted in remarkably few power interruptions.

The total force employed reached a maximum of some 1,200 men during the peak of the construction period. Local labour has been employed almost exclusively, and with the exceptions of turbines, generators, and certain special apparatus, all material entering into the work has been purchased and fabricated in Winnipeg.

During the life of the development to date some 30,000 visitors have been shown over the job, which indicates the extent of public interest in the development.

Personnel

The work was carried out under the direction of the engineering staff of the Northwestern Power Company Ltd., of which Company Mr. Edward Anderson, K.C., is president, and F. H. Martin, M.E.I.C., chief engineer.

The preliminary studies of design and the selection of turbines, switching equipment, dykes, etc., was submitted for approval to an Engineering committee composed of Messrs. R. S. Lea, M.E.I.C., J. S. H. Wurtele, M.E.I.C., C. O. Lenz, W. G. Fargo, E. V. Caton, M.E.I.C., F. H. Martin, M.E.I.C.; and Dr. T. H. Hogg, M.E.I.C., representing the government of Manitoba.

The hydraulic, structural and electrical design, and office engineering were under the direction of M. V. Sauer, M.E.I.C., J. C. Krumm, J. P. Fraser, A.M.E.I.C., and H. C. Ligertwood, respectively.

The Power Corporation of Canada Ltd. co-operated throughout with the company's staff on the design, construction and inspection.

F. F. Griffin, A.M.E.I.C., was supervisory engineer, and H. G. Cochrane, A.M.E.I.C., was resident engineer on the work.

W. L. LeRoy, M.E.I.C., acted as construction superintendent for the contractors.

G. B. McColl, A.M.E.I.C., made the preliminary surveys, prepared all final plans for registration and planned the permanent townsite.

DISCUSSION

J. S. H. Wurtele, M.E.I.C.[1]

Mr. Wurtele stated that the author's paper was very interesting, particularly his description and the way he had outlined the unusual features of the development. He believed that the tendency in the future would be towards a more simple design of plant and one with automatic equipment, also he believed that new plants should be designed with this idea in view.

Some fifteen years ago outdoor power stations were first considered; there were several operating in recent years, but one in particular was now in operation in Montana under severe winter climatic conditions and he was looking forward to the time when these outdoor plants would be used in Canada. He found the draft-tube models which the author referred to of particular interest and would ask Mr. Christiansen to give a few figures on the reinforcing steel used in the development.

A. Christiansen[2]

Mr. Christiansen remarked that in the design of the generator room substructure there were some particularly interesting features, namely—

The three different types of units and their large size;

[1] Plant Manager, Power Corporation of Canada, Ltd., Montreal, Que.

[2] Chief Draughtsman, Power Corporation of Canada, Ltd., Montreal, Que.

The completion of the superstructure before the concreting of the scroll cases and, finally, the placing of contraction joints.

The draft tube being about 54 feet wide by 31 feet deep and all stay vanes omitted, placed the load of some 6,000,000 pounds on the nose of the draft tube centre pier, which called for careful and special reinforcing.

The completion of the superstructure before concreting the scroll cases called for building column loads to be carried on a concrete beam 9 feet wide by 10 feet deep, 54 feet free span with a loading in excess of 1,000,000 pounds at each one-third of the length of the beam. This problem was overcome by placing steel supporting columns integral with the beam formwork, and then concreting the beam. These columns were to be burned out after the scroll case roof was poured and the column load could be carried on the completed substructure.

He remarked the experience gained at the Hemmings falls and Back river power plants as to contraction of the substructure, and that this was applied to the Seven Sisters plant by placing contraction joints between every second unit, giving one at about every 120 feet.

He gave some figures on the weight of reinforcing steel per cubic yard of concrete for the different units at the Seven Sisters plant, and for comparative power plants of earlier dates.

E. S. Holloway, M.E.I.C.[3]

Mr. Holloway understood that the author had stated that a water-cement ratio as low as four gallons per sack was used in proportioning the concrete and had also intimated that some slight difficulty was encountered in placing this dry mix, it would, therefore, be interesting if he would give the proportions used in designing the mix and the water cement ratio employed for the different mixes as well as the actual strength of the concrete obtained. That is, of course, the strength water-cement curve for the job.

If the strength of the test cylinders reached a figure largely in excess of 3,000 pounds per square inch, as is to be expected with a water-cement ratio of four gallons per sack, what objection would the author have had to increasing the water to facilitate the handling and placing the concrete?

It is recognized that if the Winnipeg river water is alkaline it is necessary to keep the water-cement ratio down.

Mr. Holloway also understood Mr. Christiansen to say that, for design purposes, the strength of the concrete was assumed as 3,000 pounds per square inch. It would be of value to hear his opinion regarding the desirability of using a higher figure where considerations of durability of the concrete necessitated a strength of say 4,000 pounds and what would he estimate the saving to be in various parts of the structure as head-works, power house, etc.

F. H. Martin, M.E.I.C.[4]

The author replied that the mix varied according to the designed strength of the concrete. In the spillways 2,500-pound concrete was used, in the scroll cases 3,000-pound and in some places as low as 1,500-pound concrete was used. All testing of material was under the control of the National Testing Laboratories, Ltd. The mix also varied according to the materials, the quantities used and amount of water furnished.

A. Christiansen

Replying to Mr. Holloway, Mr. Christiansen stated that the strength of the concrete for the draught tube centre piers was specified to be 3,000 pounds per square inch after twenty-eight days, whereas that of the concrete for the balance of the substructure was specified to be only 2,500 pounds per square inch.

The substructure is practically bulk concrete, and the higher stresses could not be developed to advantage.

N. J. Kayser, M.E.I.C.[5]

Mr. Kayser asked whether there were any tests made on the models of the various types of units which were used in the plant before adopting the three different designs.

F. H. Martin, M.E.I.C.

The author remarked that he was not prepared to answer this question as the manufacturers would state that tests had been made, but unless all facts and conditions surrounding these tests were known, and they were not, he was unable to accept the figures given by the various manufacturers. It was difficult to make test models and obtain the same conditions as would be found in the field and that was why the models which had been used in this case were actually made on the site.

He stated that he was not prepared to guarantee the accuracy of the results, but he hoped to obtain what he wanted and that was to have a reasonable comparison between the three different types of units. This was all that was necessary and in the preparation and arrangement of the tests both Mr. Gibson and Dr. Allen had been consulted.

Regarding the development as a whole accurate information was available as to the quantities of concrete and steel used as had been mentioned by Mr. Christiansen.

The reason for obtaining this information was that the river included a long chain of power sites in its drop of 710 feet in 400 miles and it would therefore be possible to develop some 3½ million horse power, the heads ranging from 70 to 29 feet. Few people knew the length of the water shed around Lake Winnipeg and the possible storage reservoirs on this river.

D. S. Laidlaw, Jr.E.I.C.[6]

Mr. Laidlaw enquired the reason for the outlet of the service unit being at a higher level than the remaining three units.

F. H. Martin, M.E.I.C.

The author replied that he believed this was due to the variability of the head and the fact that the development had to be carried out in stages, there was a possibility that the tailrace might never be excavated to its full depth, also they wished to get ahead with the other units as soon as possible.

M. V. Sauer, M.E.I.C.[7]

Mr. Sauer in moving a vote of thanks expressed the opinion that the author was deserving of much credit in two particulars; first, in the decision to utilize the Seven Sisters falls in one development instead of two as originally contemplated, and second, to install high speed "Propeller" type runners for a head higher than ever before had been attempted.

The concentration of the development in one head would result in greater ultimate economy, and even in the initial installation the cost had been made low by virtue of the arrangement whereby the head can be increased in successive stages.

In regard to the high speed runners the profession will await with great interest the operating results of these units and he hoped that the author would supplement his excellent paper with data on their behaviour after they have been in service.

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(3) Westmount, Que.

(4) Consulting Engineer, Winnipeg, Man.

(5) Director and Assistant to the first vice-president, Fraser-Brace Engineering Company, Montreal, Que.

(6) Beauharnois Construction Company, Beauharnois, Que.

(7) Hydraulic Engineer, Beauharnois Construction Company, Beauharnois, Que.

Quay Wall Design and Construction

Louis Beaudry, A.M.E.I.C.,
Designing Engineer, Harbour Commissioners of Quebec, Quebec, Que.

Presented before the Quebec Branch of The Engineering Institute of Canada, April 13th, 1931

SUMMARY.—This paper describes briefly various types of quay walls with special reference to the methods of construction suited to the severe climatic conditions in eastern Canada. Both cribwork quay walls and steel walls of the bulkhead type have proved satisfactory, the advantages of the former being cheapness, ease of construction and permanency under water, and of the latter, rapidity of construction and watertightness. The results of a number of tests of steel sheet-piling are given and the methods of protection against corrosion are briefly outlined.

General

It is essential that quay walls have a vertical face in order to permit vessels to lie close alongside, that they shall withstand the impact of ships against them, the pressure of current, waves, ice etc., resist overturning, sliding and deformation through the pressure of earth or other filling with its surcharge of merchandise.

Fig. 1—Crib No. 1.
Working on Course No. 25.

Solid filled quay walls are quite similar to an ordinary retaining or land wall. However, they involve features which make the necessary calculations therefor more complex and sometimes impossible. These features are the presence of water on both sides of the structure, the diminished weight of the wall due to its submergence in water, the variety of material usually found in the filling, and the variation in the weight of the filling due to the fact that part of it is submerged and part is not.

These uncertainties have at times lessened the faith in the theory that by careful calculations a quay wall may be made safe, and have convinced many that past experience is the best guide. However, this change of opinion may have been brought about through routine, misinterpretation in calculations, or discouragement through unsatisfactory results. Nevertheless, in view of the peculiar hazards involved, past experience alone is not sufficient to guarantee the stability of a quay wall.

The height of quay walls varies from that of land walls, particularly when important tide variations have to be provided for. In the port of Quebec the mean high tide is 18 feet above the lowest tide level, and the difference in elevation between the highest and the lowest tide is 22 feet, and even 24-foot tides have been experienced. To obtain 35 feet of water at mean low tide a quay wall having a minimum height of 65 feet is necessary, and over 70 feet to obtain a depth of 40 feet of water.

Classification of Quays

Quays may be divided into three types, namely:

1. Gravity;
2. Platform;
3. Bulkhead.

Gravity Type

The gravity walls are those depending on their intrinsic mass alone for their stability. They may be constructed of

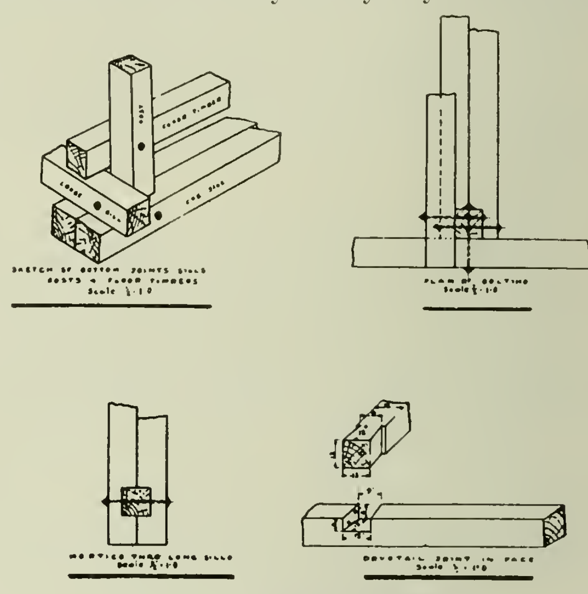


Fig. 2—Cribwork Connections.

rip-rap, cribwork, stone masonry, concrete blocks, mass concrete, caissons of concrete, steel, wood, or various combinations of these materials.

Platform Type

The platform or columnar types are those in which a platform on columns supports the live load. They are built over a sloping bank, either natural or artificial.

This type is adopted to allow freedom of movement of shore currents, for its economical advantages, and is mostly used for the construction of piers. When marine borers are not present, wooden piles are most suitable on account of their resiliency in resisting the impact of moving vessels.

However, this type of quay is not really a quay wall, so nothing further need be said on the subject.

Bulkhead Type

The bulkhead type of wall retains the fill behind by means of a row of sheet piles supported by the resistance of the ground into which they are driven, and also by tie-rods running back to anchors embedded in the ground in the rear.

Each of these types of wall have their respective advantages and often the different types are combined to the benefit of the completed wall; for example, when building a platform to support the surcharge and also a bulkhead underneath to retain the material of the ground or filling.

On account of winter conditions prevailing in eastern Canada, the wharves are nearly all of the solid filled gravity

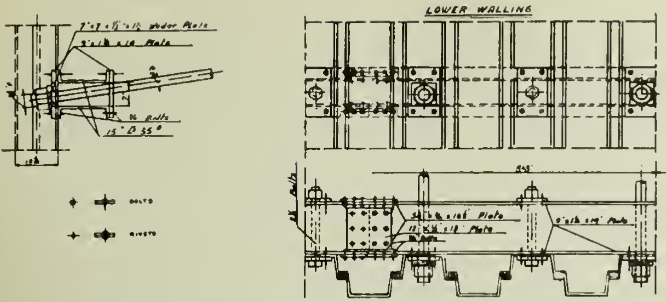


Fig. 3—Typical Section of Steel Wall.

type, built entirely of cribwork, or with a superstructure of concrete, with a few of concrete caissons. Cribwork is still extensively used as timber can be easily procured at reasonable prices.

Cribwork Quay Walls

For quay walls of the gravity type, cribwork has several advantages; its cheapness, ease of construction, and its permanency under water. As far as durability above water is concerned, there are cases where cribwork built over fifty years ago is still in good condition, although the timber exposed to the air, such as the facing, has been renewed every twenty years.

This wall was built for the port of Quebec in 1929-30. Although the superstructure, or portion of the wall extending from low water level to the top, is usually of concrete, this one is of cribwork so as to be similar to the rest of the wharf, of which it was an extension. Cross-ties are spaced eight feet on centres, and posts were used only in the substructure to connect all cross-ties to longitudinals. Fig. 2 shows the details of the connections. The timber used was all 12-inch by 12-inch B.C. fir, dressed on two sides.

This wall was calculated to resist overturning, for the maximum bearing capacity of the ground at any point of its base, to resist sliding, and was also designed to prevent deformation by back pressure. With a surcharge of 1,000 pounds per square foot, a safety coefficient of 2.5 against sliding was provided.

The unusual features in this design consisted in the provision for open pockets to permit the stone filling to penetrate into the ground, and the use of wooden piles to provide the required resistance against sliding.

Anchor Piles

The wooden piles were calculated as a cantilever, having the fixed end seven feet below the surface of the ground, or one-third of the total penetration. To obtain the required area for the fixed end, the length of pile was determined to be 35 feet, the diameter at the tip or small end to be 10 inches, and the penetration into the ground to be 20 feet. The use of 12-inch by 12-inch piles was permitted, but round piles of spruce were considered more convenient. The length was limited to 35 feet in order to reduce lateral deflection during driving, thus reducing the possibility of breaking, and also assuring more satisfactory driving. Since the use of a follower was not permitted the driving was done with a steam hammer working underneath the water. This method proved satisfactory and the driving proceeded under water to depths varying from 20 to 25 feet.

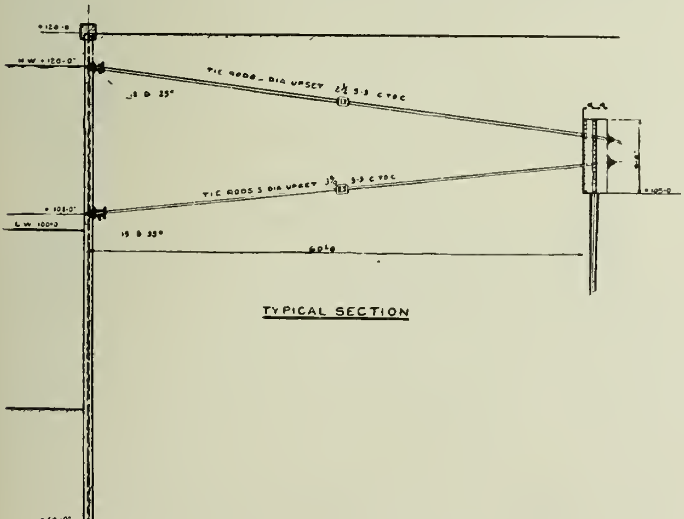


Fig. 4—Arrangement of the Anchor Rods and Walings.

Crib Seat

The operation upon which much of the success of a gravity wall depends, is the preparation of the ground to receive the wall. This is called the preparation of the crib seat for the cribwork walls.

To obtain a crib seat having a uniform elevation, and also to prevent disturbing the original compactness of the ground, a dredge of the bucket ladder type was the only one permitted to be used on this work. The ground consisted of fine sand mixed with a low percentage of clay and a few boulders.

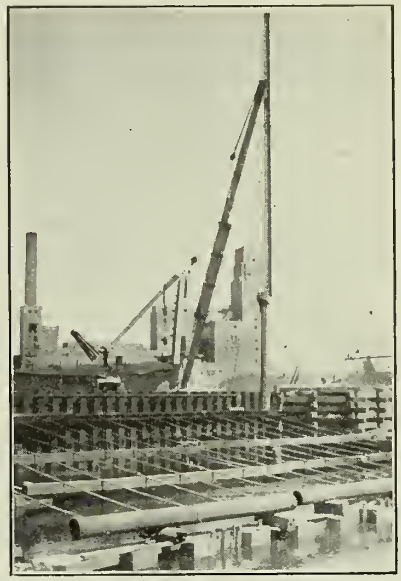


Fig. 5—Interlocking Last Sheet Pile.
Length of Pile 60 feet.

Steel Wall of the Bulkhead Type

Although the wharf walls in existence in the eastern part of Canada are mostly of the gravity type, in many cases the use of the bulkhead type would have been a more economical solution. As far as the writer is aware, this type has been used in only two cases. The first one is located at Sorel, Que., built of reinforced concrete and was completed in 1929. The other for the port of Quebec was built of steel and completed in 1930.

When the foundation permits its adoption the steel wall of the bulkhead type offers several advantages over wall of the gravity type, namely:

1. The stresses can be more definitely calculated;
2. Cheapness;
3. Rapidity of construction.

History

Although steel sheet piles have been fabricated in the United States for over twenty-five years, their use has been

Fig. 6—View showing Alignment of Steel Wall.

mostly limited to cofferdams, trenching, curtain walls of earth dams, and it is only rather recently that they have been used for quay walls of the bulkhead type.

In Europe steel walls of the bulkhead type were built as far back as 1885. As no appropriate shapes were rolled at that time sheet piles were fabricated with channels and angles. Some of these constructions are still in service, and although they may be classed as experiments they have afforded valuable opportunities for studying the exposure of these steel piles to corrosion, their durability, and their suitability for the construction of wharves.

Numerous shapes of steel piles have since been invented and rolled and at present some are rolled with a section modulus of nearly 80 cubic inches.

The steel wall of the bulkhead type was adopted by the port of Quebec as it eliminated the risk of a sliding movement, and also gave a wall of impervious construction. These two qualities were essential since it was necessary to build the wall as close as possible to a marine railway. A sliding movement might have blocked the railway, and any lack of imperviousness would have meant a loss of filling material, which would have been deposited on the railway tracks, and caused considerable damage.

The adoption of steel sheet piles was quite unusual considering the 48 feet of filling to be supported and the required level of 25 feet of water at low tide.

Fig. 7—General View showing Steel Wall, with Concrete Coping Completed.

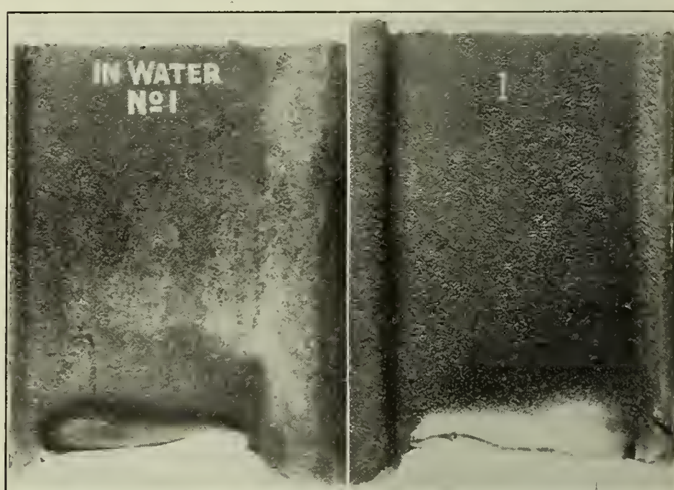
The fixed end was established five feet below the surface of the ground and the lower tie-rod was located two feet above mean low water. A span of 32 feet was the result.

Fig. 3 shows the typical section of the wall.

The sheet piles were calculated as a continuous beam, fixed at one end, and supported on two points at the walings. The required length of penetration was determined by the passive resistance of the ground. The Rankine theory was used to determine the ground pressure, the passive pressure, and to locate the anchor wall. In order to obtain sheet piles having the required section modulus without being excessive in weight, high tension carbon steel was specified, thus permitting calculations on the basis of 23,000 pounds. Structural steel grade was used for all the other steel members, and the resistance was calculated at 18,000 pounds.

Fig. 4 shows the arrangement of the anchor rods and walings. It is to be noted that they are placed at the back of the wall, to improve the appearance and also to eliminate obstructions to boats lying alongside.

The anchor wall is of reinforced concrete. It was built on wooden piles to prevent settlement. The penetration of these piles was determined by the engineering formula, on a capacity of ten tons, and with a minimum penetration of 12 feet.



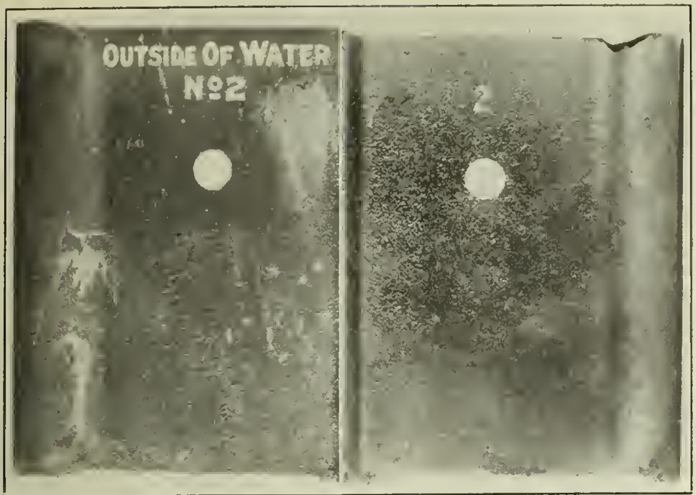
(*a*) (*b*)

Fig. 8—Pile submerged at Nearly All Times. (*a*) Before Cleaning. (*b*) After Cleaning.

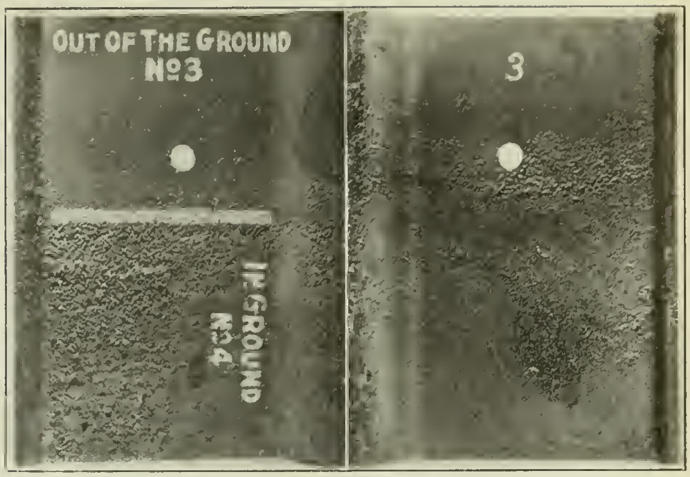
Although no heavy surcharge has yet been placed on top of the filling, the hypothesis on which the design was based, both as regards to earth pressure and location of the anchor wall, as well as the adaptability of the section modulus of two piles interlocked, has been confirmed as being correct. Since the filling was rapidly placed by the hydraulic method worse conditions were encountered than would be met should a heavy surcharge have to be supported by the wall.

Corrosion Tests

To find out the effect of corrosion on steel exposed to air, water, or soil, tests were made on steel sheet piles which were driven in on the property of the Harbour Commissioners of Quebec sixteen years previously. Three steel samples were taken. Sample No. 2 (see Fig. 9) is from the portion of pile above high water and exposed to the atmosphere at all times. Sample No. 1 (see Fig. 8) was cut at the level of the lowest tide, showing part submerged nearly all the time and part at ordinary low water mark. Sample No. 3 (see Fig. 10) shows steel buried in sand, sample being cut about two feet lower than the level of the ground surface. As for the piles located between tides, meaning in the zone between the low and high tides, they



(a) (b)
Fig. 9—Pile Continually Exposed to Air. (a) **Before Cleaning.** (b) **After Cleaning.**



(a) (b)
Fig. 10—Pile Partly Exposed to Air and Partly Buried in the Ground. (a) **Before Cleaning.** (b) **After Cleaning.**

were so perfectly preserved that a sample was not considered necessary. This perfect state of protection was attributed to the covering of the piles by a film of oil deposited by the tides.

Before the samples were cleaned of dirt and rust sample No. 3 gave the impression of being badly corroded. It was covered with a heavy crust of rust of a scaly appearance that could hardly be removed with a penknife. Sample No. 2 was clean, of a dark brown colour, and uniformly pitted. Sample No. 1 was dirty and the effect of corrosion was visible.

The samples were first given a wire brush treatment but it was only after they were subjected to a sand blast that a perfectly clean surface could be obtained. Sample No. 3 showed some pocking at the level of the ground surface, but a few inches below a good state of preservation was evident. In this sample the right half of (a) has received wire brush treatment. The even pitting that was visible can be attributed to the corrosion of the mill scale. The crust of rust and soil had undoubtedly the effect of affording protection against corrosion. The pocking at the ground surface was the result of the organic matter always present at the surface of the ground. Sample No. 1 showed some pocking. Without doubt the chemical composition of the mud that covered the ground in that vicinity had accelerated the process of corrosion. It must also be stated that the piles referred to were in the St. Charles river where at low tide the water is much polluted by the sewage of the city, which discharges in the vicinity.

To obtain a better idea of the extent of the corrosion a sample was machine cut, but this fresh cut showed no perceptible reduction in thickness.

Although no definite conclusions may be drawn from these isolated tests, the sixteen years of exposure justifies us in saying that the fears entertained as to premature deterioration of the steel wall through corrosion were not well founded. The results of the tests seem also to confirm the statements and findings of other engineers who have studied steel structures which have been exposed for even longer periods. Therefore, we may safely come to the following conclusion, "steel that is buried in sand or ground, or is submerged in water, is less exposed to damage through corrosion than when exposed to the air." This conclusion is doubly valuable since the portion of the steel wall which is most subject to corrosion is that portion which can be periodically inspected.

While the above results are no doubt encouraging, nevertheless all steel walls, as is the case with other steel structures, should be painted from time to time, at least where easily accessible, and the land side of the wall should be painted before placing the back fill.

Protection Against Corrosion

Additional protection against corrosion may be provided for steel quay walls of a permanent character, that is to say those designed for a longer than ordinary life, for example over forty years, by the following methods:

(a) Providing a cap of reinforced concrete on the top of the wall and filling the space between the upper and the lower walings so that water will not run directly on the piling.

(b) Covering all the surfaces of the steel to be buried with a heavy coating of paint, free from acid and oil, since the acid may cause corrosion and the oil may be saponified within a short period of time.

(c) Painting the piles before driving.

(d) Using heavier connections on walings and anchors because when two dissimilar metals are placed in contact with each other, riveted or bolted together, there is a tendency for one of the metals to be preserved from corrosion at the expense of the other, which will corrode much more readily in such a case.

(e) Using anticorrosive steel.

On account of its strength, elasticity and uniformity, steel is universally considered as the best building material. However, as there were doubts about its lasting qualities, the adoption of steel for several types of structures has been delayed. At present these reasons have not the same weight as formerly. Reports gathered together on steel structures which have been exposed over a long enough period of years have shown that corrosion does not cause deterioration as quickly as had been thought, where proper protection has been provided. The discovery of anticorrosive steels such as cupriferous, nickel and chromium steels has considerably changed our ideas as to the durability of steel.

Moreover, in these days of rapid change of design and methods, a considerable number of structures, in port works as well as in many other lines, tend to become obsolete in a comparatively short space of time, and thus it is sometimes not a good thing to build structures of too permanent a character since it may be necessary to demolish them before the expiration of their natural span of life in order to effect imperative improvements, involving greater wastage and sometimes considerable time and trouble in wrecking structures of too permanent a nature.

The Canadian Pacific Liner *Empress of Britain*

Features of Interest to Engineers

The following account is based largely on information furnished by Canadian Pacific Steamships Limited, and we are also indebted to descriptions in "Engineering" and in "Shipbuilding and Shipping Record"; Figs. 2 to 6 are reproduced from the latter paper with the Editor's kind permission.

The new Canadian Pacific liner *Empress of Britain,* which has just commenced her service between Southampton and Quebec, is remarkable as the largest, swiftest and most luxuriously appointed ocean-going vessel to ply between any two ports in the British Empire, and her propelling machinery is a notable example of high-pressure and high temperature steam practice.

The progressive policy of the Canadian Pacific in creating during the last six or seven years a large and up-to-date fleet of ocean steamships of all classes, for both passenger and cargo-carrying services, has involved new construction and the re-engining of existing vessels on an unprecedented scale; and not the least inducement to embark on this course, which has culminated in the building of the *Empress of Britain,* was provided by the marked economies in the cost of propulsion and operation which are now possible, and to which the work of Mr. John Johnson, the company's chief superintendent engineer, has so largely contributed.*

It may be recalled that the *Duchess* passenger steamships of the Canadian Pacific Line attained a fuel economy of 0.625 pound of oil per s.h.p. per hour for all purposes, and still more recently the same owners' *Empress of Japan* set up a world record of 0.603 pound for all purposes. Trial results indicate that this record will be surpassed by the latest and largest *Empress.*

The hull of the *Empress of Britain* has been constructed by Messrs. John Brown and Company Ltd., of Clydebank; and they have also built and installed the propelling machinery.

The principal particulars of the vessel are:

Length, overall	760 feet 6 inches
Length, between perpendiculars	730 feet
Breadth, moulded	97 feet 6 inches
Depth, moulded, to B deck	60 feet 9 inches
Depth, moulded, to top of superstructure (sun deck)	100 feet 6 inches
Load draught	32 feet
Gross tonnage	42,348 tons.
Net tonnage	22,545 tons.
Service power	60,000 s.h.p.
Speed in service	24 knots.
Passengers:	
First Class	465
Tourist Third Cabin Class	260
Third Class	470
Officers and crew	714
Total number of persons carried	1,909

*See "The Propulsion of Ships by Modern Steam Machinery" in The Engineering Journal for December, 1929, pp. 628-639.

Fig. 1—The *Empress of Britain* in the Clyde.

The ship has been constructed under survey by Lloyd's Register to meet their highest class, and complies with the latest requirements of the Board of Trade and the International Convention for the Safety of Life at Sea as regards subdivision and life-saving appliances.

The bunker capacity is sufficient to enable her to make the round voyage from Southampton to Quebec and back with adequate allowance for port use and a few days' supply of fuel in reserve.

On her official trials a maximum speed of 25.52 knots was attained, while the speed with only the two inboard turbines working was 22.6 knots. On her regular service a speed of 24 knots will enable her to make the open sea passage in three and a half days and the whole run in five days.

There are ten decks, namely, sun deck, sports deck, lounge deck, and decks *A* to *G*. *A* deck runs the full length of the vessel, the lounge deck above is 648 feet long, and the boat deck is 396 feet long at the sides.

The double bottom is subdivided into forty-four main compartments for oil, fuel, fresh water, and water ballast, and the scantlings of the vessel have been determined by treating the structure as a continuous girder to the sun deck, thus eliminating the use of expansion joints in the superstructure. Special high elastic limit steel has been used for some of the deck plating on the lounge deck and *A* deck, and for the side plating in that vicinity in order to save weight.

The lounge deck is chiefly occupied by the spacious first class public rooms, these being, starting at the bow, the ball room, the long double gallery, the American bar and writing room, the card room and the smoking room. Around these is the main first class promenade. Further promenade space is provided along the whole length of the boat deck, and also on the sun deck. The swimming bath extends from *D* deck to *G* deck, and is situated immediately abaft the after engine room. Two fully equipped gymnasiums adjoin this pool, and there is a tennis court on the after end of the sports deck, which is flood-lighted for night play. A regulation squash racquet court is also provided, and at the forward end of the sports deck a large clear space is available for deck games. The children's play room is also on the sports deck.

The main dining saloon is on *D* deck, and will accommodate 452 persons. The state room accommodation is liberally arranged as regards space. Over seventy per cent of the first class state rooms have private bath rooms, and all are outside rooms. The tourist third cabin and third class public rooms give accommodation much superior to that enjoyed by first class passengers thirty years ago.

In all living spaces on board the vessel a system of mechanical ventilation and heating on the thermotank principle has been used, separate systems of trunking being provided for each block of accommodation. The store rooms, galleys and pantries are also provided with fresh air by means of the punkah louvre system, and all lavatories, stores, kitchen spaces, hospitals, laundries, etc., are exhausted at adequate rates of air change. The first class and tourist third class public rooms and entrances are fitted with the latest revolving punkah louvres, which are suitably worked into the decorative scheme. There are over one hundred and thirty thermotank units, including the engine and boiler room fans, and about ten miles of trunking. Further provision is made where necessary for heating by means of low-pressure steam radiators, plugs being fitted in first class and tourist-third cabin state rooms to take an electric radiator when required.

A hot and cold fresh water supply is provided for all wash basins in the ship, as well as to the first-class baths and showers, while hot and cold salt water is also led to the first-class baths, and to the baths and showers in the remaining passenger spaces.

The navigating equipment includes a standard compass on the compass platform, with steering compasses in the navigating bridge wheel house and the after wheel house. The master gyro compass in the gyro room has repeaters in the wheel house, on the compass platform, and also in the captain's room and wireless office, with a course recorder in the chart room. Elaborate provision has been made for sounding, both by sounding machine and by electric echo sounding. A complete system of engine room, steering, and docking telegraphs is provided.

Ship's draught indicators, electric submarine signalling apparatus, an electric submerged log, searchlights, range finders, direction finders, semaphores, morse lamps, and clear-view screens are all available to aid in the navigation of the ship.

The anchor and warping capstans and cargo winches are all electrically driven. The steering gear is of the electric-hydraulic type with duplicate motors and pumps.

The lifeboats are handled by Welin-Maclachlan gravity davits, of which there are 22 sets, comprising: ten sets, handling 31-foot, 89-person single lifeboats; eight sets, handling nested lifeboats, each nest with a total capacity of 135 persons; two sets, handling 30-foot, 45-person motor lifeboats; and two sets handling 25-foot, 46-person emergency lifeboats. The motor lifeboats have Parsons four-cylinder engines with reverse gears. This equipment ensures that in an emergency, twenty-two lifeboats immediately become available, having a total capacity for about 1,800 persons.

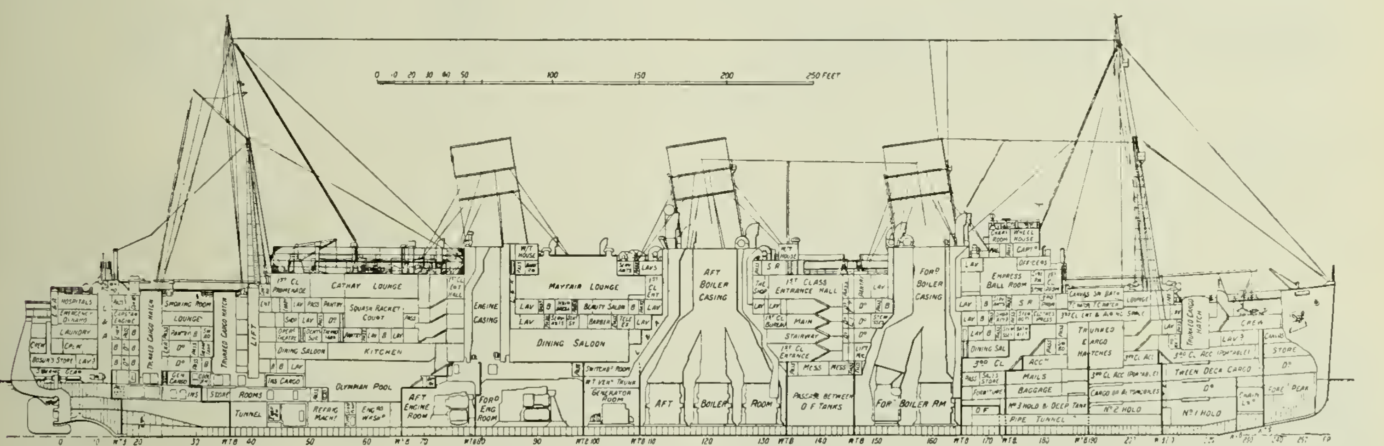


Fig. 2—Longitudinal Section.

The telephone equipment throughout the ship is most complete, loud speaking naval telephones being provided to communicate between the bridge, executive offices, engine rooms, wireless rooms, gyro room, steering engine room, boat deck, docking bridge, forecastle head, and crow's nests. The telephone system, besides including ninety lines for the service of the ship's personnel, includes two hundred lines of manual equipment for the use of passengers. Communication can be established with the shore services while the ship is in port, and the radio telephone service provides for ship to shore communication while the liner is at sea.

The wireless equipment, supplied by the Marconi International Marine Communication Company, includes a 2-kw. valve transmitter for long-wave telegraph transmission, together with a 2-kw. short-wave installation, and selective receivers ensure good reception over the complete band of wave-lengths. The short-wave installation will enable communication to be maintained over long distances with stations out of range of the long-wave transmitter.

The ordinary cabin telephones are connected to the wireless telephone through the ship's manual switchboard, so that passengers can communicate directly with any telephone in any country offering suitable terminal facilities.

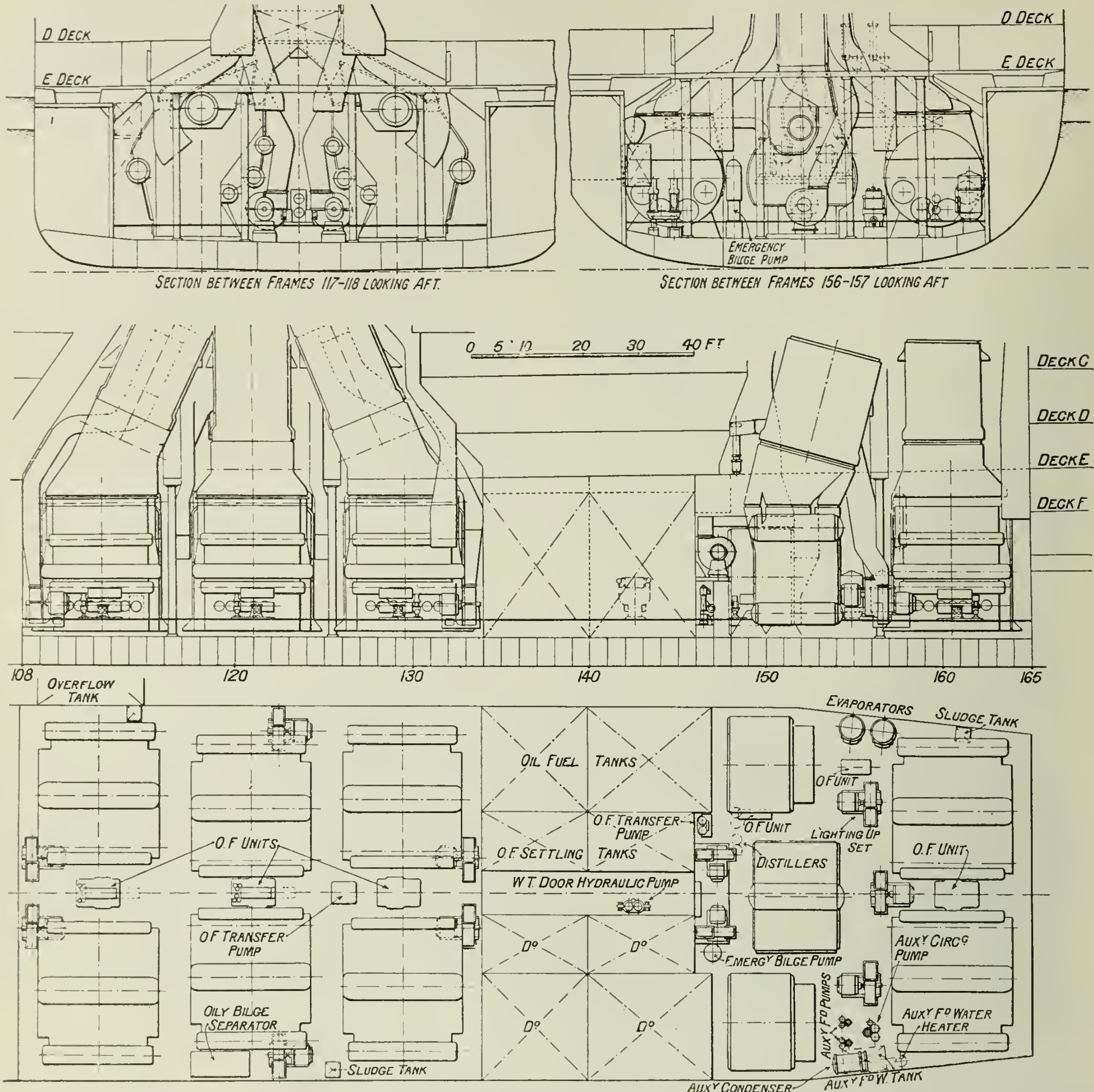


Fig. 3—Plan of Boiler Rooms.

Emergency and lifeboat Marconi equipment is also supplied, while a Marconi direction finder of the latest type, with the fixed-frame aerial system, has been installed.

Other electric equipment includes a system of electric clocks and burglar alarms, vacuum cleaning plant, talkie cinema apparatus, and an orchestra and gramophone repeater installation.

Four hospital wards are arranged on *C* deck, and a separate isolation hospital on the after end of *A* deck. There is an operating theatre, dispensary, and dental surgery.

Propelling Machinery

The vessel is propelled by four screws, each driven by an independent set of single-reduction geared turbines of the Parsons type. To suit the conditions under which the ship will run, viz., voyages between Great Britain and Canada during the summer and world cruises during the winter, the engines driving the two inboard screws are designed to develop two-thirds of the total power, while the engines driving the two outboard screws develop the remaining one-third. Under cruising conditions, if full power is not required, only the inboard engines will be used, and the vessel will then be virtually a twin-screw ship.

The machinery has been designed to develop normally a total output of 60,000 s.h.p. continuously at sea, in order to maintain a normal speed of 24 knots. If an increase of speed is necessary at any time, however, an overload power of 64,000 s.h.p. can be maintained for long periods.

Two engine-rooms are necessary for the main propelling machinery, the two inboard sets being arranged in a compartment forward of that in which the two outboard sets are installed; while much of the auxiliary machinery is in a separate auxiliary engine-room immediately forward of the two main engine-rooms.

The engineering staff on a vessel of this type is, of course, numerous, and the duties of the senior engineer officers are of a highly responsible nature. While the executive and navigating department includes nine officers and eighty-seven deck ratings, the engineering branch has forty-three officers and eighty-nine other ranks, a total of one hundred and thirty-two. The other services on the ship, including the office and medical staff, the stewards and service departments, employ nearly four hundred and fifty people.

Main Turbines

The main-turbine sets each comprise one high-pressure, one intermediate pressure and one low-pressure turbine, working in series; and each turbine drives a separate pinion, which engages with the main gearwheel. For astern running, a high-pressure unit is incorporated in the same casing with each of the two intermediate ahead turbines and a low-pressure unit in the exhaust end of each of the two low-pressure ahead turbines of the inner-shaft machinery only. No provision is made for astern working on the outer shafts, which are employed exclusively for ahead duty. The astern turbines are capable of developing 60 per cent of the aggregate ahead service power.

The high-pressure turbines are all constructed to withstand a maximum working pressure of 425 pounds per square inch and an initial steam temperature of 725 degrees F., but they have been designed to develop the service and overload powers when employing steam between the limits of 375 pounds per square inch (gauge) and 0.50 pounds per square inch (absolute), with an initial steam temperature of 700 degrees F.

The high-pressure ahead turbines are of the impulse-reaction type, comprising a two-row velocity wheel with blades of stainless steel, and a reaction portion fitted with end-tightened blades of Monel-metal. Nozzle-control valves are fitted to enable a gradual increase of power to be obtained, while at the same time maintaining as high a pressure as possible in the control chest for quick operation.

The intermediate-pressure ahead turbines are of the reaction type throughout, with end-tightened blades of phosphor-bronze.

The low-pressure ahead turbines are also of the reaction type, with phosphor-bronze blades.

The high-pressure astern turbines each have one three-row impulse wheel, while the low-pressure astern turbines each have two impulse wheels with two rows each, in which the blades are of stainless steel.

To eliminate vibration, all the rotors have been dynamically balanced. The low-pressure ahead turbines are of the double-flow balanced type, and each of the other turbines is fitted with a dummy to reduce the end thrust due to the difference in steam pressure. Michell thrust bearings of the spherical-seated type are fitted to each rotor to take up any remaining axial thrust.

Owing to the high steam temperature employed, the turbine casings are of cast steel, with the exception of the low-pressure casings, which are of cast iron.

To facilitate the lifting of the upper portions of the turbine casings, the receiver pipes have been connected to the lower halves of the turbines in every case. Emergency connections have been fitted, so that any of the turbines can be cut out if this should be found necessary at any time.

In each set the high-pressure turbine is fitted with an Aspinall patent governor combined with a fore-and-aft indicator and control, while the intermediate-pressure and low-pressure turbines are fitted with fore-and-aft indicators and controls only. With this arrangement, the steam would be shut off in the event of the turbine speed exceeding a certain limit. The fore-and-aft indicators show any axial movement of the turbine rotors; and should the wear on the thrust pads make this movement excessive, the control would then operate and shut off steam to the turbines.

Steam would also be shut off in the event of the oil pressure in the lubricating system dropping unduly or failing entirely.

Main Condensers

The main condensers, which are of the Weir two-flow regenerative type, with a large reservoir at the bottom for storing the water required for the successful operation of the closed-feed system, are slung underneath the low-pressure turbines. Each inboard condenser has a cooling surface of 20,700 square feet, the tubes being ¾-inch diameter and 14 feet 6 inches long; while each outboard condenser has a cooling surface of 9,600 square feet, with ¾-inch diameter tubes 11 feet 6 inches long. The tubes for all the condensers are made of cupro-nickel.

A particular feature of the condensers is the water doors, which have been designed to facilitate the quick examination of the tubes. Large hinged doors have been fitted in each end, and these are jointed with rubber rings recessed into the casing.

Gearing, Shafting and Propellers

The main gearing is of the usual double-helical, single-reduction type, and the main gearwheels of the inner and outer shafts have diameters of 14 feet 6 inches and 11 feet 3½ inches respectively. All the pinions are connected to their respective rotors by flexible claw-type couplings. The gearwheels and pinions are enclosed in strong cast-iron gear cases.

The thrust of the propellers is transmitted to the vessel through Michell thrust bearings of the single-collar type, fitted to the main lines of shafting immediately aft of the gearing; and the tunnel shafting is supported by bearings of the Michell pivoted-pad journal type.

The propellers, which are of solid bronze, have diameters of 19 feet 3 inches and 14 feet 0 inch for the inner and outer shafts respectively. When developing the

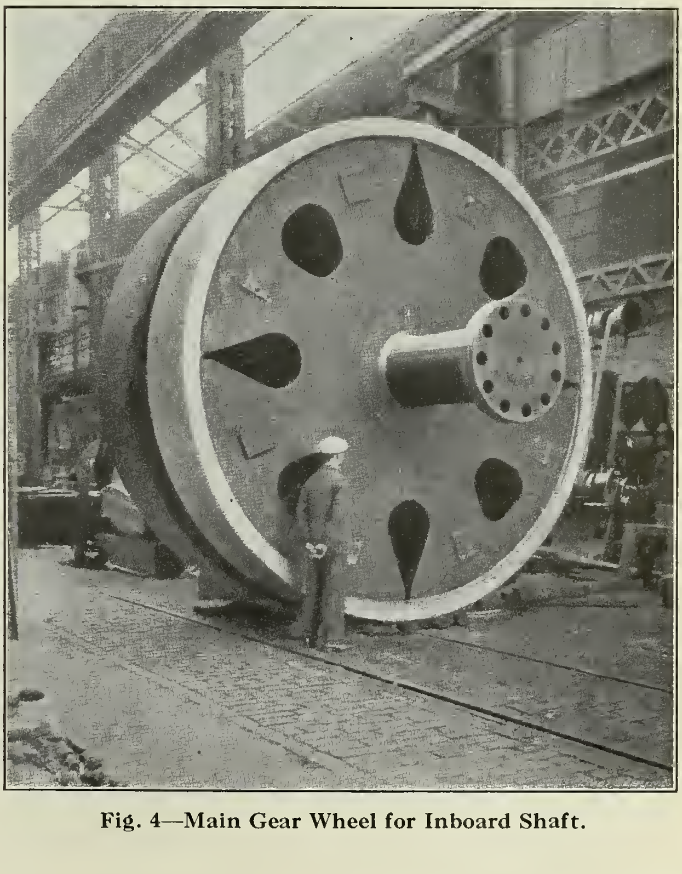


Fig. 4—Main Gear Wheel for Inboard Shaft.

normal service power of 60,000 s.h.p., the speeds of the propellers are 150 and 200 r.p.m. and the corresponding speeds of the turbines are 1,365 and 1,795 r.p.m. for the inner and outer shafts respectively. The reduction ratio, therefore, is about 9 to 1.

Steam-generating Installation

The main boiler installation consists of eight oil-fired water-tube boilers of the Yarrow type and one oil-fired water-tube boiler of the Johnson type.

Six of the boilers are placed in the after boiler-room, normally supplying the forward inboard engines; while three boilers are installed in the forward boiler-room, supplying the outboard engines in the after engine-room. The arrangements are such that any or all of the boilers can supply the ahead and astern turbines in the forward engine-room.

The Yarrow boilers are of the double-flow, side-fired type, having one steam drum, three water drums, and one superheater drum. The flow of the gases is through both sides of the boiler, after which they pass through a large tubular air-heater and thence to the funnel.

The boiler and superheater drums are hollow rolled forgings with ends formed integrally, and represent the latest practice for high-pressure boiler work.

The Johnson boiler consists of two large-diameter drums, placed vertically one above the other and connected to each other by curved tubes which are arranged longitudinally and across the ends in such a manner that the combustion space is almost entirely enclosed by water tubes. In addition, there is a wall of water tubes along the centre of the boiler, which divides the combustion space into two separate compartments. This arrangement of tubes provides for a considerably larger amount of tube surface exposed to radiant heat than in other types of marine water-tube boilers.

The boiler was constructed at Clydebank and a series of very complete trials showed that it is capable of generating double the amount of steam per square foot of heating surface, while registering the same efficiency as a Yarrow or other standard type of boiler worked at ordinary mercantile rating.

Each main boiler is fitted with two automatic feed regulators, one of the Weir and the other of the Mumford type, while Parry soot-blowers are also provided. In order to give the alarm when the water in the boilers falls below a pre-determined level, Mumford low-water alarm gear has been installed.

In the forward boiler-room there are also two cylindrical boilers of the return-tube type for auxiliary purposes. These boilers are arranged to burn oil fuel with the Howden system of forced draught, and work at 200 pounds per square inch.

The oil-fuel pumping and heating installation is of the Wallsend-Howden type.

Boiler Feed System

The satisfactory working of a boiler installation of this kind is dependent on a supply of pure de-aerated feed water, and for this purpose, in both forward and after engine rooms, a Weir closed feed system of the internal capacity type is installed. Fig. 6 shows a diagrammatic arrangement of the closed feed system for the forward engine room. The evaporation of the raw feed water takes place in the auxiliary boilers, the steam from these being led to an intermediate stage of the turbines.

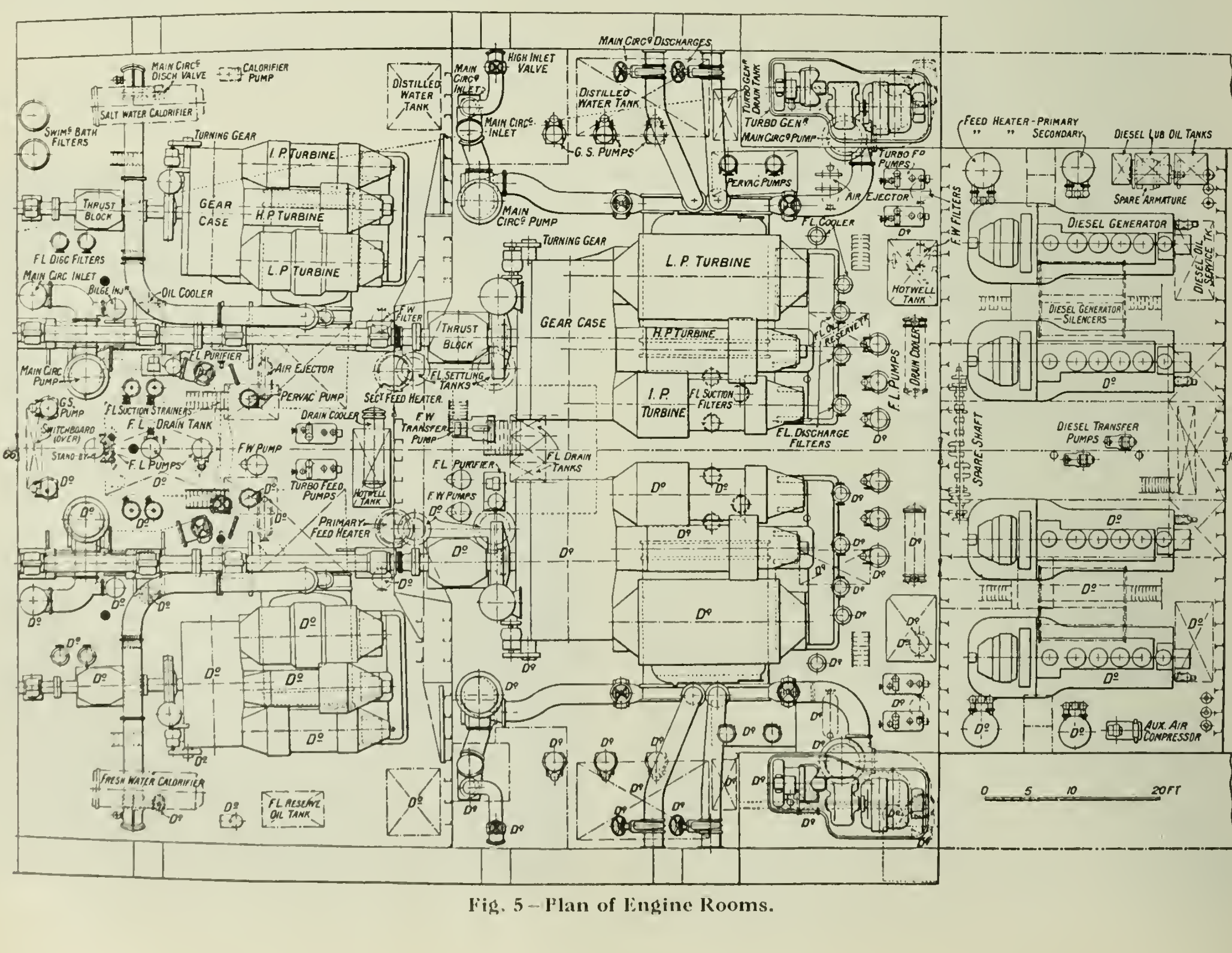


Fig. 5 — Plan of Engine Rooms.

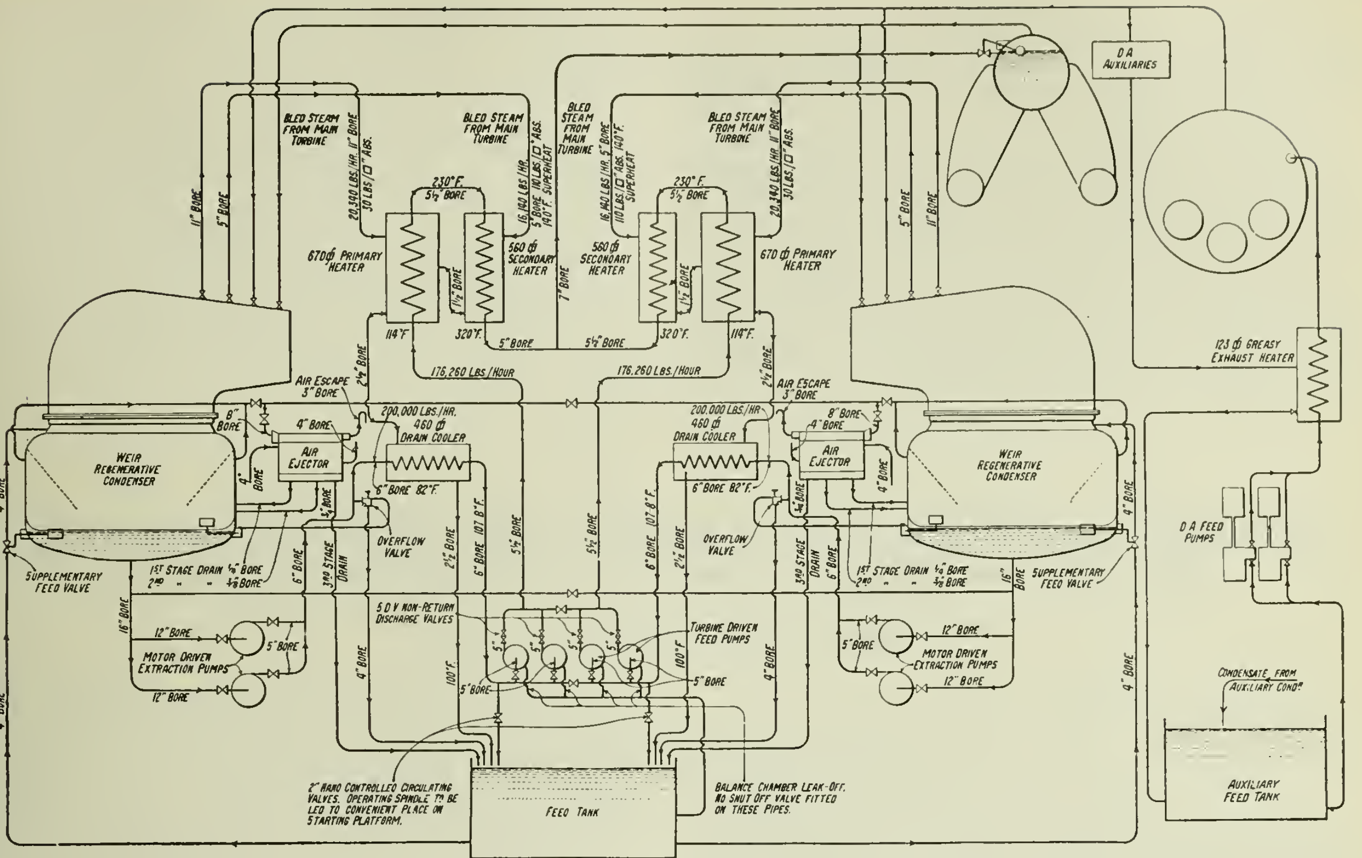


Fig. 6—Diagrammatic Layout of Closed Feed System for Forward Engine Room.

The regenerative condensers are fitted with condensate wells, the level of the water in which is maintained by float-operated supplementary feed valves admitting water from the feed tanks. The condensate is first passed through a drain cooler, where the heat of the drains from the primary heaters is absorbed before the feed enters the suctions of the feed pumps. The latter are turbine-driven and discharge through primary and secondary surface feed heaters, taking bled steam from the turbines at low and medium pressures, to the high pressure boilers through automatic feed-water regulators. As regards freedom from corrosion, the efficiency of a closed feed system of this type depends on the action of the condenser as a de-aerator, and the Weir regenerative condenser is ideal in this respect, delivering the condensate at practically the temperature corresponding to the vacuum, and with a very low oxygen content. Any feed water drawn in is thus completely de-aerated before entering the main circuit. In the event of the water level rising in the condenser, the excess feed is returned to the feed tank through overflow valves, also float operated.

Two motor-driven extraction pumps are fitted for each condenser, each capable of dealing with 120,000 pounds of condensate per hour; the air and non-condensable gases are withdrawn from the condensers by means of steam-jet air ejectors.

Four two-stage turbo-feed pumps are fitted in pairs, port and starboard, one working and one standby, each pump being capable of delivering 200,000 pounds of feed water per hour against a pressure of approximately 500 pounds per square inch. They are supplied with steam at 400 pounds per square inch, superheated to 725 degrees F., and exhaust to the main condensers, or against a pressure of 15 pounds per square inch to the primary heaters.

From the turbo-feed pumps the feed water passes through the primary surface feed heaters which are capable of raising the feed from 114 degrees F. to 230 degrees F., when supplied with steam bled from the turbines at a pressure of 30 pounds per square inch absolute, plus the drains from the secondary heaters. The secondary heaters are each capable of raising the feed from 230 degrees F. to 320 degrees F., when supplied with steam bled from the turbines at a pressure of 110 pounds per square inch absolute.

The closed feed system for the after engine room is on similar lines to that described above, but the capacity of each condenser is approximately half that of the forward set.

Electric-generating Plant

In the separate compartment between the forward main engine-room and the after boiler-room are situated four Diesel engine-driven generators.

Each of these has an output of 450 kw. and is driven by a Fiat-British single-acting, two-stroke, four-cylinder engine developing 660 b.h.p. at 260 r.p.m. Each engine drives its own double-acting scavenging pump, three-stage air compressor, circulating-water pump and lubricating-oil pump.

For emergency use and for supplying starting air, there is a Reavell electrically-driven compressor, and in the auxiliary engine-room there are also two fuel-oil transfer pumps.

In addition to the Diesel engine-driven generators, there are two British-Thomson-Houston turbo-driven generators of 800 kw. each. These are situated in the forward main engine-room and are supplied with high-pressure superheated steam from the main boilers, the exhaust being connected directly to the condensers. The turbo-driven generators are driven at 670 r.p.m. through gearing, the turbines running at 6,000 r.p.m. Two 75-kw. generating sets and a storage battery are provided for emergency use.

Other Auxiliaries

The remaining auxiliaries, which are mostly electrically driven, are arranged in three pairs, so that one pair will serve each of the larger main engines and the remaining pair the smaller outboard sets.

The main circulating pumps are of the vertical-spindle centrifugal type, driven by electric motors. Nine Drysdale Centrex pumps have been supplied for the forced-lubrication system, and Vickcen centrifugal separators are installed for the purification of the lubricating oil.

Centrex pumps are also provided for the bilge, ballast, sanitary, fire and wash-deck services, a battery of six pumps being situated in the forward engine-room and two in the after engine-room. Three smaller pumps of a similar type are also installed for dealing with fresh water.

A well-equipped workshop is situated in the shaft tunnel and the refrigerating machinery is also arranged in this tunnel.

The refrigerating equipment consists of two twin-compressor vertical enclosed CO_2 machines each of which is directly coupled to an electric motor of 64 h.p. The capacity of the insulated cargo chambers amounts to 27,000 cubic feet, part of which is fitted with brine grids while part is air-cooled. The capacity of the refrigerated provision chambers amounts to 29,500 cubic feet, and there are brine connections to thirty-four cold cupboards.

A complete Lux CO_2 fire-extinguishing system is provided in the boiler-rooms and in the auxiliary machinery room.

Discussion on "Steam Station for the Head Office Building of the Sun Life Assurance Company of Canada, Montreal, Que."

Paper by F. E. Combe, M.E.I.C.[1]

R. E. MacAfee, m.e.i.c.[2]

Mr. MacAfee observed that the steam generating equipment consisted of cross drum sectional header boilers and forced draft compartment type chain grate stokers.

The boiler tube bank of each boiler was composed of twenty sections in width, each section having eight plus two tubes in height, making a total of two hundred tubes 18 feet long. The arrangement, starting at the bottom or point nearest the furnace, consisted of two rows of tubes, a blank space the equivalent of two rows of tubes and then the main bank of eight rows of tubes. The two bottom rows of tubes acted to a certain extent as a slag screen. The blank space made it possible to baffle the boiler so that a large part of the two bottom rows of tubes were directly exposed to the furnace. The sectional header boiler could readily be arranged to make practically any provision required for a suitable slag screen, as well as making it possible to expose part or all of the bottom rows of tubes to the furnace. The actual arrangement of the tube bank would depend on the load to be carried, the volume of combustion space available and the coal to be burned.

The cross drum straight tube boiler would lend itself to installations where limited head room was essential, it being possible to provide reasonable combustion space in minimum headroom.

Each stoker was fitted with five air compartments between the upper and lower run of the chain. The air to each compartment was under control, making it possible to regulate the air supply to the fuel bed to meet any operating conditions desirable.

The speed of the grate could be varied and the thickness of the coal bed could be regulated. With the adjustment of the coal supply, the air supply, and the speed of the grate, all conditions of load between minimum and maximum could readily be taken care of.

When the load was below 15,000 pounds of steam per hour it was the intention to operate on natural draft. To do this it was simply necessary to shut down the forced draft fan and to open up the doors in the wind boxes at the sides of the stoker.

It was to be noted that this stoker, when properly set for a given load condition would operate practically smokelessly when burning Dominion coal. With slight modification when the original design was being made, the stoker could be adapted to burn such fuels as coke breeze, anthracite screenings or a mixture of anthracite screenings and bituminous slack as might be most economical.

Forced draft chain grate stokers were suitable for the application of preheated air. At this plant the air to the stoker compartment runs around 180 degrees F. and air temperatures up to 350 degrees F. could be used depending on the characteristics of the coal.

The fuel consumption per square foot of grate surface varied with the furnace volumes, load, and the coal to be burned. When using Dominion coal this rate varied from 25 to 35 pounds. For other coals with a higher ash fusion temperature the rate could be increased to 40 and in some cases as much as 60 pounds per square foot of grate.

From this it would be seen that the overall arrangement of the unit depended on a number of variables. For this reason it was essential that the design be prepared by engineers entirely familiar with the problems involved.

J. T. Farmer, m.e.i.c.[3]

Mr. Farmer stated that the author was to be congratulated on having conceived and carried to completion what was undoubtedly the most advanced example of a steam plant devoted to the services of a commercial building in Montreal, and probably in the whole of Canada.

Perhaps the most noticeable feature in the general scheme was that the owners had been wise enough to allow the mechanical design to control the design and disposition of the enclosing building. Consequently the design and layout of the equipment had not been hampered by architectural and other considerations which frequently in such cases introduced complications and often necessitated compromises and variations from the most desirable scheme.

In this instance, the design had apparently been worked out untrammelled by major considerations of meeting space limitations, and consequently it exhibited a harmonious combination of the mechanical units with the building structure, and an economic adaptation of the latter to the

(1) This paper was presented at the Annual General Meeting of The Institute, Montreal, February, 1931, and appeared in the February, 1931, issue of The Engineering Journal.

(2) Manager, Eastern Branch, Babcock-Wilcox and Goldie McCulloch, Ltd., Montreal.

(3) Mechanical Engineer, Montreal Engineering Company, Montreal.

coal-handling and other auxiliary equipment. It had also developed a symmetrical arrangement of the boiler units in individual settings spaced so as to afford ample accessibility for operation and upkeep which, in itself, constituted a valuable asset.

The concentration of population in a large modern office building led to heavy demands in steam and power for ventilation and air-conditioning, as well as for the numerous other services which modern ideas of convenience called for. In the instance under discussion, provision had been made for a total steam output of some 128,000 pounds of steam per hour. The paper was confined to a description of the means taken to meet this maximum requirement. No account was given of the preliminary calculations—which must have been quite extensive—in arriving at this estimate of maximum plant capacity. Such an estimate would be much simplified if, as in some manufacturing operations, a definite figure could be arrived at which would represent reasonably closely the demand to be met as long as operations continued. A heating load in a climate such as that of Montreal had very different characteristics. It had a fairly predictable seasonal variation, complicated by erratic peaks of short duration which might very greatly exceed not only the average, but the ordinary heavy load. It was interesting to note the steps taken to meet these varying conditions, particularly in providing for the extreme conditions, which must be taken care of, but at the same time arranging that the power demands necessary to carry the heavy loads were not made a continuous tax on the plant during the long periods when they were not needed. It would be interesting to know what proportion of the time it was estimated that the mechanical draft fans would be in operation.

Where such variable conditions were encountered, it must be recognized that it was physically impossible to meet every stage of the variations with the same efficiency. In general, the best that could be done was to design as nearly as practicable for the condition that represented the weighted average of the whole operation. For departures from this condition, there would be more or less loss of efficiency, but this was a minor consideration; the main one was to maintain continuity of operation through the most extreme variations met with.

There was one instance in which this principle appeared to have been departed from. In connection with the induced draft equipment, heat recovery apparatus was introduced in the shape of economizer surface of nearly fifty per cent of the boiler surface proper. The use of this apparatus was limited to the time when the induced draft was in use, which excluded the summer and the long mild periods in spring and autumn, leaving the three or four cold months of the winter, during most of which only a portion of the apparatus installed would probably be actually in service. In view of this relatively short period of activity, the question presented itself as to whether the demonstrable saving in fuel offset the considerable first cost of this heat recovery.

Another question which suggested itself was whether the situation would not have lent itself to the production of a block of base load power by the use of a high pressure turbine. By generating steam at 400 pounds pressure and 150 degrees superheat and exhausting at the pressure of 100 to 125 pounds into the heating system, an output of some 1,200 kw. could be secured in conjunction with the steam production of 50,000 pounds per hour, or one-half the maximum capacity, which, presumably, would be something of the order of the sustained demand during a large portion of the year. This, it would appear, would be a useful contribution to the power requirements of the building.

One would expect that the power requirements would relax somewhat during the summer—the period of light heating load—and that there would be excess power demands coincident with, and in part arising from the heavier heating loads. Thus, it would appear that the local generation of a varying block of power, when and as steam was available, would act to reduce to an approximately constant figure the amount of power required from outside sources, a very desirable condition from the standpoint of both the purchaser and the power supply agency.

The cost of power so generated in conjunction with the heating would consist in the main of the fixed charges and the operating and maintenance expense on the equipment involved, with very little expense for additional fuel. This should show up very favourably even as against the low cost of purchased power available in this city. A further advantage would be the availability of the secondary source of power in the event of a power interruption.

It was quite conceivable that, on closer investigation, under the actual conditions it would not prove possible to generate a sufficient block of power with sufficient continuity to materially improve the load factor or the overall cost of the purchased power; and that, consequently, the net saving effected would not warrant the additional investment involved.

It would be interesting to hear whether this possibility had been considered, and if so what were the reasons that decided against its adoption.

F. A. Combe, M.E.I.C.[4]

The author in reply to Mr. Farmer stated that he was sorry that the allotted length of paper did not permit of dealing with the reasons for the adoption of certain arrangements of design or the engineering problems involved. In view of the many features of interest in the engineering of the main building, it had been decided to confine the papers to a brief description of the equipment installed.

As regards the heating load on the plant, there were many variables which influenced the load curve relation with the outside temperature. The maximum load on a cold day would comprise approximately 25,000 pounds steam per hour for direct radiation, 60,000 pounds steam per hour for ventilation and 15,000 pounds steam per hour for miscellaneous services, bringing the total up to around 100,000 pounds per hour. This load would, however, be subject to variation due to the amount of air which may be recirculated for ventilation; the entrance heating, which will be at a maximum during entry and exit of employees; the natural heat from some 10,000 people during occupancy; kitchen, laundry and other services.

The question of installing a high pressure plant to generate power was carefully studied, but was considered undesirable, principally for the following reasons:—

> The load in the summer, which is made up to a large extent by ventilating fans, is practically the same as in winter.
>
> The possible saving would not justify the plant expenditure for power production throughout the year.
>
> The additional space required for plant.
>
> The higher class operating staff necessary for a high pressure power installation.
>
> The policy of the Sun Life Assurance Company to carry on only such service work themselves as other legitimate businesses cannot supply. Such policy also applies to printing, breadmaking and other services or supplies which no doubt might be furnished at some saving by plants of their own.

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[4] Consulting Combustion and Steam Engineer, Montreal.

M. W. Booth, M.E.I.C.[5]

Mr. Booth observed that the paper described a steam generating plant, which although laid out on conventional lines, embodied an unusually complete equipment viewed from both the points of view of the steam requirements and of the economy in operating costs. The provision of three boilers, each of which could be operated economically over a wide range by the extra draft and economizer equipment provided, left very little to be desired in this respect.

The selection of the type of boiler was of course a matter these days largely of personal choice, and the stoker perhaps was in somewhat the same category, but it was interesting to note that the grate area and the details of the furnace setting were designed in particular for the use of Nova Scotia coal.

The analysis of this coal as given could be taken as fairly representative, but exception might be taken to the general statement that the iron content was high, which after all would only cover a certain section of the coals mined in Nova Scotia and shipped to the St. Lawrence district, and which were not in such proportion, as now generally selected for general stoker purposes, as to affect the burning and maintenance properties of this fuel.

It was difficult however in other respects to find other points for which the furnace design had not provided. The short arch was noted and was well off the grate, agreeing with the easily ignitable quality of the coal, with consequent low maintenance under any conditions of fuel and load requirements; and also, as specially mentioned in the paper, the large area of the boiler tube heating surface exposed to direct radiation from the grate, which would ensure both economical operation and low furnace maintenance.

However, returning to the general subject of the plant, Mr. Booth stated he could not but regret the absence of any tendency in the design to depart from the small station idea, and to embark upon something which would suggest the large central station.

Montreal was growing rapidly, steam was still accepted as being the cheapest and most convenient form of heating for domestic and general purposes, no matter whether the fuel was coal or oil; and in order to settle the problem from a smoke point of view, from a traffic convenience point of view, and from an economy standpoint, the trend must inevitably be towards the central station, whether for steam alone, or for steam and power.

An ideal opportunity appeared to be offered in this particular instance for departing from the usual procedure, and establishing a plant along modern and accepted lines for serving what was rapidly becoming a highly concentrated and important section of a rapidly growing city, and he would hope that this was by no means too late, and that such a plant if not already conceived and under way in some other location would be so in the very near future.

F. A. Combe, M.E.I.C.

In reply, the author stated that while the question of a central heating plant to serve a large district area was an interesting one, there would be no economy from such a plant to the Sun Life Assurance Company, and it could not afford to sell steam as cheaply as the company is making it. The previously mentioned policy of the Sun Life Assurance Company applied in this case,—that they do not wish to take on the functions of a general utility business.

J. H. Hunter, M.E.I.C.[6]

Mr. Hunter desired to ask the author if he could give any figures of the floor area and volume per horsepower developed, both for these steam generating units and also for the boiler plant as a whole, as it would appear that although very liberal working space had been allowed around the boilers and in the plant generally, the layout had provided a very high capacity for the dimensions of the building. This was of course reflected in the cost of the plant as a whole. Also, was the author at liberty to give out any costs?

In Mr. Hunter's opinion, the arrangement and setting of the main steam generating units was of particular interest. These illustrated the most advanced boiler practice of dividing the heating surface of the unit into separate water heating and evaporating sections, each with its independent circulation, so obtaining a greater difference of temperature between the gases and the water than was possible in a self-contained boiler with single circulation. It would be interesting to know what were the different temperatures throughout the unit under normal operating conditions.

This development in steam generating unit design showed how little was meant to-day by rating boilers on the old basis of ten square feet of heating surface per "boiler horse power." In the units installed in this plant the actual heating surface of the boiler proper was only 4,500 square feet, which would give a normal boiler capacity on this old basis of only 450 h.p. Actually the output of the boiler was approximately 1,150 boiler horse power, equivalent to 260 per cent of such rating, but with the particular arrangement of heating furnace the intensity of operation of the unit was probably not particularly high, due to the fact that the work done was more evenly distributed than would be the case in a boiler alone.

F. A. Combe, M.E.I.C.

In reply to Mr. Hunter, the author said that sufficient tests had not yet been carried out to give exact figures of temperatures through the steam generating units, but it might be said that under a load of approximately 30,000 pounds of steam per hour the gas temperature at boiler outlet was approximately 560 degrees F., and leaving the economizer approximately 340 degrees F. The feed water entered the economizer at 210 degrees F. and left it at around 310 degrees F. As the boilers are operated at 100 pounds pressure it would be seen that the feed water is heated up in the economizer to within 28 degrees F. of the actual steam temperature, making the water section of the unit very economical and efficient. These figures illustrated the advantage of splitting up a steam generating set into independent evaporating and water heating sections. The inefficient back end of a standard type boiler had been removed and replaced by a very efficient heat transfer section.

As regards figures of volume and area per unit capacity, the steam generating unit itself had a floor area of 480 square feet, giving about 2.3 h.p. developed per square foot of floor area. The volume of the unit worked out at approximately 9 cubic feet per developed horse power. The boiler plant as a whole had a capacity of approximately ½ h.p. per square foot of floor area and 100 cubic feet of building volume per horse power. For a plant of this type, these figures compared well with good practice while providing liberal working spaces. The cost of the plant would be in the neighbourhood of $70 per horse power, which was also very moderate.

F. S. B. Heward, A.M.E.I.C.[7]

Mr. Heward remarked that the author of the paper had referred to a number of quite ingenious arrangements that had been incorporated in his design of the plant, and one of them, in particular, in connection with the heat recovery apparatus, also appeared to be somewhat original.

[5] Steam Engineer, British Empire Steel Corp., Sydney, N.S.

[6] General Superintendent and Chief Engineer, Canada Starch Company, Montreal.

[7] F. S. B. Heward and Associates, Montreal.

In this regard the author had mentioned that when the boilers were operating under forced draft, the air for combustion was drawn down from above street level through an encasement around the chimney and steel flues leading thereto, with the result that the air, before reaching the grates, was preheated by heat extracted from the outgoing flue gases.

In his discussion of the paper Mr. MacAfee had mentioned that during certain tests recently conducted at this plant, the air temperatures were observed to run as high as 180 degrees F., and Mr. Heward had also understood Mr. MacAfee to say that the stokers in the plant could operate at air temperatures up to 350 degrees F., depending on the fuel being burned.

He would like to know whether the air heating device arranged by the author would permit of heat recovery to an extent of 350 degrees F., because, if so, it would be a most interesting device as it would then seem to render possible the combination of water economizer and air preheater which heretofore had been so difficult to justify from the economic standpoint, particularly in the case of the small steam plant. In any event, no doubt, the author would be able to confirm that the arrangement used in this plant to raise the air even to 180 degrees F., paid for itself very well.

F. A. Combe, M.E.I.C.

The author replied that it was not expected that the temperature of the air for combustion would be brought higher than 180 degrees F. in the main forced draft duct with the pre-heating arrangement adopted, but it might be noted that a small percentage of this air was circulated through the furnace lining and discharged under the arch at the front end of the stoker at a temperature of, probably, around 300 to 500 degrees F. Higher temperatures of air passing up through the grate were apt to cause trouble and high maintenance costs with Dominion coal.

M. B. Watson, A.M.E.I.C.[8]

Mr. Watson remarked that the author was to be congratulated upon having presented a most interesting description of the new steam plant; but he regretted that an opportunity had been missed of carrying out more fully one of the objects of The Institute, viz., the interchange of professional knowledge among the members, in that the reasons or considerations determining various features of the design had not been given.

Upon first glance at the illustrations, there would appear to be a great deal of waste space in the plant, but the author did not tell why the equipment was disposed as it was. For example, one wondered why the chimney was not placed in the same bay with boiler No. 4; why the chimney was not started at the level of the natural draft flue, thus saving the cost of that amount of chimney; why the economizer was not placed above the boiler smoke outlet, and the induced draft fans placed in the large empty space above the natural draft flue, which would leave the space where the economizers were now placed to be used for the incoming air duct to the forced draft fan and dispensing with about two-thirds of the ash basement volume.

There had been a number of unusual ideas worked into the layout which were worthy of emphasis. Among these were the following:—

(*a*) The use of economizers under heavy loads only. In this connection a statement of the expected terminal flue gas temperatures under each condition would have been real professional information. Also on what factors would depend the operation of one boiler at high rating with economizer, or the operation of two boilers at medium rating without economizers.

(*b*) The combination of ventilation of the upper part of the boiler room, with the furnace air supply, under forced draft operation was quite ingenious, especially the feature designed to prevent the dust from above the bunkers flowing into the boiler room. Mr. Watson doubted whether the velocity of air flow through the bunker space would be sufficient at more than a few points to carry the coal dust. The author did not state the degree of pre-heating expected, or whether this slight amount of pre-heat would increase the efficiency sufficiently to compensate for the reduction of draft and the expense of the complicated duct arrangement required. Once this duct arrangement was installed, it appeared to him that it should be made use of, under small load conditions, to ventilate, as far as possible, the overboiler space, because it was generally at small load periods that repair work in this space was carried out and when comfortable working conditions were of importance.

(*c*) The reasons for hydraulic soot disposal from the rear boiler pass, instead of using the ash cars, were not stated, but would be of interest. Was it not questionable whether the soot was sufficiently buoyant to remain in suspension in the ordinary slow flowing street sewer, or whether there might not be sufficient fly-ash in the soot to settle out and eventually block the sewers?

The facilities for removal of soot and fly-ash from the flues and economizers had not been described, but would appear to require special attention when such elaborate equipment was installed for rear boiler pass soot removal.

(*d*) It was stated that coal from the storage bin might be distributed in one-ton cars to the crusher or directly to the stoker hoppers. It was inferred that these cars were moved and dumped by hand. One would expect to find some arrangement whereby the motor trucks could dump directly to the suspended bunker or the conveyor above it, from the floor above, in order to save the extra manual and mechanical handling when it was unnecessary to crush the coal. It would be interesting to know whether this layout was dictated by architectural conditions or by the possibility that it was necessary to keep this coal, which was rather high in sulphur, moving and not in storage for any considerable time.

There was no mention made of ventilation in the coal handling floor.

(*e*) The availability of softened water for make-up was fortunate with regard to boiler cleaning. It was noted that a deaerating heater had been employed to preclude corrosion where the natural protection of scale would be missing.

Mr. Watson concluded by stating that he felt that valuable professional knowledge might have been given in further data on the furnaces: including the furnace volumes, expected maximum and normal rates of operation, b.t.u's per cubic foot per hour, also the types of refractory and insulation in the setting, with provision for expansion, if any.

F. A. Combe, M.E.I.C.

The author stated that many of the points raised by Mr. Watson had been dealt with in previous replies. It was hardly possible in such a paper to explain fully the reasons for adoption of particular details of plant layout

[8] Partner Angus and Watson, Toronto.

as these were governed by so many factors and condition requirements; for instance, the layout of the future building overhead, fronting on Mansfield street, and its communications with the main building, determined the location of the chimney and the method of coal handling.

In regard to the economizers it was very advisable, when the temperature of the water is raised to such a high degree, that the natural upward flow be maintained if possible.

It was hardly possible to give arbitrary times and loads for putting into commission certain sections of the boiler units and auxiliary equipment, as this must be left to the judgment of the operating engineer to suit conditions and the best results. The object was to design the boiler units to be elastic and to have a wide range of economic operation. It might be mentioned that on the completion of the building over the boiler plant, the increased height of stack would make unnecessary the operation of the induced draft fans to the same extent as at present.

In the matter of soot disposal, all familiar with the operation of boiler plants knew that while it was a comparatively easy matter to dispose of ashes, nobody wanted soot, and the method of disposal adopted at this plant had not given, and was not expected to give, trouble or cause difficulties. Soot from the economizers was disposed of in the same manner by flushing to the sump.

L. M. Arkley, M.E.I.C.[9]

Professor Arkley asked if the author had any information as to the efficiency of the boiler plant, and also why the special type of stoker he had put in was chosen, and why Nova Scotia coal was used.

F. A. Combe, M.E.I.C.

The author replied that during a test made the efficiency of the boiler and stoker worked out at around 75 per cent. With the economizers it was expected that an efficiency of around 80 per cent would be maintained.

The choice of stoker was determined largely by its suitability for Nova Scotia coal and by the necessity of having a smokeless chimney under all loads. The author was of opinion that the chain grate stoker with a properly designed furnace was best suited for smokeless operation under the conditions prevailing in a plant of this type. There had been an entire absence of smoke from this plant at any load so far carried.

The plant was designed to burn Nova Scotia coal as this is a Canadian product and is the lowest priced bituminous coal available in Montreal.

(9) Professor of Mechanical Engineering, Queen's University, Kingston, Ont.

J. Stadler, M.E.I.C.[10]

Mr. Stadler remarked that as he understood it, no provision had been made for the generation of power, consequently even the power required when the fans were in use would be supplied from outside. The peak of steam demand might possibly come at the same time as the maximum peak in the load in Montreal. Mr. Farmer had already mentioned the possibility of power that could be generated from steam by using a higher pressure; therefore, he would not cover that field. But he would ask whether it was possible to anticipate the load curve of the boiler plant in relation to the power demands of the city of Montreal? In other words, was it anticipated that their peak demands would not correspond with a maximum load demand of the city of Montreal. Further, had it been considered that it might be advisable to make provision for steam storage by operating the plant at a variable pressure.

F. A. Combe, M.E.I.C.

The author stated that the peak steam load on the station would not coincide with the peak electric power load in the city, in that being mainly a heating plant the maximum peak would come in the early part of the morning during the first hours of occupancy; later, by reason of its occupancy and since usually the outdoor temperature moderated, the steam demand would drop during the afternoon.

He did not think that steam storage could be used to advantage as the load curve was gradual and arrangements were made in the building for zoning of the heat in different sections to suit outdoor conditions by thermostatic or manual control.

In a central operating room in the main building the load dispatcher would be in a position to so regulate his load as to offset any sudden demand and also to iron out the peaks by diversity of steam usage. With such a system the author did not think that any large steam accumulator storage would be justified.

(10) Industrial Engineer, Montreal.

Communication on Civil Airways in Canada*

Lieut.-Colonel W. Arthur Steel, M.C., A.M.E.I.C.,
Royal Canadian Corps of Signals, Ottawa, Ont.

Paper presented on April 23rd, 1931, before the Aeronautical Section of the Montreal Branch of The Engineering Institute of Canada (Montreal Section, Royal Aeronautical Society).

SUMMARY.—In this brief survey of the various systems of communication applicable to aircraft and airways, radio aids to air navigation are first described. These include directive beacons and direction-finding equipment. As a means of two-way communication with aircraft in flight, radio telegraphy is considered more effective and reliable than radio telephony. In order to permit of continuous service, blind landing equipment is required, and the use of radio beams for this purpose is discussed. Reference is made to the present system of communicating meteorological reports by teletype, and the existing organization of civil airways in Canada is described.

Introduction

A great deal has been written in the technical press about communication for aircraft, but the whole subject of aviation is so new that some benefit may still be derived from a general survey of the various systems of communication applicable to aircraft and to the recognized airways over which these machines fly. In addition to this summary the writer hopes to show how these communication aids are being utilized in the development of civil aviation in Canada.

The systems of communication required on recognized air routes may be summarized under the following heads:—

1. A radio system to keep the plane on its course between airports.
2. Two-way radio communication between the plane in flight and the airports.
3. Blind landing facilities.
4. A system for the collection and dissemination of weather information along the airways.

A variety of systems have been developed and applied to these problems in different parts of the world and in the following paragraphs will be found a short description of the more important of these schemes that are at present in operation.

Radio Aids to Air Navigation

The Directive Beacon

The directive beacon, or equisignal beacon as it is sometimes called, provides a number of zones of equal signal strength, arranged normally at 90 degrees or 180 degrees to each other and which radiate in straight lines from the transmitting aerial. An example of this will be found in Fig. 8. These zones can be oriented in practically any desired direction. The pilot is informed when he is in one of these zones either by a characteristic signal received in the telephones in his head set, or by means of a visual indicator installed on his dashboard and operated by the receiver on the plane.

Either method will keep the pilot continuously informed whether or not he is on his correct course. It will also tell him whether he is drifting to the right or the left of the desired route. This indication, however, does not give the pilot his actual position but merely informs him when he is on the proper course. In certain instances attempts have been made to give the pilot his approximate location by means of marker beacons erected at periodic intervals along the course. These marker beacons consist of low power transmitters emitting a characteristic signal received by the pilot either in the telephones or on a visual indicator.

*This is the third of a series of papers on aeronautical subjects which have appeared as follows:
"Aerial Cameras and Photography" by Flight Lieutenant J. R. Cairns. May 1931 issue of The Engineering Journal.
"Some Problems Connected with Fluid Motion" by J. J. Green, A.R.C.Sc., Ph.D. June 1931 issue of The Engineering Journal.

The directive beacon system has been extensively employed on the airways in United States and satisfactory ranges up to 120 miles have been consistently obtained. The width of the equisignal zone is of the order of six degrees, that is, about seven miles wide at 100 miles from the transmitter.

By means of a vertical rod antenna on the aircraft it has been possible to reduce "night effect" to such an extent that the system is equally useful by day or by night.

A very satisfactory type of rod antenna has been developed in America. It is easy to install and yet does not detract from the performance of the aircraft. It is pointed out, however, that the use of such a small antenna necessitates a very sensitive receiver with high amplification, and, as a result, the engine ignition system must be completely screened. This problem, however, had already been partially solved in this country in connection with the work done on telephone reception in aircraft.

The directive beacon is most useful on established routes where the courses to be followed are straight for approximately 100 miles. Unless the route is comparatively straight for distances of this order, the cost becomes prohibitive due to the number of transmitters required.

Direction Finding Equipment

The methods used in marine direction finding can be applied to aircraft with practically no alteration in either equipment or method of operation. It is well known that in marine work the actual bearings may be taken either on the ground and transmitted to the ship, or may be taken on the ship itself. Both of these methods are equally applicable in aviation. The basic principle underlying the operation of all systems of directional reception is the receptive properties of the simple loop antenna. With such a receiving system the signals are at maximum when the plane of the loop is pointing towards the transmitting station, and at a minimum when the loop is turned at right angles to the line of transmission.

When the equipment is mounted on the ground, two large loops of wire are rigidly supported at right angles to one another and to the horizontal. Two of these stations are required in order to take a bearing on either a ship or an aeroplane. It is also essential that these two stations should be in communication with one another so that the two sets of readings can be taken, plotted, and the location of the resulting intersection transmitted to the ship or aircraft. When the receiving equipment is on the plane the bearings must be taken on two different transmitting stations on the ground. The big disadvantage in all direction finding stations lies in the time required to make these bearings. When the equipment is on the ground heavy and expensive transmitting equipment must be mounted on the aircraft. This system is also subject to excessive variations due to the so-called "night effects." It is also pointed out that while bearings are being taken the aircraft is bound to be out of touch with the ground for normal communication

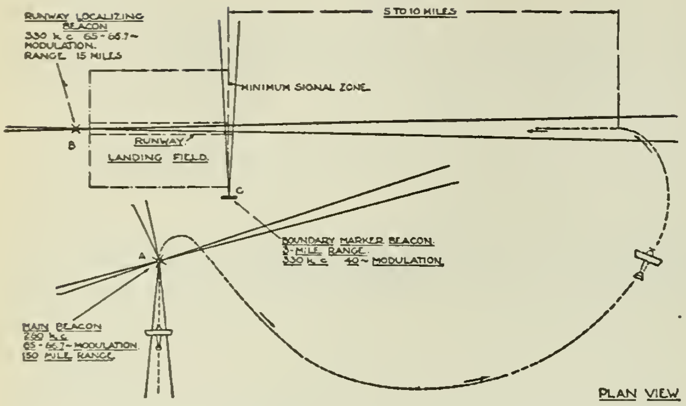

Fig. 1—General Arrangement for the Low Power Runway Localizing Beacon.

purposes. A further serious defect lies in the fact that any two ground stations can only serve one plane at a time. With dense traffic and poor visibility the subsequent delay becomes very serious indeed.

In order to reduce "night effect" a method known as the "Adcock System" has been evolved. Night error is due to the effect on the horizontal wires in the loops of vertically-polarized waves which have been reflected from the Heaviside layer. In the Adcock antenna system the horizontal members of the loops are eliminated by an ingenious method of construction. Unfortunately this system can only be erected on the ground. It does give very definite freedom from night variations but is subject to all the other defects of direction finding systems.

Another method, known as the "Robinson System" for aircraft, involves two loops, set at right angles to one another, and built into the wing structure of the plane. This system is, of course, only applicable for installation on aircraft. This device is essentially a method of homing the plane on a known transmitting station. It does not actually show the true position of the plane but only indicates when it is on the proper course. Strong cross winds, while causing the plane to drift badly, will not prevent it from reaching its final destination although the path, instead of being a straight line, will be a curve depending upon the strength and direction of the cross wind.

Two-Way Communication

This is required both by the operators on the ground and by the pilot in the air. The operator wishes to advise the pilot regarding changes in schedules, airport conditions, and other purely company business. On the other hand the pilot wants information about the weather ahead, about emergency fields and, in case of forced landings, to call for help and to advise his headquarters of his location. Having once made the decision to adopt two-way communication, the question then arises shall we use telephone or telegraph for this service? This whole question has been admirably treated by Mr. W. G. Logue of the Radio Marine Corporation of America in the June 21st copy of Aviation. Mr. Logue is strongly in favour of the use of radio-telegraphy for plane-to-ground communication, and his reasons may be summed up briefly as follows:—

(*a*) Radio telegraph apparatus in the planes is less complex than radio telephone apparatus, and is therefore less liable to failure.

(*b*) It is lighter in weight and less bulky.

(*c*) It is more economical. This applies to first cost as well as maintenance.

(*d*) It provides increased reliability of communications because telegraph signals are easier to "read" than telephone signals under bad atmospheric conditions, and certain types of telegraph signals are less subject to skipping and fading.

(*e*) Telegraph signals create less interference. Telephone communications occupy many times as much space in the ether as a telegraph signal. This is important in a service where channels are scarce.

Our air-to-ground work in Canada during the past ten years has led us to exactly the same conclusions as given by Mr. Logue. This is particularly true when reliability of communication is concerned. A two-way radio service for aircraft must be of such a type that it will provide 100 per cent communication or it will have failed in its purpose. It has been demonstrated through years of operation on other forms of transport that radio-telegraphy is the surest means of maintaining contact under the worst operating conditions. Communication with aircraft is fundamentally no different from communication in other mobile fields and, in the long run, the tried and proven methods will undoubtedly again prove to be the most satisfactory.

Blind Landing Equipment

It should be remembered that any system of blind landing aids must indicate to the pilot the position of the aircraft in three dimensions as it approaches and reaches the instant of landing. Up to the present this has been attempted by sub-dividing the problem into two parts: (*a*) field localization and (*b*) accurate height indication. Without going into detail the writer would point out that field localization has been attempted mainly by the use of buried "leader cables" providing a complete circuit around the landing field, or perhaps a straight cable down the field, with a visual indicating device on the plane instrument board. Height above ground has been measured in many ways but the only perfectly satisfactory device yet developed is the sensitive barometric altimeter so constructed that adjustments may be made in the air for any change in barometric pressure. This involves two-way communica-

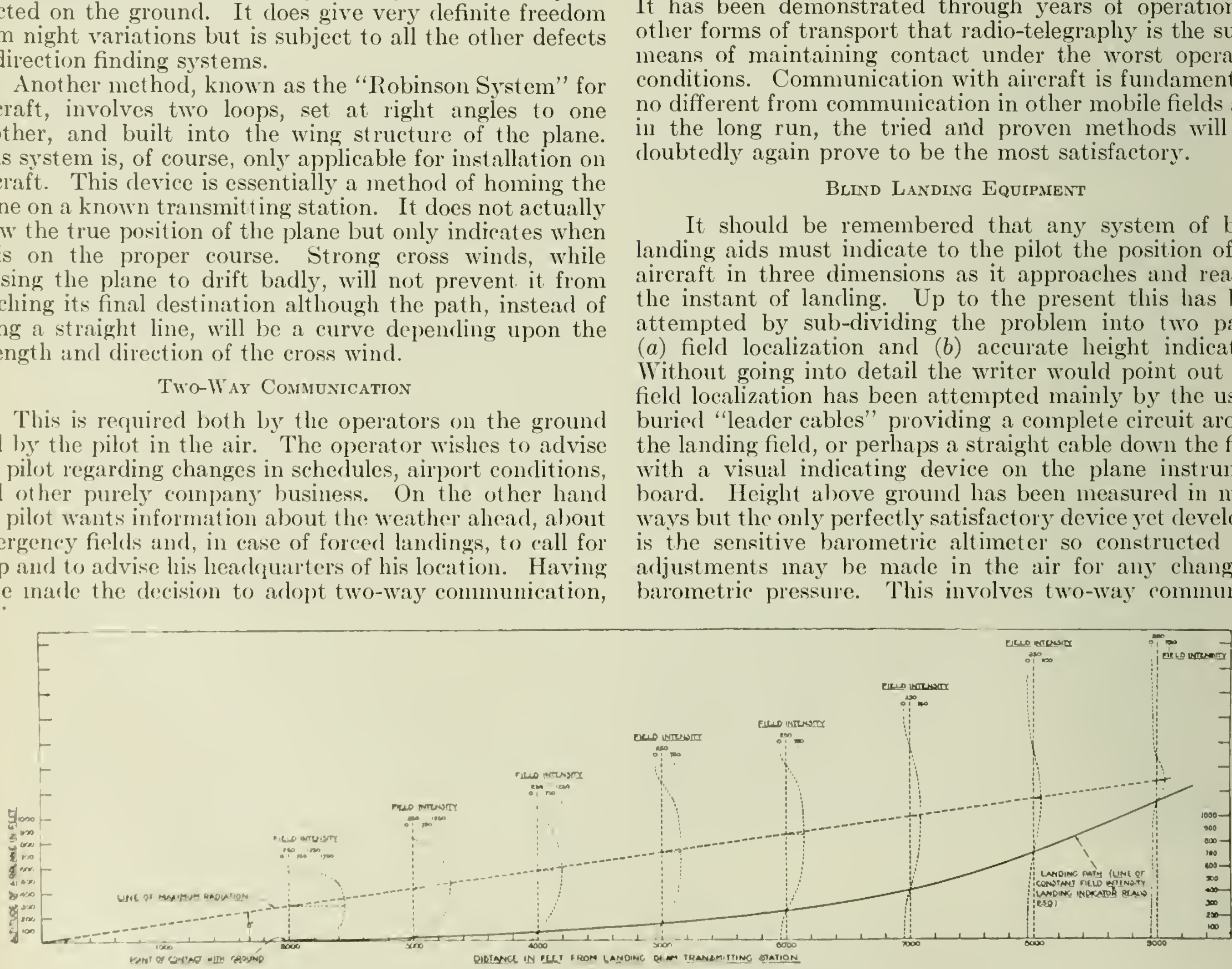

Fig. 2—Gliding Path Marked out by the Inclined High Frequency Beam.

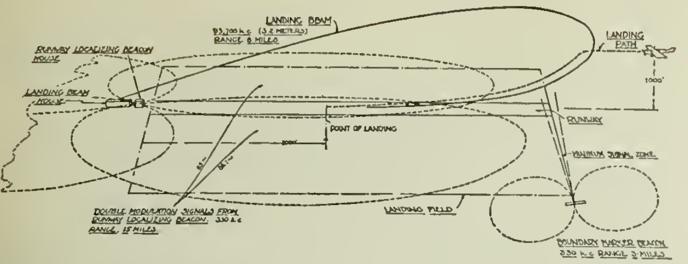

Fig. 3—A Three Dimensional View of the Blind Landing System

tion between pilot and airport to enable details regarding the change in pressure to be received in the air when required. Other schemes are being developed for height indication, the most promising ones being the sonic and the radio altimeters. Both of these depend upon the time taken for a wave to travel from the plane to the ground and back. However there are no instruments of either of these types at present available for practical use.

The Bureau of Standards at Washington have been working on the blind landing problem for several years in conjunction with their programme of radio aids to air navigation. The most successful, and at the same time the simplest system yet devised, is the one now installed at their experimental field near Washington.

The system is intended for use at airports where it may be necessary for aircraft to land under conditions of poor or perhaps no visibility. The system consists of three elements indicating to the pilot the path of the aircraft as it approaches the field and finally reaches the instant of landing. This system is a development of the directive beacon with visual indicators, as described earlier in this paper.

The three fundamental aids that must be available to the pilot are as follows:—

(*a*) The runway on which he is to land must be marked out by a clear, strong beam, along which he can readily guide his machine.

(*b*) He must be told, promptly, when he is exactly over the boundary of the airport.

(*c*) He must be provided with a definite path, marked out by means of a radio beam, which will coincide exactly with the gliding path of his plane.

In Fig. 1 will be found a diagram illustrating the first of these aids. A low power runway localizing beacon, using the same radio and audio frequencies as the main route beacons on the airway, is located just off the airport and is directed along the runway on which the plane is to land. The standard receiver and visual indicator on the plane are used to guide the plane along this path.

The boundary of the airport is marked out by a second low power transmitter, using the same radio frequency as the runway localizing beacon, but modulated at 1,000 cycles or similar audio frequency. The aerial used is so arranged that the radio field only extends for about 100 feet on either side of the airport boundary. This signal is heard by the pilot in the headphones normally used to receive the weather reports.

The landing path is obtained in a very ingenious manner. An ultra-high-frequency radio beam transmitter (a three-meter wave, actually) is set up near the runway localizing beacon and directed along the centre of the runway being used. This beam is inclined at eight degrees above the horizontal, as is shown in Fig. 2. The aeroplane is equipped with a high frequency receiver with a meter in the output circuit. If the plane were to fly along the line marked "line of maximum radiation," the reading of this meter would steadily increase as the plane approached the transmitter. If, however, the machine flies below this line, the signal will be less the further the plane is from this line of maximum radiation, i.e., from the centre line of the inclined radio beam. Therefore we have two forces acting—an increase in signal strength, due to the steady approach towards the source, and a decrease, due to the departure from the line of maximum radiation. These two operations can be made to balance, resulting in a steady reading in the meter as the plane approaches the transmitter. If the path, along which this signal is of uniform strength, is plotted out it will be found to coincide practically exactly with the gliding path of an aeroplane. Such a path is shown as a solid line in Fig. 2. The pilot watches the meter, if he is flying too high the meter will read "high," if he flies too low the meter immediately indicates this by reading "low." When he keeps the meter at its constant value, i.e., at midpoint on the scale, he is on the correct course.

Only one additional instrument is required, when the machine is already equipped for flying on airways provided with visual route indication. The normal reed or visual indicator, shows when the pilot is flying along the runway on which he is to land. The airport boundary indication is received audibly by means of the headphones used by the pilot to obtain his weather reports. The additional instrument consists of the high frequency receiving set with the meter in its output circuit. By keeping the deflection of this meter at a fixed value the pilot directs the plane along the curved path coinciding with the gliding path of the machine. Fig. 3 is a three-dimensional drawing, in which an attempt has been made to depict these three operations simultaneously. Fig. 4 is a drawing showing the arrangement of the various pieces of equipment in the plane itself.

The System of Civil Airways in Canada

Canada has not as yet a complete transcontinental air mail system but steady progress is taking place towards that end. It should be remembered that in this country a great deal of what might be called itinerant flying takes place. In this article no mention is made of such flying, although it is very important and constitutes a very large proportion of the total civil flying in this country. The writer has confined himself solely to recognized airways and to airmail routes carrying government mail contracts.

Our airmail system, as it exists at present, is shown in Fig. 5. It begins in Moncton, N.B., in the east and reaches Montreal via the state of Maine, crossing into the United States at McAdam, N.B., and returning to Canada at Megantic, Que. In the summer time there is a service connecting with the trans-atlantic passenger steamers at Father Point and reaching Montreal via Quebec and the St. Lawrence river route.

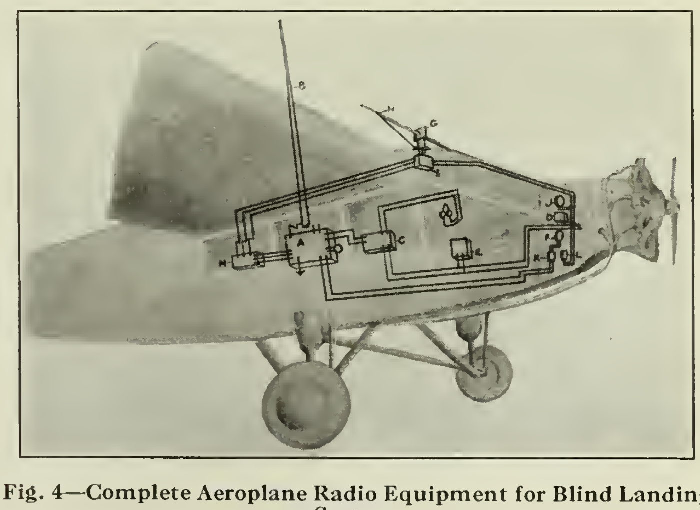

Fig. 4—Complete Aeroplane Radio Equipment for Blind Landing System.

Fig. 5—Map of the Canadian Airmail System.

From Montreal the mail goes to Detroit via Kingston, Toronto, Hamilton, London and Windsor. At Detroit trans-continental mail is transferred to the United States lines and taken as far west as Minneapolis. Here a United States branch line picks it up and takes it to Pembina on the international boundary just south of Winnipeg. At this point Canadian planes again pick up the mail and deliver it to Winnipeg in time to catch the night run across the prairies to Calgary.

From Winnipeg the mail route runs over Forrest (just north of Brandon), Broadview, Regina, Moose Jaw, Maple Creek, Medicine Hat, Lethbridge and Calgary, following in general the route of the Canadian Pacific Railway.

From Moose Jaw there is a northern mail route serving Saskatoon, North Battleford and Edmonton. It is probable, however, that this will be altered in the near future and that two feeder lines will be used, one from Moose Jaw to North Battleford, and the second from Lethbridge through Calgary and Red Deer to Edmonton.

The gap between Lethbridge and Vancouver has not yet been completed although aerial surveys have been made and a satisfactory route laid out through the Crow's Nest pass to Vancouver.

In addition to these routes across Canada, a northern service is being given by the Commercial Airways from Edmonton to Aklavik via the MacKenzie River valley. Mail is taken by train to Waterways (near Fort McMurray) from which point the planes fly northward via Fort Smith, Resolution, Simpson Norman and Good Hope to Aklavik in the delta at the mouth of the MacKenzie river.

These routes are all flown throughout the entire year and passengers as well as mail and express are carried on all flights.

In addition to those already mentioned there are several smaller routes scattered over the country. A winter service is given from Quebec to Seven Islands and Anticosti Island. It is hoped to expand this into an all-year route and to handle mail from Quebec to Belle Isle during the season of fast steamers from Quebec to England. This would save almost two days on the Montreal-Southampton mail run. A winter service is also given between Moncton and Magdalen Islands in the gulf of St. Lawrence.

Further inland there are three short mail routes. In Quebec, Oskelaneo on the Canadian National Railways connects with Chibougamau. In Ontario, Sioux Lookout, Red Lake and Woman Lake, all in the mining area, are interconnected, while in Manitoba, Cranberry Portage on the Hudson's Bay railroad is connected with Kississing by air. These three routes operate throughout the entire year.

In the east there is a second connection with the American airmail through the Canadian Colonial route between Newark, Albany and Montreal. This line carries passengers and express and is an all year round service.

The radio aids to air navigation now being installed on air mail routes in Canada by the Directorate of Civil Aviation, consist of directive radio beacons, two-way communication stations and a teletype service. Up to date no attempt has been made to provide blind landing equipment.

The western half of the system has been installed first, since the mail schedule in the west involved night flying. Beacon stations were placed at approximately 250 mile intervals, since the dependable range of the receivers and visual indicators is about 125 miles. The chain consists of 2 k.w. stations located at Forrest, Man., Regina and Maple Creek, Sask., Lethbridge and Red Deer, Alta. It will be observed from the map that at Broadview, Morse and Medicine Hat the direction of the mail route changes somewhat and the beams from the beacon stations intersect at these places. It is proposed to erect marker beacons at

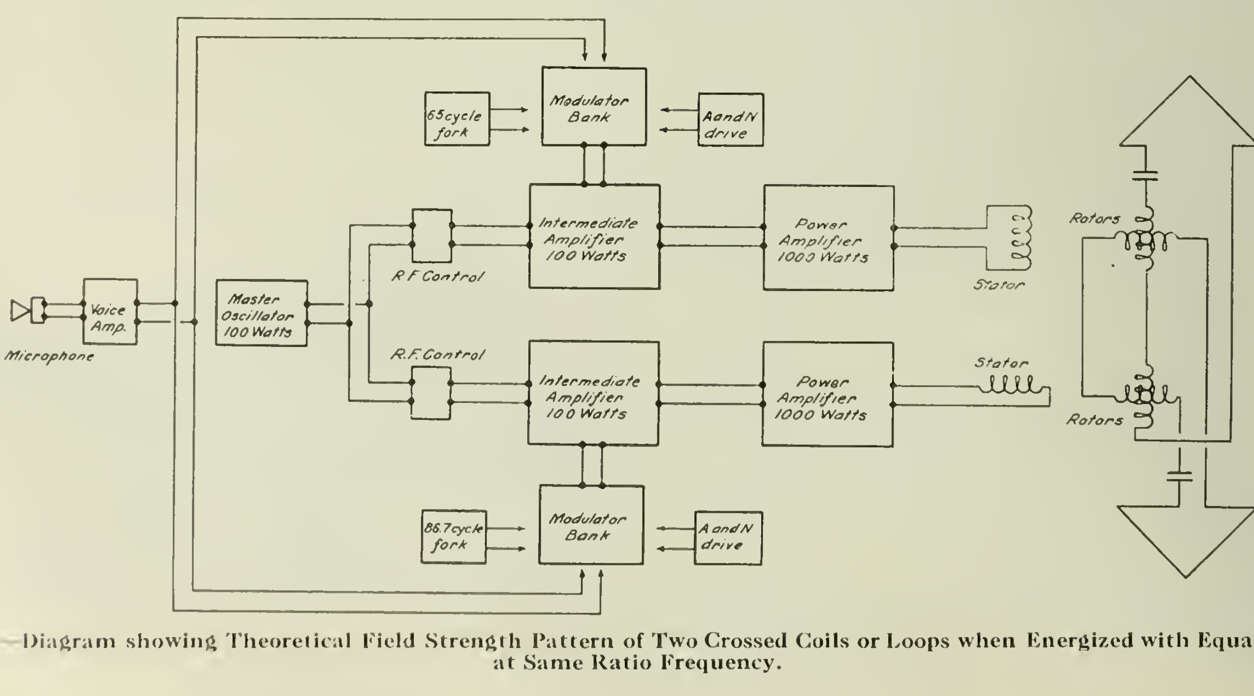

Fig. 6—Diagram showing Theoretical Field Strength Pattern of Two Crossed Coils or Loops when Energized with Equal Power at Same Ratio Frequency.

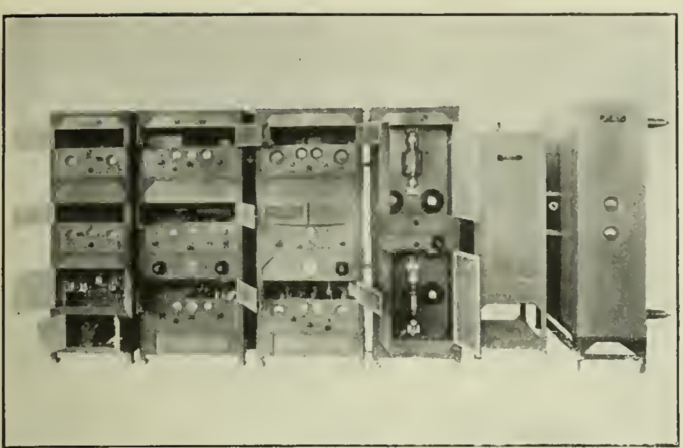

Fig. 7—The Marconi Beacon Transmitter.

these points and to use a third reed in the visual indicator. Until such time as these special stations can be erected, "on course" lights have been installed to indicate to the pilot that he must change direction.

The eastern radio system will have beacon stations at Moncton and McAdam in N.B., Megantic and St. Hubert in Quebec, Kingston, Toronto and London in Ontario. In addition there is a large station at St. Hubert equipped to transmit either by code or voice and it is used both for ground station traffic and for communication to planes in flight.

The section between Lethbridge and Vancouver, across the Rocky Mountains, will be served by means of two-way communication, since the route is far too tortuous for beacon stations to be used.

Under a recent agreement between United States and Canada the wavelengths between 850 and 1,350 meters are to be used for the radio beacon and weather broadcasting service. For the two-way communication between planes in flight and the ground stations, wavelengths in the band between 50 and 100 meters have been set aside. These wavelengths have been so chosen that machines flying between United States and Canada will be able to use the same apparatus in either country.

The Directional Transmission System as Applied to Canadian Civil Air Routes

Ground Equipment

No attempt will be made here to give the theory of the directive beacon but the accompanying diagrams and photographs will illustrate the equipment itself which has been designed and built in Canada by the Canadian Marconi Company in collaboration with the engineers of the Royal Canadian Signals. The equipment is similar in principle to the transmitters developed for use on American airways, but several unique features have been built into the Canadian apparatus. Fig. 6 is a schematic diagram of the arrangements of the parts of the beacon transmitter, while Fig. 7 is a photograph of the beacon transmitter with the doors of the various units open for inspection. The photographs of the antenna system and of the interior of the station were taken at Lethbridge, Alberta.

Beginning at the left of the diagram of Fig. 6 it will be noted that the transmitter consists of a master oscillator of 100 watts output feeding two intermediate amplifiers each of 100 watts. Between the master oscillator and the intermediate amplifiers are placed phase control devices so that either two or four courses may be produced by proper phase adjustment of the currents in the two loops. In Fig. 8 will be found the field pattern giving four courses from one beacon transmitter. Each of the intermediate amplifiers control a power amplifier of one kilowatt rating. The output from these last stages is fed through a four coil goniometer into the two loop antennae. Tuning is provided in each leg of each loop so that an exact balance of the aerial system may be secured. The modulation frequencies are introduced into the two intermediate amplifiers, and in this part of the circuit certain modifications have been introduced into the Canadian apparatus. It will be observed that the two audio frequencies of 65 and 86.7 cycles are obtained from two valve driven tuning forks, the temperatures of which are held constant by means of thermostats, at 90 degrees F. Two UX. 210 valves are used as an output amplifier for the tuning fork, the energy from this amplifier being fed into the intermediate amplifier through a bank of UX. 845 modulation valves. Means are provided to control the depth of modulation produced by the tuning fork signals. In order to provide for planes not equipped for visual indication, apparatus has been provided to convert the beacon to the aural, or A and N type. A small 500 cycle generator, together with a motor-driven set of interlocked cams, may be switched into the circuit in place of the forks and the output of the two loops, modulated with a 500-cycle signal, may be keyed as in the original American system. This modulation will provide for service to visiting American aircraft not equipped for the visual system, or for any of our own planes that may be flying beyond the range of operation of the visual indicator. No change is required on the aircraft receiver, as head telephones are already provided to receive the meteorological broadcast.

It is usual to supply the hourly weather report on the same wavelength as the beacon signals so that it will not be necessary for the pilot to make any change in his receiver. In the American system this is done by providing a second transmitter at the airport. There are two disadvantages to this scheme. First—the cost of the second transmitter with its power plant and associated equipment. Second—the time taken to change from one transmitter to another and back again several times each hour.

To overcome these difficulties a further modification has been added to the Canadian beacons. A microphone and speech input amplifier have been included in the transmitter, together with the necessary switching, so that

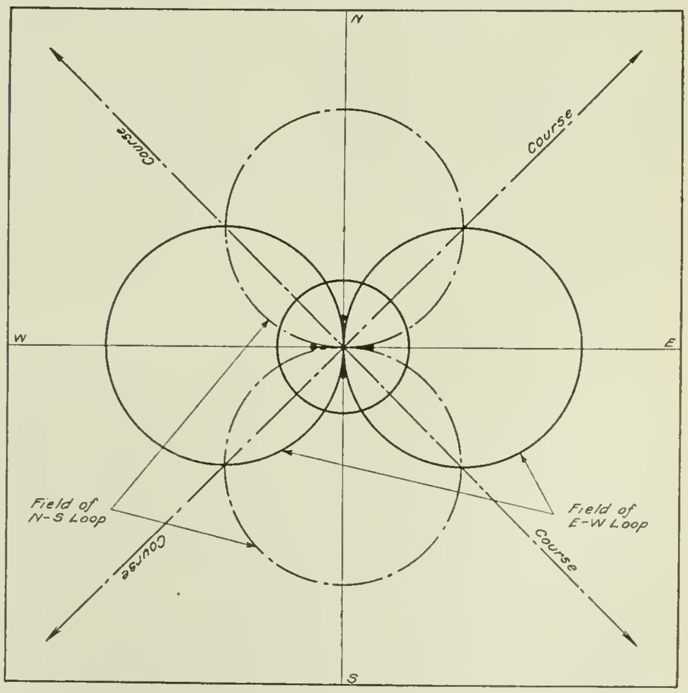

Fig. 8—Schematic Diagram of Arrangements of Parts of Canadian Radio Beacon.

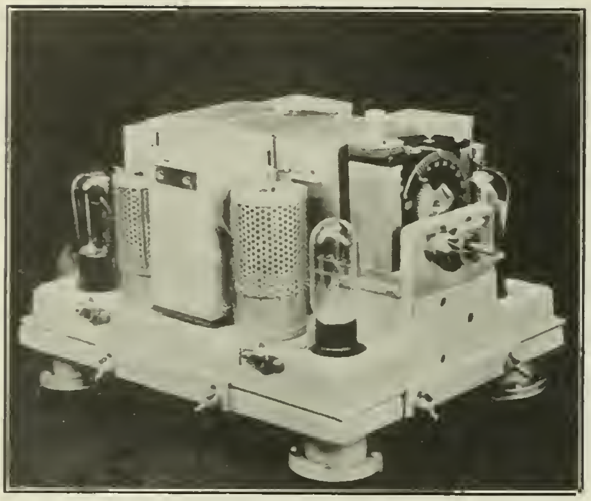

Fig. 9—The Western Electric Beacon Receiver of the Northern Electric Company.

voice modulation of the output of each loop can be secured. In order to transmit weather reports or other information to the pilot, it is only necessary for the operator at the station to throw the switch from either of the beacon positions to "voice" and to speak over the microphone provided. No change is required in the tuning of the aeroplane receiver and the pilot can adjust the strength of the speech by means of the volume control provided on the remote control device.

The goniometer, coupling the power amplifiers to the crossed coil antennae, is used to enable the courses mapped out by the beacon to be oriented in any direction required. The goniometer consists of four coils, two stator coils at 90 degrees to each other and two rotor coils also crossed at 90 degrees. The stator coils are connected to the plates of the power amplifiers, while the rotor coils are connected each in series with one loop antenna. The currents in the loop antennae, due to the driving voltage from each stator coil, create a resultant field in a direction such as would be produced by an imaginary antenna rotating with the goniometer rotor. Since there are two stator coils at 90 degrees, there are two such phantom antennae rotating as the two rotor coils turn together, thus allowing the equisignal zones or courses in space to be swung into any required direction.

There is a further advantage to be gained from this system. By suitable adjustments of the goniometer coils and the transmitter, two different effects may be secured. First—two of the right angle courses may be eliminated, leaving only one direction along which aircraft may fly. Second—the four courses may be retained but the angle between the two directions may be varied over quite wide limits. This is often necessary at airports where a number of radiating courses are in existence.

The Aircraft Beacon Receiver

The aircraft receiver is of the high gain type, employing three stages of screen grid radio frequency amplification ahead of a detector and two-valve audio amplifier. This amount of amplification is required to operate the visual indicator, since it has been found necessary to use a vertical rod type aerial on the plane to minimize "night errors," or variations in apparent direction due to reflections from the heavyside layer. This antenna consists of a streamlined metal rod, mounted on the fuselage of the machine and extending about seven feet above the upper surface of the plane body. The actual receiver is mounted in any convenient place in the tail of the aeroplane and the "on and off" switch, telephone jack and volume control are mounted in a small box on the instrument board. The visual indicator is also mounted on the instrument board in some spot where it can easily be seen. The effect of the electromagnets of the visual indicator on the compass has been completely eliminated by proper screening of the indicator box.

Fig. 9 illustrates the beacon receiver manufactured by the Canadian Marconi Company, while Fig. 10 shows the receiver handled by the Northern Electric Company.

In order to obtain the maximum benefit from these receivers, complete shielding of the ignition system should be employed. The high and low tension wires, the spark plugs and the magneto distributor blocks should all be shielded. Special shielded ignition harness has been developed by several United States firms, chief among whom is the Breeze Company of Newark, N.J.

In this harness the distributor blocks are covered by metallic shields and special metal shields are used around each spark plug. It is possible to use plugs, in which the shield is an integral part of the plug, but these do not give the same satisfaction as the metal shields. Shielding "cans" made by the R.F.L. Company of Boonton, New Jersey, were used at one time in this country, but these gave trouble in wet weather due to rain entering the ventilation slots and short circuiting the plug.

Power Supply for Beacon Stations

Where possible power is obtained from the system supplying the town or city near which the airport is located. In such cases the power is brought out by pole line at 2,400 volts, 3-phase, and from a distance of 1,000 feet from the station is carried underground by "Parkway" cable into the basement of the station. Transformers, lightning arresters and switch gear are provided in a transformer vault and power at 550 volts, 3-phase, is carried through the switch board to the motor-generator sets, also mounted in the basement of the station. Lightning arresters are mounted on the last pole erected, to protect the buried cable from damage during a storm.

Where power is not available locally, a 20 k.w. gasoline driven set is provided and operated in the same building as the beacon transmitter. Here the power is generated directly at 550 volts, 3-phase, 60 cycles and stepped down to 110 and 220 volts for the lighting and incidental services around the building.

A tungar rectifier and charging panel are provided on each station to take care of the batteries required for the operation of both the transmitter and receiver.

Fig. 10—The Beacon Station and Antenna System at Lethbridge, Alta.

The Teletype System for Meteorological Reports

The teletype service for the collection and dissemination of weather information has been devised with the idea of minimizing the amount of radio transmission required by civil aviation. It is well known that the number of channels available for this work is limited and that they must be conserved for the essential services between air and ground, since these services cannot be served in any other way.

The teletype system comprises leased telephone or telegraph circuits over which signals are transmitted by an automatic typewriter giving a typed record on all machines in the circuit. The transmission over this system is at a rate of approximately forty words per minute. All stations are equipped with transmitting and receiving equipment and consequently any two stations can intercommunicate, but the record of the conversation will be available in all other stations on the circuit.

It is not possible yet to use one single circuit from coast to coast. The area to be covered is, therefore, broken up into sections and when messages or weather reports have to be repeated between divisions, it is necessary for the terminal stations to retransmit this information into the next subdivision of the teletype system. However, this is an advantage in many respects as it speeds up traffic in each individual division.

Current weather information is collected on an hourly basis from the principal intermediate landing fields and from certain critical points along the route. This system of weather collection is co-ordinated with the radio beacon service. The beacon transmitter is stopped at a certain definite period each hour, the station identifies itself first and then gives the broadcast of current weather information.

In addition to the collection of weather information, the teletype circuit is used to transmit the information from the secondary net covering the off airways weather data. This report is given every three hours. In addition the available upper air data is transmitted from the weather bureau for the information of all transport operators and intermediate landing fields along the route.

As an example of the method of applying the general teletype system to a particular service, the following detailed description of the Canadian teletype service may be of interest. It may be followed by referring to the map of the Canadian air mail system, Fig. 5.

In order to permit the aerodromes to keep closely in touch with one another, a line has been installed with teletype instruments at St. Hubert, Kingston, Toronto, Hamilton, London and Windsor. The meteorological department in Toronto have arranged for special observers at each of these places and weather reports may be obtained from any station at any time during the day. In addition to these special reports, a number of routine weather reports are transmitted from each station to all other stations every day. These reports give full meteorological information so that every station on the teletype system has on hand at all times a complete file of weather reports covering all stations on the system. This information is available for pilots or others contemplating flights over any part of the route.

A second line has been installed from Winnipeg to Calgary with instruments at Forrest, Regina, Moose Jaw, Maple Creek, Medicine Hat, Lethbridge and Calgary. In addition there is a third line from Regina to Edmonton via Saskatoon to provide communication for the planes carrying the mail between these three towns. The Winnipeg-Calgary line will be night flying almost entirely, but for the time being at any rate, the Regina-Edmonton route will be given a daylight service only.

Observers have been provided by the Meteorological Department at each of the flying fields and the same routine followed as in the case of the eastern mail route. A weather report, collected over the teletype system from all other stations on the chain, is broadcast by voice once every hour from each of the beacon stations. This can be easily arranged since they are equipped to operate as broadcasting stations as well as radio beacons. The routine followed on each station is somewhat as follows: During the time when machines are in the air, the beacon signals are shut off exactly on the hour and the weather report transmitted for the information of the pilots. At this time special messages dealing with navigational matters, or orders for the pilots from owners of machines using the route, are broadcast. At present it is necessary to shut down the beacon while this broadcast is taking place but experiments are now under way to make it possible to operate both at the same time. It is hoped that this improvement will shortly be available for all ground stations and aircraft receivers.

In view of the fact that the teletype service in the east is not as yet very widely extended, steps have been taken to tie-in the various Marine Department radio stations along the St. Lawrence and on the eastern coast. Through the co-operation of the Radio Branch, Department of Marine, the stations at Saint John, N.B., Father Point, Quebec, Kingston and Toronto are co-operating with the airways station at St. Hubert in the collection and distribution of weather reports. This service has proved very valuable and will be maintained even when the teletype service is in more general use in the east.

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Canadian Radio Broadcasting

Nearly two years have passed since the issue of the report of the Royal Commission on Radio Broadcasting. During this time the matter has received considerable attention in the press, and has been the subject of many newspaper items and editorials. No apology is needed for bringing it again* to the attention of the readers of The Engineering Journal, or for recalling the pioneer work performed in the early stages of Canadian radio engineering by two departments of the Dominion government. In 1927 the Department of Marine, in conjunction with the Bell Telephone Company, Canadian Pacific Telegraphs, Canadian National Telegraphs, and the Northern Electric Company, carried out the first Dominion-wide broadcast from coast to coast long before the existence of the special circuits and other technical facilities now available for such work; further, the staff of that department have developed what is probably the most complete and effective radio direction-finding system now available to assist navigators of ships at sea. Their radio service in aid of navigation extends from Coronation Gulf on the Arctic Ocean, through Hudson Bay and Strait, down to the Atlantic coast, up the St. Lawrence, and across the Great Lakes, and from Vancouver to Alaska, and is probably the largest system of its kind in existence to-day. In addition, the Department of National Defence has organized and equipped a remarkable network of radio communication with isolated stations in the northwest, and with aircraft flying on Canadian airways.

*See The Engineering Journal for October, 1929, p. 546.

Radio communication, and particularly general broadcasting, is of special importance in a country like ours, where the population to be served is scattered so widely, and where so many people in remote districts are dependent on radio for their contact with the outside world. It should also be noted that we are within the sphere of influence of one of the most extensive and powerful radio systems in the world, and for these reasons it is evident that the organization and management of radio broadcasting in Canada should receive the closest attention.

It will be remembered that the Royal Commission was appointed in 1928, following a somewhat heated discussion in the House of Commons arising from a decision of the Minister of Marine withdrawing the privileges of an association which was operating several broadcasting stations in Canada, and whose activities did not appear to be in the public interest. Under the chairmanship of Sir John Aird the Commission was asked "to examine into the broadcasting situation in the Dominion of Canada and make recommendations to the government as to the future administration, management, control and financing thereof."

Briefly, the Commission in its report proposed the organization of a national company operated on a basis of public service, the board of that company to be composed of representatives of the Federal and provincial governments. It was also recommended that provincial groups should have full authority over the programmes broadcast in their respective territories.

Since the issue of the report no definite steps have been taken to carry out its recommendations, and indeed before this can be done an important question as to the relative powers of the Federal and provincial governments under the British North America Act has to be settled by the courts. The business of radio broadcasting, however, in Canada has not been standing still, and has been developing rapidly along the lines which are followed in the United States, in which the funds for operation are provided entirely by revenue from the publicity given. On this basis it is inevitable that control will become centred in the hands of powerful commercial organizations, whose primary concern is their financial return, and not the benefit of the community at large.

It is doubtful whether the general public clearly understands the implications of the Aird report. Pamphlets, news items regarding the report, and other publicity matter have originated largely from quarters opposed to the Commission's suggestions, while, on the other hand, editorial comment throughout Canada has been generally favourable. The problem is of such importance, and the future development of our country is so dependent upon its proper solution, that every Canadian citizen should try to form his own considered opinion.

The essential points to be borne in mind are briefly these:

(1) Under the present system there is no way of controlling programmes so as to serve the best interests of the citizens of Canada, as distinguished from the financial or personal interests of the parties operating the broadcasting systems.

(2) Means of doing this are available without resorting to government ownership, as has been shown by European experience, particularly in England and Germany.

(3) If nothing is done Canadian broadcasting will follow the same course as in the United States, and will be operated on a profit-making basis.

(4) Is it desirable to permit such a development to continue, or is it worth while for the country to go to the trouble and expense of re-organizing the industry, so that radio can be used to the nation's best advantage?

In order to aid in forming a judgment on these points, the following paragraphs, based on notes kindly supplied by Dr. A. Frigon, M.E.I.C., are placed before The Journal's readers.

Business men are usually opposed to government ownership of any public utility. The Aird report does not propose that the Federal and provincial governments should own or operate radio broadcasting in Canada, but it does argue that broadcasting should be considered as an instrument of education in the broad sense and not as a money-making business. It seems evident that to attain such an ideal, broadcasting cannot be operated on a basis of go-getting publicity, and should not be a profit making enterprise. The Commission therefore suggests an organization which would be neither a private enterprise, nor a government department, whether Federal or provincial. The national company which is proposed would possess all the powers of a private enterprise, but would be controlled by a board of directors composed of representatives from every province and from the Federal government. This company would own and operate a group of stations throughout Canada, and the selection of programmes would be left in the hands of provincial commissions or provincial directors of broadcasting.

The question of financing such an enterprise is evidently an important one and is fully dealt with in the report. In this connection, consider for a moment the profound influence that broadcasting has in directing public opinion and in deciding the general lines along which youthful minds will develop. Think how important it is that this powerful instrument of contact with the public should be operated on a truly Canadian basis, while it is still possible to do so. It will then be realized that the expenditure of a million dollars more or less per year on such an enterprise is of little importance compared with the results to be obtained. If this were clearly understood there is no doubt that the public would willingly pay a three dollar annual license fee on radio receivers and would also approve of a substantial subsidy by the Federal government to the company in order to insure first-class Canadian broadcasting.

Comparisons have often been made between the British Broadcasting Company and the company recommended by the Aird Report. In the few articles published by the members of the Commission since the report was issued, it has been shown clearly that the system suggested for Canada is very different from that of the B.B.C. although both are based on the principle of control by the public. As a matter of fact, the Commission's proposal follows closely the method used in Germany, not that employed in Britain.

The Canadian government will soon have to decide whether radio broadcasting in Canada shall continue to follow the lines of broadcasting as it is done in the United States, or shall be directed along the lines adopted in most European countries and in Japan. Considering that the countries in Europe have organized their radio broadcasting systems with full knowledge of what has happened in the United States, it is interesting to note that nearly all of them have rejected the system of private ownership. Even in France, where broadcasting is still chaotic, successive Ministers of Communications have submitted *projets de loi* in favour of the public control of broadcasting.

If it is decided to adopt, wholly or with modifications, the report of the Royal Commission on Radio Broadcasting, there is one factor upon which success absolutely depends, namely, the spirit in which the Commission's suggestions are to be worked out and acted upon by the governmental authorities concerned. If a loyal group of men, not engaged in partisan politics, known for their integrity and their faithfulness to Canadian ideals, are appointed to take charge of the organization, the enterprise will succeed, and broadcasting in this country will take its proper place as a national institution, fulfilling national and not commercial ends. On the other hand, if nominations to the board of the radio broadcasting company, or the appointment of its general manager, are to be tinged ever so slightly with political colour, it would be far better to retain the system, or lack of system, which we now have.

We may well express the hope that this vital question will be settled with the least possible delay, and in a truly national spirit.

The Governor General Accepts Honorary Membership

The Institute has been honoured by the Governor General, His Excellency The Right Honourable the Earl of Bessborough, P.C., G.C.M.G., who has graciously consented to accept Honorary Membership in The Institute. Accordingly, the necessary formalities having been complied with, Council has given instructions for His Excellency's name to be added to the list of Honorary Members.

The Past-Presidents' Prize 1931-1932

The subject prescribed by Council for this competition for the prize year July 1st, 1931, to June 30th, 1932, is **"The Effect of the Development of the Electronic Valve upon Electrical Engineering and Industry."**

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 during the prize year by the General Secretary of The Institute, either direct from the author or through a local branch.

Recent Graduates in Engineering

Congratulations are in order to the following Students and Juniors of The Institute who have recently completed their course at the various universities.

McGill University

Honours, Medals and Prizes

Bennett, George Francis, Ottawa, Ont.—B.Sc., (El.); Montreal Light, Heat and Power Cons. Third Prize.

Charlewood, Charles Benj., Victoria, B.C.—B.Sc., (Me.); Crosby Steam Gauge and Valve Company's Prize for Summer Essay.

deChazal, Marc Philippe, Vacoas, Mauritius.—B.Sc., (Ci.); Honours in Civil Engineering.

Fogarty, James William Patrick, Moncton, N.B.—B.Sc., (El.); British Association Medal; Honours in Electrical Engineering; Montreal Light, Heat and Power Cons. First Prize.

Hawley, Eric Farwell, Ormstown, Que.—B.Sc., (El.); Undergraduates' Society's First Prize for Summer Essay.

Hulme, Gordon Donaldson, Westmount, Que.—B.Sc., (El.); Montreal Light, Heat and Power Cons. Second Prize.
Pimenoff, Clement John, Montreal, Que.—B.Sc., (Ci.); Honours in Civil Engineering; Jenkins Brothers Limited Scholarship.
Savage, Palmer Ernest, Montreal West, Que.—B.Sc., (Ci.); Departmental Prize for Summer Essay.

Degree of B.Sc.

Arcand, Louis Joseph, B.Sc., (Ci.), Montreal, Que.
Bennett, George Francis, B.Sc., (El.), Ottawa, Ont.
Blachford, Henry Edmund, B.Sc., (El.), Westmount, Que.
Charlewood, Charles Benj., B.Sc., (Me.), Victoria, B.C.
Clarke, George Frederick, B.Sc., (Me.), Jamaica, B.W.I.
Clarke, Owen Mawbey, B.Sc., (Me.), Jamaica, B.W.I.
Crain, Reginald Albert, B.Sc., (Ci.), Ottawa, Ont.
Crossland, Charles Wilfred, B.Sc., (Me.), Barrie, Ont.
Cunningham, Harold Emberson, B.Sc., (Ci.), Westmount, Que.
deChazal, Marc Philippe, B.Sc., (Ci.), Vacoas, Mauritius.
Ellis, David Edward, B.Sc., (El.), Ottawa, Ont.
Ferguson, Allan Andrew, B.Sc., (Me.), Pictou, N.S.
Fogarty, James William Patrick, B.Sc., (El.), Moncton, N.B.
Hawley, Eric Farwell, B.Sc., (El.), Ormstown, Que.
Hines, William Sylvias, B.Sc., (El.), East Noel, N.S.
Hulme, Gordon Donaldson, B.Sc., (El.), Westmount, Que.
Lea, Harry Windsor, B.Sc., (Ci.), Montreal, Que.
Massé, Gaston Wilfred, B.Sc., (El.), Sherbrooke, Que.
Morrison, Claude Wilson, B.Sc., (Me.), Town of Mount Royal, Que.
Pascal, Fred., B.Sc., (Mi.), Outremont, Que.
Pimenoff, Clement John, B.Sc., (Ci.), Montreal, Que.
Rogers, Howard Weaver, B.Sc., (El.), Montreal, Que.
Ross, Donald Ralph, B.Sc., (El.), Montreal, Que.
Sauer, George Douglas, B.Sc., (Ci.), Beauharnois, Que.
Savage, Palmer Ernest, B.Sc., (Ci.), Montreal West, Que.
Smith, Gordon Carington, B.Sc., (Chem.), Quebec, Que.
St. Jacques, Jean, B.Sc., (El.), Montreal, Que.
Thomson, Elihu, B.Sc., (Me.), Westmount, Que.
Warnock, Robert Nicholson, B.Sc., (Ci.), Westmount, Que.
Williams, Richard Louis, B.Sc., (Me.), Lachine, Que.

Queen's University

The L. M. Arkley Prize

Conn, Hugh Gordon, B.Sc., (Me.), New Lowell, Ont.

Degree of B.Sc. (with honours)

Campbell, James Stouffer, B.Sc., (Me.), Toronto, Ont.
Rice, Herbert Ralph, B.Sc., (Mi. and Met.), Niagara Falls, Ont.
Walker, William Deans, B.Sc., (Me.), Niagara Falls, Ont.

Degree of B.Sc.

Barton, Edward Allen, B.Sc., (Ci.), Lachine, Que.
Cairncross, Alexander Thomas, B.Sc., (Ci.), Long Branch, Ont.
Conn, Hugh Gordon, B.Sc., (Me.), New Lowell, Ont.
Fenwick, Stuart, B.Sc., (Ci.), St. Thomas, Ont.
Goodman, James Edward, B.Sc., (Ci.), Kingston, Ont.
Greenwood, Frederick Dwyer, B.Sc., (Me.), New Liskeard, Ont.
Hastings, Meredith Heath, B.Sc., (Me.), Kingston, Ont.
King, Peter Campbell, B.Sc., (El.), Toronto, Ont.
Mill, George Lawrence, B.Sc., (Met.), Quebec, Que.
Miller, Alexander Gordon, B.Sc., (Me.), Kingston, Ont.
Minns, Harold Clarke, B.Sc., (Me.), Iroquois, Ont.
Rombough, Joseph Harold Melville, B.Sc., (Ci.), Oshawa, Ont.
Seright, Robert, B.Sc., (Me.), Kingston, Ont.
Waite, Matthew J., B.Sc., (Me.), Kingston, Ont.

University of New Brunswick

The Ketchum Silver Medal

Parlee, Rutherford Justus, B.Sc., (Ci.), Lower Millstream, Kings County, N.B.

Degree of B.Sc.

Barbour, Clarence Allen, B.Sc., (El.), Saint John, N.B.
Hurley, Joseph Louis, B.Sc., (Ci.), Fredericton, N.B.
Macredie, John Robert Calderwood, B.Sc., (Ci.), Fredericton, N.B.
Parlee, Rutherford Justus, B.Sc., (Ci.), Lower Millstream, Kings County, N.B.
Patriquen, Frank Andrew, B.Sc., (Ci.), Fredericton, N.B.

University of Toronto

Prize

Phillips, Ernest Albert, Toronto, Ont.—B.A.Sc., (Ci.); The Canadian Engineer Prize.

Degree of B.A.Sc. (with honours)

Phillips, Ernest Albert, B.A.Sc., (Ci.), Toronto, Ont.

Degree of B.A.Sc.

Dutton, William Lawrason, B.A.Sc., (Ci.), Chatham, Ont.
Carter, John Russell, B.A.Sc., (Ci.), Toronto, Ont.
Hanly, John Bruce, B.A.Sc., (Ci.), Toronto, Ont.
MacLean, George Edward, B.A.Sc., (Chem.), Ottawa, Ont.

University of Manitoba

University Gold Medal and Joseph Doupe Gold Medal

Jones, Llewellyn Edward, B.Sc., (Ci.), Transcona, Man.

Degree of B.Sc.

Bell, George Moore, B.Sc., (El.), Weyburn, Sask.
Berry, Melville Douglas, B.Sc., (El.), Hamilton, Ont.
Courtney, Alexander Gordon, B.Sc., (El.), Winnipeg, Man.
Fraser, Ralph Percy, B.Sc., (El.), Norwood, Man.
Gingras, Francis Percival, B.Sc., (El.), Winnipeg, Man.
Gooderham, Walter James, B.Sc., (El.), Winnipeg, Man.
Hunt, Edward Victor, B.Sc., (El.), Peterborough, Ont.
Jones, Llewellyn Edward, B.Sc., (Ci.), Transcona, Man.
Leightner, Donald Benjamin, B.Sc., (El.), Winnipeg, Man.
Lyon, Grant MacKenzie, B.Sc., (Ci.), Winnipeg, Man.
Murray, Walter Muir, B.Sc., (Ci.), Winnipeg, Man.
Neufeld, James Cornelius, B.Sc., (Ci.), Winnipeg, Man.
Oddlafson, Axel Leonard, B.Sc., (El.), Winnipeg, Man.
Swartzman, Lewis, B.Sc., (Ci.), Winnipeg, Man.

University of Alberta

The Association of Professional Engineers of Alberta Prize in Electrical Engineering

Sillitoe, Sydney, B.Sc., (El.), Edmonton, Alta.

Degree of B.Sc.

Kent, William Leslie, B.Sc., (Ci.), Edmonton, Alta.
Nix, Charles Edward, B.Sc., (Ci.), Edmonton, Alta.
McIntyre, Douglas Vallance, B.Sc., (El.), Edmonton, Alta.
Patterson, Gordon Neil, B.Sc., (Eng. Physics), Edmonton, Alta.
Olsen, Arnold Mayne, B.Sc., (El.), Edmonton, Alta.
Peffers, William Oswald, B.Sc., (El.), Edmonton, Alta.
Sillitoe, Sydney, B.Sc., (El.), Edmonton, Alta.
Simons, Finlay William, B.Sc., (El.), Edmonton, Alta.

Nova Scotia Technical College

Alumni Medal

Ritchie, Kenneth Schaffner, B.Sc., (El.), Halifax, N.S.

Degree of B.Sc.

Black, Frank Leslie, B.Sc., (El.), Moncton, N.B.
Bowman, Albert Lorne Hay, B.Sc., (El.), Halifax, N.S.
Brown, William Broughton, B.Sc., (El.), Clarke's Harbour, N.S.
Chandler, Edward Sayre, B.Sc., (El.), Charlottetown, P.E.I.
Coffey, Laurence Edward, B.Sc., (El.), Moncton, N.B.
Egan, Edward Joseph, B.Sc., (Me.), Halifax, N.S.
Glotzer, Samuel, B.Sc., (El.), Odessa, Russia.
Hault, George Christie, B.Sc., (Ci.), Sydney, N.S.
Lang, John Taylor, B.Sc., (Me.), Halifax, N.S.
MacDonald, John Winston, B.Sc., (El.), Balmoral Mills, N.S.
Muir, Clarke Bower, B.Sc., (Me.), Shelburne, N.S.
Ritchie, Kenneth Schaffner, B.Sc., (El.), Halifax, N.S.
Tibbitts, Angus Gordon, B.Sc., (Me.), Truro, N.S.

University of Saskatchewan

Prize

Fourth Year Scholarship, Saskatchewan Branch, The Engineering Institute of Canada—awarded jointly to Clarence Rudeford Forsberg, B.Sc., (Ci.), Dunblane, Sask.; and to Donald Waldron Wood, B.Sc., (Me.), Morse, Sask.

Degree of B.Sc.

Anderson, Gordon Stuart, B.Sc., (Ci.), Theodore, Sask.
Clark, Ralph William, B.Sc., (Ci.), Saskatoon, Sask.
Douglas, Arnold Howard, B.Sc., (Ci.), Indian Head, Sask.
Forsberg, Clarence Rudeford, B.Sc., (Ci.); Dunblane, Sask.
Fowler, Jos. Sims, B.Sc., (Me.), Saskatoon, Sask.
Mollard, John Ellis, B.Sc., (Me.), Watrous, Sask.
Olson, Arthur Bishop, B.Sc., (Me.), Saskatoon, Sask.
Schnedar, Clarence Christopher, B.Sc., (Me.), Saskatoon, Sask.
Wood, Donald Waldron, B.Sc., (Me.), Morse, Sask.

OBITUARY

Francois Charles Laberge, M.E.I.C.

It is with deep regret that the death is recorded of Francois Charles Laberge, M.E.I.C., which occurred at Montreal on June 19th, 1931.

Mr. Laberge was born at Ste. Philomene, Que., on November 3rd, 1871, and received his education at the University of Ottawa and the Ecole Polytechnique, Montreal, graduating from the latter institution in 1892 with the degree of B.A.Sc.

FRANCOIS CHARLES LABERGE, M.E.I.C.

Following graduation, Mr. Laberge was for a time assistant on the Geological Survey and in 1893-1894 was in the engineer's department of the Keystone Bridge Works. In 1894 he was appointed professor of surveying geology, practical astronomy and meteorology at the Ecole Polytechnique. Entering private practice in 1895, Mr. Laberge acted as town engineer for four suburbs of Montreal and was consulting engineer on the Montfort Railway and for several municipalities and corporations. In 1905 he represented the Quebec government on the Interprovincial Boundary Commission which settled the boundary between Ontario and Quebec from Lake Temiskaming to James Bay. When the Quebec government established the Public Utilities Commission—now known as the Quebec Public Service Commission—Mr. Laberge was named one of its first members.

Mr. Laberge joined The Institute (then the Canadian Society of Civil Engineers) as an Associate Member on March 16th, 1899, and transferred to full Membership on October 24th, 1907. He took a keen interest in the affairs of The Institute and was chairman of the Montreal Branch during the year 1928.

PERSONALS

Sydney Sillitoe, S.E.I.C., who graduated from the University of Alberta in the spring of this year with the degree of B.Sc., is now employed by the Electric Light and Power Department of the city of Edmonton, Alta.

George G. Reid, S.E.I.C., who was formerly with the Canadian Consolidated Felt Company, Ltd., at Kitchener, Ont., is now a member of the staff of E. S. Stephenson and Company, Ltd., Saint John, N.B.

R. H. Moulton, Jr.E.I.C., formerly traffic superintendent of the west district, city of Montreal, for the Bell Telephone Company of Canada, Ltd., has been transferred to Sherbrooke, Que.

Major J. C. Craig, D.S.O., M.E.I.C., has returned to British Guiana for another term of duty as director of public works at Georgetown, which office he first assumed in 1927.

M. S. Madden, A.M.E.I.C., formerly of the Hydrometric Bureau, Dominion Water Power and Reclamation Service, Department of the Interior, North Bay, Ont., is now with the Hydrographic Bureau, Department of Marine, Ottawa, Ont.

D. N. McCormack, Jr.E.I.C., is on the staff of the Highways Division of the Department of Public Works of New Brunswick. Mr. McCormack was for a time with the Canadian Dexter P. Cooper Company at Welchpool, Campobello Island, N.B., and in 1930 was connected with the Donnacona Paper Company, Ltd., at Donnacona, Que.

M. F. Goudge, A.M.E.I.C., mining engineer, Department of Mines, Ottawa, is extending his investigations regarding the use of Canadian limestones for buildings. Work already carried out by Mr. Goudge has demonstrated that, within the Dominion, limestones can be produced which are superior in strength and durability to any that are imported.

O. J. McCulloch, A.M.E.I.C., is now connected with the tunnel division of the Rayner Construction Ltd., Toronto, Ont. Prior to accepting his present position, Mr. McCulloch was with the Sydney E. Junkins Company, of British Columbia, Ltd., at Vancouver, B.C. He was for a time with Porter Brothers and Robert Porter at Detroit, Mich., and in 1927 was engaged on the construction of the Welland Ship Canal at St. Catharines, Ont.

J. Murray Mitchell, Jr.E.I.C., has recently been appointed by the Bell Telephone Company of Canada to the position of district traffic superintendent of a newly-formed district embracing the territory lying largely north of the St. Lawrence river between the Quebec and Montreal suburban districts, and with headquarters at Three Rivers. Mr. Mitchell, a graduate of McGill, 1923, has had successive experience in the same position in the west and central districts of the city of Montreal.

Professor R. W. Angus, M.E.I.C., to Represent The Institute

Professor R. W. Angus, M.E.I.C., professor of mechanical engineering at the University of Toronto, Toronto, has consented to represent The Institute at the ceremonies connected with the seventy-fifth anniversary of the foundation of the Verein Deutscher Ingenieure, to be held

PROFESSOR R. W. ANGUS, M.E.I.C.

in Cologne, Germany, on June 28th, 1931. Professor Angus is head of the department of mechanical engineering at the University of Toronto, having held that appointment since 1906 when the department was established. His duties include the direction of all the heat-engine and hydraulic work in the university, and he is entirely responsible for the design and equipment of the mechanical and hydraulic laboratories of the university. Through extensive travel, Professor Angus has kept in touch with the most advanced engineering work in America and Europe.

M. H. Marshall, M.E.I.C., has retired from the Dominion Water Power and Reclamation Service, Department of the Interior, Calgary, Alta., and is now located at Glenmore dam, city of Calgary water works. Mr. Marshall had been connected with the Department of the Interior since 1914. In 1929 he was resident inspection engineer for the Department at the Island Falls power development, Island Falls, Sask., and is the author of a paper on that project which appeared in the June, 1931, issue of The Engineering Journal.

Major E. L. M. Burns, A.M.E.I.C., has been appointed general staff officer surveys at Headquarters, Department of National Defence, Ottawa. Major Burns, who was formerly district engineer officer for Military District No. 5, Quebec, is a graduate of the Royal Military College, Kingston, of the year 1915. He 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.

Ross L. Dobbin, M.E.I.C., General Manager of the Public Utilities Commission, Peterborough, Ont., was elected president of the American Water Works Association, at the fifty-first convention of that association recently held at Pittsburgh, Pa. Mr. Dobbin has been a member of the association for a number of years and has taken an active part in the committee work of the organization. He is also keenly interested in Institute affairs and has represented the Peterborough Branch on the Council for a number of years.

C. L. Blackmore, Jr.E.I.C., has joined the staff of the Montreal office of the James R. Kearney Corporation of Canada Ltd. as sales engineer. Following graduation in 1927 from McGill in electrical engineering, Mr. Blackmore was employed by the International Paper Company for over three years as engineer on maintenance and electrical construction. He also spent considerable time working as an electrician before graduation, and was employed by the Canadian Comstock Ltd. and the Northern Aluminum Company.

Morley G. Taylor, Jr.E.I.C., who has just secured the degree of M.Sc. at the Massachusetts Institute of Technology, has left for Venezuela, where he will take over the position of manager of the Barquisimeto branch of the Venezuela Power Company, Ltd., for the Montreal Engineering Company. Mr. Taylor graduated from the Nova Scotia Technical College in 1927 with the degree of B.Sc. in electrical engineering, and following graduation was for a short time with the Nova Scotia Tramways and Power Company at Halifax. In 1928 he was sent by the Montreal Engineering Company to Venezuela where he was located at Maracaibo with the Venezuela Power Company Ltd.

T. H. G. Clunn, A.M.E.I.C., who has been connected with the Department of the Interior, Ottawa, for the past twenty-eight years, first in the Topographical Survey and the International Boundary Survey and latterly with the supervisory mining engineer, has recently retired from the service. Mr. Clunn's work has taken him into all parts of

T. H. G. CLUNN, A.M.E.I.C.

Canada, including the Yukon, where he acted as Canadian attaché on the Alaska Boundary Survey. He is a member of the Professional Engineers of Ontario, is a Dominion Land Surveyor, and has been an Associate Member of The Institute since 1907. On the occasion of his retirement from the Government service, the members of the Ottawa Branch of The Institute, of which he was an active member, having acted as chairman of various committees, presented Mr. Clunn with a silver vase.

E. E. Eisenhauer, A.M.E.I.C., formerly field representative of the Alberta Wheat Pool, is now connected with the Colonization Department, Lethbridge Northern Irrigation District, Lethbridge, Alta. Mr. Eisenhauer graduated from the University of Saskatchewan in 1918, with the degree of B.Sc. in agriculture, and in 1922 secured the degree of B.Sc. in civil and irrigation engineering at the Colorado State Agricultural College and School of Mechanical Arts. During 1918, 1919 and 1920 he was assistant irrigation investigator on water work and ditch measurement in settlement of water disputes at Coaldale, and during the years 1923 to 1926 was in charge of irrigation instruction at Alberta schools of agriculture, being in charge of special instruction in irrigation at the University of Alberta in 1923-1924.

R. R. Duffy, A.M.E.I.C., of Price Brothers Sales Corporaton, has been transferred to the Toronto office of the corporation. Mr. Duffy graduated from Acadia University in 1910, with the degree of B.Sc. in arts, and from McGill University in 1913 with the degree of B.Sc. in applied science. On his return from overseas in 1919, Mr. Duffy became outside manager and vice-president of W. H. Duffy Sons, Ltd., at Hillsboro, N.B. In 1923-1924, he was with the logging division of the Bathurst Company at Bathurst, N.B., and from February to November, 1924, was with the Brompton Pulp and Paper Company at East Angus, Que. In November, 1924, Mr. Duffy became connected with Price Brothers and Company, Ltd., being in the engineering division at Kenogami, Que., assistant land surveyor and later assistant logging engineer at Chicoutimi, Que. In 1930 he was appointed district sales manager for Price Brothers Sales Corporation at Montreal, Que.

ELECTIONS AND TRANSFERS

At the meeting of Council held on June 16th, 1931, the following elections and transfers were effected:

Member

ALEXANDER, David Tasker, chief dftsman., Canadian Bridge Co. Ltd., Walkerville, Ont.

Associate Members

GUMLEY, Franc Stewart, (Heriot Watt Tech. Coll.), designer, Western Bridge Company, North Vancouver, B.C.

LUDGATE, James Vernon, B.Sc., (Queen's Univ.), Parry Sound, Ont.

RIDOUT, Geoffrey Swabey, B.A.Sc., (Univ. of Toronto), divn. plant engr., Montreal Divn., Bell Telephone Company of Canada, Montreal, Que.

RYBKA, Karel R., Mech. Engr., (Prague and Bruo), designing dftsman., engrg. dept., Ross & Macdonald, Montreal, Que.

SCRYMGEOUR, Charles, (Liverpool and Bootle Engrg. Colleges), refinery engr., Imperial Oil Refineries Limited, Dartmouth, N.S.

TJONNAAS, Ole Hansen, (Grad., Kristiania Tech. Inst.), dftsman., C.P.R. engrg. dept., Winnipeg, Man.

WIGHT, Cecil Douglas, B.Sc., (Queen's Univ.), partner in firm, MacRostie & Wight, consltg. engrs., Ottawa, Ont.

Juniors

BREAKEY, James, (Assoc. in Engrg., Sheffield Univ.), associate editor of technical publications, MacLean Publishing Company, Toronto, Ont.

FOSS, Wallace Leland, B.Sc., (Univ. of Sask.), field engr., City of Saskatoon, Sask.

LEACH, John William, B.Sc., (Univ. of Sask.), maintainer of Diesel electric cars, C.N.R., Montreal, Que.

MORTON, Philip S. A., B.A.Sc., (Univ. of Toronto), junior engr., Canadian General Electric Co. Ltd., Peterborough, Ont.

ROSS, Hugh Campbell, B.A.Sc., (Univ. of Toronto), asst. testing engr., H.E.P.C. of Ontario, Toronto, Ont.

Affiliate

GRAY, Donald Walker, B.Sc.F., (Univ. of Toronto), asst. forester, Ontario Forestry Branch, Parry Sound, Ont.

Transferred from the class of Associate Member to that of Member

Du CANE, Charles George, Lt.-Col., O.B.E., B.A. (Mech. Sci. Tripos), (Cambridge Univ.), partner in firm, Sir John Wolfe Barry & Partners, consltg. engrs., 2 Queen Anne's Gate, Westminster, S.W. 1.

Transferred from the class of Junior to that of Associate Member

DUNCAN, James Edgar, B.Sc., (Univ. of Man.), geophysicist, Canadian Western Natural Gas, Light, Heat & Power Co. Ltd., Calgary, Alta.

Transferred from the class of Student to that of Associate Member

ABBOTT, Arthur Caldwell, B.Sc., (McGill Univ.), distribution engr., commercial and distribution dept., Shawinigan Water & Power Company, Three Rivers, Que.

CLANCY, John, B.Sc., (N.S. Tech. Coll.), telephone systems engrg. dept., Northern Electric Co. Ltd., Montreal, Que.

KYLE, Willard Hugh, B.Sc., (McGill Univ.), asst. engr., Montreal district, C.N.R., Montreal, Que.

PIGOT, Charles Hugh, B.Sc., (McGill Univ.), asst. engr., rly. dept., Beauharnois Construction Company, Beauharnois, Que.

ROSS, William Thomas Dygnum, B.Sc., (McGill Univ.), chem. engr., explosives divn., Canadian Industries Limited, Montreal, Que.

Transferred from the class of Student to that of Junior

DURLEY, Thomas Richard, B.Sc., (McGill Univ.), asst. supt., Plant No. 1, Canada Cement Company, Montreal East, Que.

ROWE, Gordon William, B.Sc., (Univ. of Man.), field engr. on inspection of reinforced concrete grain elevators, C. D. Howe & Company, of Port Arthur, Ont., at Lethbridge, Alta.

Students admitted

LEIGHS, Clifford Henry, B.Sc., (Univ. of Alta.), Edson, Alta.

MILLER, Frank Robert, B.Sc., (Univ. of Alta.), P.O. Box 765, Kamloops, B.C.

CORRESPONDENCE

THE EDITOR, Montreal, May 14th, 1931.
THE ENGINEERING JOURNAL,

DEAR SIR:—

Following my previous letter, I would ask, how is the engineer to obtain the recognition due to his work, a recognition that will allow him to utilize his powers and qualities for the benefit of the community? He must advertise, not himself, but his work, but he must advertise in the right place; he must get into contact with that portion of the public who are in need of engineering services.

A merchant in contemplating the opening up of a retail business, may have a good line of goods, and an efficient staff; but unless his store is located in the right psychological place, the enterprise will be a failure. We have the ability, we have the men, and it is now our duty to see that the work we do is made known to those who are in a position to appreciate it; it is useless to advertise among the general public. You do not find Rolls Royce cars advertised in Le Canard, nor do you find in the Athenaeum advertisements which read "Learn to play the piano in five lessons"; so our advertising must be placed in periodicals regularly read by those likely to be interested.

All commercial and public enterprises are financed by means of borrowed money, which is obtained through the services of banks, loan companies and security brokers, and it is to the men in charge of these financial establishments that the engineer must display his wares.

The secret of successful advertising is to find out the particular point of self interest that will induce a man to part with his money. Of course, for the advertising to be continuously successful, it naturally follows that the advertiser must get continued value for his money, and the following are examples. The insurance company describes the destitution of a widow and children to stimulate the parental instinct; the house-furnishing firm draws a picture of a nicely furnished room to stimulate the sexual instinct in providing a home. The tooth paste manufacturer uses such words as gingivitis, pyorrhea, Riggs disease, etc., to raise the fear of toothache or lost teeth. The radio salesman tells Mrs. Smith that Mrs. Jones has just bought a 9 tube radio with dynamic speaker, so a feeling of pride induces Mrs. Smith to purchase a 9½ tube set with heterodynamic speaker. The stock salesman stimulates the instinct of acquisitiveness, to induce the prospective purchaser to buy bonds and stocks. The physician stimulates the instinct of fear, to encourage an interest in his business. So we engineers must stimulate the instinct of acquisitiveness, if not of fear, to attain the same ends.

The position of the financial magnate to-day in regard to engineering is exactly the same as was, at one time, that of the ordinary person to pyorrhea. Forty years ago the man on the street knew neither pyorrhea or gingivitis, was quite happy in his ignorance, and the tooth brush manufacturers were just ordinary citizens like himself. Ali Baba used the magic word "Sesame" to obtain untold wealth, and the manufacturer obtained a similar result by using the magic words pyorrhea and gingivitis, not once but millions of times. There does not seem to be any such simple way for engineers to use a magic word, but the same principles apply.

The bankers, loan companies and financial houses should be told of all the perils and dangers that lurk in poor construction; they have a hazy idea in principle that a poor workman produces poor work, but as to tangible results, they are absolutely ignorant. As everyone knows, major engineering works are designed and supervised by engineers, but the great mass of construction designed by architects and casual engineers is built according to rule of thumb methods, and is very wasteful, each individual piece of work being too small to allow of expert design and inspection. While the loss on each building is small, in the mass it is enormous.

I am not suggesting that architects and small consulting engineers are not competent; they are, but their hands are tied, because the man who handles the money cannot see the need of expert design, supervision and inspection.

All progress in material civilization has its inception in the brain of some man of vision: engineer, chemist or physicist (using these terms in their broad sense). These new ideas generally call for new kinds of material and new methods of working, which, if not faithfully carried out can only result in failure.

Every new process or innovation is opposed by the vast majority of mankind, and by innovation is not meant novelty, for there is a difference; a new song, a new shaped boot, high or low legs on the radio cabinet, are all novelties, they can be taken up without thinking; but to wear a sensible dress, eat sensible food, to operate a new kind of machine, are innovations, and as such, are strenuously opposed. Radio did not become generally popular until it was possible to produce music by a simple turn of a button; if any degree of skill were necessary, only a small number would be purchased, and radios would be no more plentiful than pipe organs.

If this mental inertia is so common among persons of ordinary intelligence, how much more is it among those who do the great mass of physical labour necessary to our existence? It is well nigh impossible to induce them to adopt new methods except under compulsion; if one wants a labourer to use a shovel or a hammer in a new way, only a threat of dismissal will bring him to a complacent state of mind; all thinking must be done for him, and he must learn the new way by numbers, as they do in the army.

To train men into new ideas and supervise new methods is the work of an inspector, and while all advance has been due primarily to the original thinker as explained above, the material success of the actual doing rests upon the inspector. In the mechanical world this is well understood, for without adequate inspection what is known as quantity production would be impossible, and all mechanical output would be limited to the extent of that produced by high grade workmen.

We engineers all know this, but the financial man does not. He realizes that his motor car is an assemblage of perfectly fitting parts, but he seldom knows how this perfection is attained, and if he could be got to understand that there is need of careful design and inspection in building, with commensurate lowering of costs, he would be willing to pay money for such engineering services.

This brings out the fact that the key to increased recognition is the inspector and his work. The inspector is the liaison officer who works between the owner and the contractor, who represents the owner on the job and who is in the best position to consider costs and profits. The inspector, his opportunities and restrictions, will be dealt with in another letter.

Yours very truly,

C. D. NORTON, A.M.E.I.C.

Montreal,
June 4th, 1931.

The Editor,
The Engineering Journal,

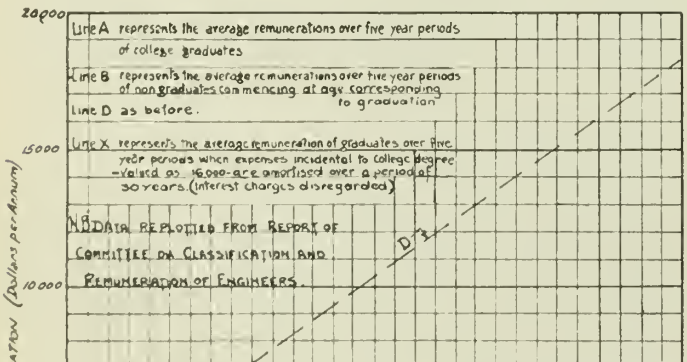
Re: Report of Committee on Classification and Remuneration of Engineers

Dear Sir:—

I wish to preface the following remarks on the above report by complimenting the committee on their valuable contribution to the engineering profession in drawing attention to tendencies in remuneration of engineers, based on the result of average accomplishment over a period of years. The conclusions cited by your committee have been read with considerable interest and the writer desires to bring forward a new graph which portrays the results from a slightly different viewpoint.

In replotting the figures, as shown in the graph attached, it has been assumed that the loss in income and costs incidental to education are equivalent to $16,000 and the line (X) represents the average remuneration allowing for the amortization of this expenditure over a thirty year period. (Interest on this amount has been neglected in plotting the results). It will be noted that the amortization is the most favourable to the comparison though least acceptable to practice, since it is held that thirty years is far too long a period over which to recompense the college trained man through increased earnings for his expenditures made on university studies.

According to statement, the results are based upon a 30 per cent answer to the committee's questionnaire. Since the filling in of the questionnaire form takes but a very few minutes, one may not be entirely wrong in assuming that at least two out of every three members of The Institute are either unthinking of the committee's efforts, or on the other hand, are so absorbed in technical details and other matters



that they cannot find time to consider material questions which have reference to the engineering profession generally, and the place which it occupies among the intelligentsia and informed throughout the various provinces of this Dominion.

Whatever be the reason, this is none the less an unhealthy condition, for it is essential to advancement and greater public usefulness that the profession take heed to itself and continually reconstruct the stones and mortar of its inner sanctum wherever they may show need for repair.

From the amended curves in graph (2), which roughly attempt to amortize, over a thirty year period, the costs and losses in earning incidental to a college education, it would seem that the small margin of remuneration between college and non-college trained indicates that the science course, as measured by success, is a waste of time. College training is held to be, at the present time, an essential requirement before entering the practice of engineering (there are, of course, exceptions to every rule), and while from the curves it appears that the college man has not raised the average earning standard relative to years of experience, the known tendency has been to continually substitute him throughout the entire profession for his not-so-trained colleague.

The question of remuneration has been given consideration by a number of members both in The Institute and other engineering bodies; however, in many cases the monetary reward of engineering skill still remains very small as compared with the proportion received by Capital and Labour.

I trust that it will not be deemed too radical to suggest that attention be given to the remuneration which it is within the power of older members to vouchsafe to the younger, and that the latter should be more liberally paid than is now the case. This would make it easier for them to contribute to the funds of The Institute, and in this way would aid the profession's manifold services to society.

Yours very truly,

STANLEY FARQUHARSON, A.M.E.I.C.

BOOK REVIEWS

The Airplane

By Frederick Bedell. Van Nostrand Company, New York, 1930, cloth, 6 x 9 in., 371 pp., illus., figs., tables, $3.75.

The author states that this book is intended to meet the needs of flyers and designers on the one hand, and of the general reader on the other. To some extent it is suitable for the general reader who desires to obtain some superficial knowledge concerning flight as applied to heavier-than-air craft.

The first portion comprises material which is said to have appeared in earlier editions, but which has been extended for this present issue. The material of the last five chapters now appears for the first time—and deals with engines, instruments, special problems and gives general information on particular types of heavier-than-air craft

In the first few chapters, lift and drag of aerofoils are discussed at some length, and their effect on performance indicated. A number of typical curves are included in the discussion of aircraft performance at ground level and at height. The airscrew, its general characteristics and relation to performance, forms the basis of two chapters. Climbing and gliding flight constitute the substance of another chapter. The functions of the various control surfaces, and the usual methods of actuating them are dealt with briefly. Stability, under the headings longitudinal, lateral and directional, is explained. The factors affecting each are individually discussed. The critical treatise on the aeroplane then ends.

A chapter has been included on the principles of internal combustion engines, both of the spark-ignition and the compression-ignition types, carburetters, fuel distribution, detonation, and such kindred subjects. Photographs of several modern engines have been reproduced in the chapter.

Two chapters are devoted to descriptions of typical modern aircraft, with illustrations.

Instruments, their various principles illustrated by sketches, and their uses, form the text of one chapter.

The final chapter presents a statement of what the author considers the present outstanding problems which confront aviation. It includes paragraphs on blind flying— actually a misnomer in that it is "instrument flying"—though commonly called "blind," the automatic pilot, altitude determination, collision, ice formation, fog penetration, and high altitude—high velocity transport.

The book ends with a glossary of American aeronautical terms reprinted from National Advisory Committee for Aeronautics report No. 240.

In conclusion, it must be stated that the subject of Dr. Bedell's book of necessity includes a number of highly theoretical problems—the treatment of which cannot be successfully effected without mathematical analyses if it is desired to cater to the designer or engineer. His analyses, for the most part, can only be considered to consist of somewhat superficial solutions, which may even be misleading to a reader who is unfamiliar with the subject. In attempting to cover an overwhelming range of topics and to bring the book up to date, the author has set himself a task which cannot be accomplished with complete success in a single small volume. For this reason, the book can hardly be said to be of more than general interest.

A. O. A.

The Rigid-Frame Bridge

By Arthur G. Hayden. Wiley & Sons, New York, 1931, cloth, 6 x 9 in., 236 pp., front., photos, figs., tables, $4.50.

Review by J. F. Brett, A.M.E.I.C.

The rapid development of highway communications which has taken place in the United States and Canada during the past few years has caused a great deal of attention and study to be given to the design and construction of the bridges required, not only to carry highways over valleys and streams, but also for grade separation of intersecting highways, city streets and railways.

Since the purely utilitarian pioneer view point of the past is rapidly passing away, to be replaced by a new consciousness of things beautiful and artistic, more attention is being paid to the appearance of public works in general.

The stereotype design of highway bridge consisting of simply supported beams and girders of constant depth offers only limited possibilities for artistic treatment. Continuous structures with varying moment of inertia, such as the type of frame described in Mr. Hayden's book, may be treated very effectively, as may be judged by the photographs of several fine bridges designed by the author and reproduced in the book.

Aside from its artistic merits, the author points out, the rigid frame bridge is particularly suitable for subways and underpasses. On account of the very small rise and the shallow depth of the deck slab, the height of the approach fill of the overhead traffic way is reduced to a minimum.

The following special types of frames are fully described in the book, complete design calculations being given:

Symmetrical single span free end concrete frame.
Symmetrical single span fixed end concrete frame.
Unsymmetrical single span concrete frame free end.
Unsymmetrical single span steel girder frame.

The theory and design of the symmetrical double span free-end concrete frame and the single span free-end concrete skew frame are also given.

The method of analysis employed is based on the method of work and the Maxwell-Mohr theorem of reciprocal deflections and dummy unit load, which is eminently suitable for the frames under consideration.

The author, who has had many years of actual experience with rigid frame bridges, has succeeded in presenting his method of analysis in a very practical and simple form, well adapted for use in engineering offices. Since the elastic equations used are based on geometrical relations, the calculus is not needed to apply the method and it is not used in the book.

Many practical points in connection with design and construction, such as the condition of stress at the corners, the influence of spread footings, the location and detailing of construction and expansion joints, placing of reinforcement, etc., are fully explained and illustrated.

A chapter by Professor Beggs deals with the mechanical analysis of rigid frames. It is pointed out that while the author's standardized method of analysis has been found easily and rapidly applicable to the frames discussed in the book, the Beggs deformeter gauge method may be used with advantage for multiple span frames which are highly indeterminate.

In the last chapter of the book, Gilmore D. Clark, of the American Society of Landscape Architects, treats of the architectural appearance of short span bridges. Live loads and unit stresses used by the Westchester County Park Commission in connection with the bridges described in the book are given in the appendix.

The volume is well illustrated; its usefulness would have been increased by the provision of an adequate index. Any engineer dealing with highway structures and grade separation will find the book a valuable addition to his library.

Handbook of Aeronautics

Published under the Authority of the Council of the Royal Aeronautical Society. Gale & Polden, London, 1931, cloth, 5½ x 8¾ in., 702 pp., diagrs., tables, 25/-.

This excellent compendium has been issued with the approval of the Council of The Royal Aeronautical Society, and is intended to present in easily accessible form such information as the aeronautical engineer requires in the course of his work. The contents have been selected judiciously, and the issue has been supervised by the joint technical editors, the present and past secretaries of The Royal Aeronautical Society. The list of contributors includes officers of prominent aircraft manufacturers, the Air Ministry, and the National Physical Laboratory, and the wise course has been taken of omitting the numerical tables of areas of circles, logarithms, and so on, which usually occupy so much space in engineering handbooks. In this way room has been found for a surprising amount of useful information grouped under the heads of materials, performance, aerodynamics, design and construction, airscrews, engines, air survey and photography, instruments and navigation, radio, and meteorology. Much of this material has been drawn from the reports of the Advisory Committee for Aeronautics which have been issued during the past twenty-two years, and which in themselves are too bulky for office use.

The editors gratefully acknowledge the co-operation of such bodies as the Air Ministry and the British Engineering Standards Association, and ask for constructive criticism, particularly with regard to any data which have been omitted, and which should be included in a future edition.

The handbook can be recommended as supplying a very definite need, and will be found of great value to aeronautical engineers.

High Speed Diesel Engines

By Arthur H. Goldingham. E. and F. N. Spon, London, 1931, cloth, 5½ x 8½ in., 148 pp., figs., charts, tables, 10/6 net.

Review by J. L. Busfield, M.E.I.C.

This book deals with automotive, aeronautical and marine high speed Diesel engines with full discussion of the various fuel injection mechanisms, together with sectional views of numerous existing designs with their working parts.

The first chapter deals with the history of the Diesel engine, the characteristics of its working cycle, heat losses, efficiency, and so forth.

The second chapter treats of details of fuel injection systems, and describes the fuel pump built by the Man Company, the Bosch fuel pump and also the Benes.

Chapters three, four and five describe and illustrate the following engines:—Packard (aviation); Junkers; Man; Hesselman; Cummins; Mercedes-Benz; McLaren-Benz; Deutz; Brotherhood-Ricardo; Treiber; Mumford; Lister; Saurer; Ruston; A.E.C.; Beardmore.

Brief descriptions are also given of the Gleniffer; De la Vergne; Gardner; and Aveling and Porter engines.

As the author states in the preface, the work is essentially a compilation of recent information and a record of the progress made during the last few years in this special field. The assistance of the several engine-builders is suitably acknowledged.

Textile Mechanics and Heat Engines

By Arthur Riley and Edward Dunkerley. Pitman & Sons, London, 1930; cloth, 8½ x 5½ in., 286 pp., figs., tables, 15/-.

This volume is one of a number of technical manuals issued by the same publishers and dealing with various phases of the textile industries in England, including the spinning and weaving of rayon, wool and cotton, the machinery involved in these various processes, and the testing of the finished products.

The volume under review is intended for students employed in textile work, and particularly in cotton spinning, and covers elementary mechanics and physics and their application to textile machinery and power plants for textile factories. It does not profess to give any advanced theory in these subjects, but gives a condensed course in applied mechanics and steam and internal combustion engine power as applied in the textile industry.

Most of the examples given are taken from spinning and weaving equipment and other mechanical applications likely to be familiar to textile students. The earlier chapters deal with such topics as the transmission of motion by belting and gearing, cams, ratchet gear, differential trains and so on, and these are followed by chapters on work, friction and simple machines. The elements of elasticity and strength of materials and hydraulics are then taken up, and chapters follow on heat and the properties of gases, steam boilers and accessories, the steam engine, and internal combustion engines.

Throughout the book the special interests of the readers are borne in mind. For example, in the chapter on heat, attention is given to problems connected with atmospheric humidity, and the mechanical questions discussed are almost all taken from examples occurring in the complex movements required in actual spinning and weaving machinery. The volume covers part of the course required by the City and Guilds of London Institute for their examinations in engineering applied to the cotton industry, and is more particularly intended for those taking the textile mechanics examinations of the Union of Lancashire and Cheshire Institute's cotton spinning courses. It is not intended as a textbook for advanced engineering students, but would seem to be eminently suited for the special audience to which it is addressed.

There is a useful index, the diagrams are clear, and each chapter is followed by a series of numerical examples and exercises.

Erratum

In the May issue of The Journal, when printing Mr. C. C. Paterson's address on "The National Electricity Supply Scheme of Great Britain," an error occurred which completely reversed the meaning of one of the author's remarks.

In line three of the right hand column, page 279, the words "are in doubt" should read "are in *no* doubt."

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Presented by the Societies:

Society of Automotive Engineers, Inc.: Membership Roster, Feb. 1931.

Fédération des Associations Belges d'Ingénieurs: Compte Rendu des Journées de l'Ingénieur, du 17 au 21 juin, 1930.

The Institution of Civil Engineers: Minutes of Proceedings, vol. 230, Part 2, 1929-30.

Canadian Engineering Standards Association: Year Book, 1930.

The Institution of Engineers, Australia: Selected Papers from the Journal, Vol. 1, 1929.

Reports, etc.

Dept. of Mines, Mines Branch, Canada:

The Mining Laws of Canada—Revised edition, 1931.

Investigations in Ore Dressing and Metallurgy, 1929.

Dept. of Trade and Commerce, Bureau of Statistics, Canada:

Preliminary Report on the Central Electric Station Industry in Canada, 1929.

Dept. of the Interior, Forest Service, Canada:

Bulletin 83: Sawmill Waste and Its Utilization in British Columbia.

Dept. of Mines, Ontario:

Thirty-ninth Annual Report of the Department, Vol. 39, Part 2, 1930.

Hydro-Electric System, City of Winnipeg:

Nineteenth Annual Report, December 31st, 1930.

Canadian Electrical Association:

Advance Reports for the Forty-first Annual Convention, June 16-18, 1931.

Ministry of Transport, Great Britain:

Report of the Committee on Main Line Electrification, 1931.

Geological Survey, United States:

Water Supply Paper 620: Geology and Ground-Water Resources of Western Sandoval County, New Mexico.

Water Supply Paper 641: Surface Water Supply of the United States, 1927. Part 1: North Atlantic Slope Drainage Basins.

Water Supply Paper 643: Surface Water Supply of the United States, 1927. Part 3: Ohio River Basin.

Bureau of Mines, United States:

Tin in 1929.

Phosphate Rock in 1929.

National Electric Light Association:

Underground Systems Committee, Eng'g. National Section:

Cable Sheath Damage and Protection.

Oil Reservoirs and Accessories for Underground Cables.

Technical Books, etc.

Presented by Dorset Gliding Club:

Gliding, 1931: A Yearbook published by Dorset Gliding Club.

Presented by Northern Electric Engineering Society:

Motion Picture Projection, by J. R. Cameron. 1928.

Protective Relays, by V. H. Todd. 1922.

Telephony, Including Automatic Switching, by A. B. Smith. 1924.

Radio and High Frequency Currents, by E. T. Larner. 1925.

A Manual of Automatic Telephony, by Charles W. Wilman. 1927.

Loud Speakers, by C. M. R. Balbi. 1926.

The Art and Craft of Cable Jointing, by C. G. Watson. 1927.

Broadcast Reception, by J. Laurence Pritchard. 1926.

Principles of Transmission in Telephony, by M. P. Weinbach. 1924.

Airplane Structures, by A. S. Niles and J. S. Newell. 1929.

Radio Telegraphy and Telephony, by R. L. Duncan and C. E. Drew. 1929.

Transmission Circuits for Telephonic Communication, by K. S. Johnson. 1927.

Vacuum Practice, by L. Dunoyer. 1926.

Presented by "Factory and Industrial Management":

How to Set Up Production Control for Greater Profits, edited by H. Diemer.

Presented by "The Engineer":

Directory and Buyers' Guide—1931.

Presented by Canadian Industries Limited:

Journal of the American Society of Heating and Ventilating Engineers, vol. 27-34, 1921-28.

Heating, Piping and Air Conditioning, vol. 1, 1929.

Chemical Abstracts, vol. 22, 1928.

Chemistry and Industry, vols. 46-49, 1927-30.

Presented by Taylor, Rogers & Bliss, Inc.:

History of the Development of Rigid Conduit for Electrical Wiring. —Published by Trade Extension Committee, Rigid Conduit section, National Electrical Manufacturers Association.

Purchased:

Lydiatt's Canadian Market and Advertising Data Book, 1931.

Technical Data on Fuel, published by British National Committee, World Power Conference. 2nd ed., 1930.

Concrete, Plain and Reinforced—Vol. 2: Theory and Design of Continuous Beams, Frames, Building Frames and Arches, by F. W. Taylor, S. E. Thompson and E. Smulski. 1928.

Chambers's Seven-Figure Mathematical Tables, edited by James Pryde. Revised edition, 1930.

Bibliography of Aeronautics, 1929.—Published by National Advisory Committee for Aeronautics, United States.

Catalogues

McGregor-McIntyre Iron Works, Ltd.:

Steel Trough Stairs; Safety Gratings, [etc.]. 15 pages.

Dominion Engineering Works, Ltd.:

Dominion Farrel-Sykes Reduction Gearing. 4 pages.

De Laval Steam Turbine Company:

De Laval Clogless Pumps. 16 pages.

De Laval Pumps at Ross Station, Pittsburgh, Pa. 4 pages.

B. M. Root Company:

The Root Ship-Lap Sawing Machine. 4 pages.

The Root Panel Saw. 4 pages.

George W. Reed & Co. Ltd.:

Co-Steel Products for Modern Buildings. 16 pages.

The Cork Manufacturing Co. Ltd.:

Langite—A Soft Jointing Material. 16 pages.

The S.S. Noronic of the Canadian Steamship Lines leaving lock No. 7 in the Welland Ship canal. The Noronic has a keel length of 362 feet, 52-foot beam and a gross tonnage of 6,905 tons. It will be noticed that the roof of the upper cabin is level with the top of the walls showing that the ship has a freeboard of about 51 feet.

In connection with the hydro-electric power development of the Northwestern Power Company at Seven Sisters on the Winnipeg river, The William Kennedy and Sons Ltd., Owen Sound, Ont., supplied a stoplog machine with a capacity of 24 tons, for pulling logs as well as ramming them down. This machine can handle logs from both the spillways and the sluiceways, the latter being 20 feet in height while the sluiceways are 30 feet long. In order to serve both openings, the machine is designed to telescope ten feet. The telescoping is done by means of a ratchet wrench, and locking devices are provided for holding the spuds at the desired centre distance. The machine is also equipped with a log piler and handles logs to and from the machine by means of trolleys which make the use of skids unnecessary. The depth from deck to sill of the spillways is 30 feet and the sluiceways are 35 feet from deck to sill. The gearing of each spud is provided with a clutch so that one spud may be disconnected and full power applied to the other in case a log sticks. Breaking pins are provided on the main frames supporting the rack pinions so that if foreign substances get into the teeth of the pinions or racks, the pins will break and prevent damage to the frames or teeth by letting the teeth drop out of mesh.

A crane type wound rotor motor was used for furnishing power and three speeds to hoistings are provided by means of sliding gears. The machine is also arranged for hand operation in case of emergency and has a power connection for traversing along the dam. The racks and rack pinion frames are steel castings and all the gears and pinions are steel castings with cut teeth.

BRANCH NEWS

Border Cities Branch

Harold J. A. Chambers, A.M.E.I.C., Secretary-Treasurer.
Harvey E. Bushlen, S.E.I.C., Branch News Editor.

New Developments at Copper Cliff and the Frood Mine

The regular monthly meeting of the Border Cities Branch was held on May 15th. The speaker of the evening was Mr. C. E. MacDonald, of the International Nickel Company of Canada, Ltd. In his address, he dealt with the Frood mine and indicated how this mine had revolutionized their old methods and processes. At the conclusion of his address, Mr. MacDonald showed slides of the mine and of some of the reduction processes.

Nickel is found in Manitoba, British Columbia and Quebec, as well as in northern Ontario. In the latter location the ores are associated with norites—a basic rock. The Creighton mine which is the older mine of the International Nickel Company has been in operation for over twenty-five years. The Frood mine, which is a later development, has been responsible for all the company's changes in plant and process.

Drilling for this latter mine revealed a high-grade ore below the 1,400-foot level. Above this high grade ore deposit existed ninety million tons of low grade ore. The company decided to commence operations at the 1,400-foot level and reserve the low grade deposit above this for future use. The cut and fill method was adopted. The drifts and stopes frequently caved and consequently it was necessary to timber them. Small stopes were essential for fire protection. The mining methods were dictated by the nature of the field.

The ore at the Frood mine was found to be mostly fines. On this account it could not be hand sorted, nor was it suitable for roasting, or for the blast furnace. This ore is three parts copper to one part nickel. Differential or select flotation is used to separate the copper. From this process the ore is taken to the mill and crusher plant, thence to the screens. Next it is placed in bins to which sulphuric acid is added. The ore is then put through the classifier. The oversize is sent back to the grinders and is ground to sixty-five mesh. After this grinding and screening, the ore is taken to flotation tanks, where the reagents are added. From this 40 per cent copper content product, more nickel and iron are removed until but 2 per cent nickel is left. The remaining product is then taken to the reverberatory furnace and thence to a converter where it is blown with air. The remainder of the nickel and iron is oxidized during this stage. The balance of the material is put through another flotation process and 99 per cent of the metal is recovered.

Prior to the working of the Frood mine all the copper had been refined in New Jersey. After development began in this mine they were unable to handle all the ore in New Jersey and it became necessary to build a copper refinery. This refinery was built at Copper Cliff, Ontario, at a cost of nine and one-half million dollars. At present the company is still shipping copper with nickel to the refinery at Port Colborne, Ontario. This plant, however, is to be removed to Copper Cliff, bringing with it five hundred men.

The Frood mine is at present one of the world's largest mines To date they have 22 miles of underground development. The shaft for this mine proved to be a big problem. A 14-foot by 6-foot cage, capable of 1,500 feet per minute, is operated along with an auxiliary, which operates at 3,000 feet per minute. It is necessary to handle one and one-half million feet of timber and between two and three thousand men per month in this shaft in addition to the ore.

This mine, as well as being rich in copper and nickel, is one of the largest platinum producing mines in the world. Their plant is capable of a yearly output of 300,000 ounces of this precious metal. Palladium is also found in this mine.

Hamilton Branch

J. R. Dunbar, A.M.E.I.C., Secretary-Treasurer.
J. A. M. Galilee, Aff.E.I.C., Branch News Editor.

Annual Meeting

The annual meeting of the Branch was held recently as a luncheon meeting in Murphy's restaurant. About twenty members of the Branch were present.

On the motion of E. M. Coles, A.M.E.I.C., seconded by W. A. T. Gilmour, Jr.E.I.C., the minutes of the last three meetings were taken as read.

The first item of business was the presentation of the Branch students' prizes. This is the first year in which a competition has been held for the Branch students' prizes and three papers were presented in the competition. A fourth student's paper is now in the course of preparation and the four papers will be submitted from this Branch for the John Galbraith prize.

The first prize was presented to D. E. Bridge, S.E.I.C., for his paper "Electrical Furnaces as Applied to Industrial Heating," the second prize going to P. R. Adams, S.E.I.C., for his paper "A Brief Résumé of the Air Brake and its Relation to Transportation."

The Secretary then read the report of the Executive committee for the year ending May 31st, 1931.

Report of Executive Committee for Year Ending May 31st, 1931

The Branch held the following meetings during the year:—

1930

Sept. 11.—"The Future of The Institute and How to Improve Finances and Increase Membership," by A. J. Grant, M.E.I.C., President of The Institute.
Several members of the Niagara Peninsula Branch were our guests at this meeting.
Dinner meeting. Attendance 40.

Oct. 10.—"Mechanical and Electrical Features of the Welland Ship Canal," by J. B. McAndrews, A.M.E.I.C., and L. P. Rundle.
The Hamilton Branch E.I.C. were the guests of the Ontario Section A.S.M.E. at this meeting.
Joint dinner meeting of Ontario Section A.S.M.E., Toronto Section A.I.E.E., and Toronto Branch E.I.C.
Attendance 113 at dinner, 175 at the meeting.

Oct. 21.—(1) "Illumination of the Endless Caverns of Virginia," by G. F. Foot.
(2) "Floodlighting and its Applications," by G. F. Mudgett.
Attendance 60, including ten ladies.

Nov. 4.—"Combustion of Pulverized Fuel," by E. G. Bailey.
The members of the Hamilton Branch E.I.C. were the guests of the Engineering Society of Babcock-Wilcox and Goldie-McCulloch Company at this meeting.
Attendance 175.

Nov. 12.—"Weather Reporting to the R 100," by J. Patterson.
Attendance 35.

Dec. 10.—"The Telephone Carrier System," by W. A. Dancey.
Attendance 55.

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Jan. 13.—"Railway Construction Through the Yellowhead Pass," by W. R. Smith.
Attendance 45.

Feb. 11.—"Construction and Operation of Oil Electric Rail Cars," by H. F. Finnemore.
Attendance 75.

Mar. 10.—Students' Meeting.
"A Brief Résumé of the Development of the Air Brake and its Relation to Transportation," by P. R. Adams, S.E.I.C.
"Electric Furnaces as Applied to Industrial Heating," by D. E. Bridge, S.E.I.C.
"The Power Supply of Southern Vancouver Island," by H. W. Blackett, Jr.E.I.C.
Attendance 25.

April 2.—"Steam Storage," by J. P. Wys.
This was a joint meeting with the Ontario and Buffalo Sections A.S.M.E. and Niagara Peninsula Branch E.I.C. In the afternoon visits were paid to works of the Canadian Westinghouse Company Ltd., Steel Company of Canada, Firestone Tire and Rubber Company, and Dominion Glass Company. After dinner Japanese research films were shown. Members of the Buffalo Section A.S.M.E. explained the films.
Attendance 100 at dinner, 120 at evening meeting.

April 24.—"Interesting Developments and Problems in Central Station Engineering," by R. E. Powers.
This was the annual joint meeting with the Toronto section A.I.E.E.
Attendance 240.

May 6.—Annual Branch meeting.
Attendance 20.

A total of ten Branch meetings were held during the year exclusive of meetings at which we were the guests of other organizations, with an average cost of approximately $32 per meeting.

A particularly interesting meeting was the Students' meeting on March 10th. Three papers of excellent quality were submitted.

By a vote, those present at the meeting decided that Mr. Blackett's oral presentation was the best, followed closely by Mr. Adams.

The Branch Prize Committee considered the papers and decided that Mr. Bridge's paper was so well prepared and contained such good material that he was entitled to the first prize. Mr. P. R. Adams was awarded the second prize. Mr. Blackett's paper, although it was not awarded a prize, showed evidence of careful preparation and his oral presentation deserves particular mention.

This year owing to unwillingness on the part of nominees for office to accept nomination, all Branch offices were filled by acclamation.

The proposal regarding the fees that was referred to in last year's report was drawn up this year as a formal amendment to the by-laws and submitted to headquarters. On the request of headquarters those who signed the proposed amendment again withdrew the proposal from consideration for this year.

Seven executive committee meetings were held during the year with an attendance of six or seven at each meeting.

The following is a statement of the membership.

MEMBERSHIP

Class	Resident	Non-Res.	Total	Last Year
Members	25	5	30	31
Associate Members	51	9	60	57
Juniors	13	4	17	14
Students	31	3	34	38
Affiliates	3	0	3	3
Branch Affiliates			20	21

The Executive Committee for the season 1931-32 were then introduced to the branch membership. The following are the members of the Executive Committee for the coming year:—

Chairman.....................E. P. Muntz, M.E.I.C.
Vice-Chairman.................H. P. Stuart, A.M.E.I.C.
Secretary-Treasurer............J. R. Dunbar, A.M.E.I.C.
Executive Committee..........E. M. Coles, A.M.E.I.C.
G. A. Colhoun, A.M.E.I.C.
W. A. T. Gilmour, Jr.E.I.C.
J. Stodart, M.E.I.C.
Ex-officio.....................E. H. Darling, M.E.I.C., Councillor
W. F. McLaren, M.E.I.C., Past Chairman.

An interesting discussion followed regarding the Branch activities for the coming year. It was suggested that a membership drive should be organized, which will be done as soon as the new Executive Committee is able to get functioning properly. Two or three of the members present suggested that noon luncheon meetings would be very desirable in addition to the regular evening meetings.

London Branch

F. C. Ball, A.M.E.I.C., Secretary-Treasurer.
J. R. Rostron, A.M.E.I.C., News Editor.

REFORESTATION

The regular May meeting of the Branch was held on the 19th in the auditorium of the city hall, the speaker being Arthur Herbert Richardson, forester in charge of reforestation, province of Ontario, and his subject "Reforestation."

An interesting feature of this meeting was the presence of a number of boys and girls from the county of Middlesex who had entered a competition, inaugurated by W. R. Smith, A.M.E.I.C., Branch chairman, for the best essay on "Reforestation." A number of these essays, which were read to the meeting, showed that the competitors had a thorough grasp of the subject and augured well for the preservation and cultivation of our wooded areas by the rising generation.

Mr. Smith, who presided, made some interesting comparisons between the progress of reforestation in the United States and in Canada, which went to show that the latter were not behind in this respect—in Ontario alone 2,000,000 trees were distributed by the government for planting purposes.

Mr. Richardson's address was illustrated by coloured slides showing the effect of land, otherwise waste, reclaimed by reforestation. Views were shown of various kinds of trees in all stages of growth from the planting up to thirty years old. Land, originally a barren waste, was transformed into a beautiful and profitable park. Roads which formerly drifted up with sand and were costly to maintain were shown now protected with growths of pine thus eliminating the cost of maintenance and beautifying the landscape. Views were shown of demonstration areas planted by the government in various parts of Ontario. The speaker pointed out that vast tracts of waste land as far as cultivation was concerned, such as hill sides, rocky places or swamps, could by this means be turned into profitable areas. He outlined the government's plan of raising trees from seedlings and distributing and planting them free if the land is provided and fenced by the municipality or county. Individual owners can also obtain this service either free or at a nominal cost according to the area of the land that is proposed to be planted. Such areas reforested will make their yield from twenty-five years up according to the kind of trees planted whether of quick or slow growth. It was estimated that say an acre planted with pine would yield about 1,200 trees or about 25,000 B.M. of lumber worth about $20 per thousand on the stump, thus a yield of from four hundred to five hundred dollars an acre could be expected. Carolina poplar was mentioned as a quick growing and profitable species. Not only this, but the areas so planted formed a windbreak and prevented aridness of the surrounding land, thus increasing its fertility and productiveness, while the trees themselves together with the undergrowth conserved the underground water supply.

It was urged that municipalities, counties, public or private persons, farmers, land owners, or any persons having control or interest in unprofitable areas of land, large or small, give this matter full consideration. Full information can be obtained by application to the Ontario Forestry Branch, Toronto. Any resident in Ontario may secure five hundred trees free each year for windbreaks, or 3,500 trees each year for planting on their property either for reforesting waste land or filling in the wood lot. Additional quantities may be purchased at the rate of $1 per thousand.

An interesting discussion followed the speaker's address and a hearty vote of thanks was ably proposed by W. C. Miller, M.E.I.C., city engineer of St. Thomas, who pointed out that his municipality had already accepted the government's offer and was planting trees in the vicinity of the waterworks, and J. R. Rostron, A.M.E.I.C., seconded the vote of thanks.

About fifty-five members and guests were present.

Following this meeting a motor trip was made on Saturday, May 30, to view the reforested area at St. Williams, which was much appreciated by about thirty interested people. There would have been a larger turn-out had it not been for the rainfall.

Moncton Branch

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

The annual meeting was held on May 30th. L. H. Robinson, M.E.I.C., chairman of the Branch, presided. The annual report and financial statement was presented, and on motion adopted. The scrutineers reported on the result of the Branch elections, and it was announced that the following officers will act for the year 1931-32.

Chairman.....................G. E. Smith, A.M.E.I.C.
Vice-Chairman.................T. H. Dickson, A.M.E.I.C.
Secretary-Treasurer............V. C. Blackett, A.M.E.I.C.
Executive Committee..........E. T. Cain, A.M.E.I.C.
H. J. Crudge, A.M.E.I.C.
R. H. Emmerson, A.M.E.I.C.
A. S. Gunn, A.M.E.I.C.
H. W. McKiel, M.E.I.C.
A. F. Stewart, M.E.I.C.
Ex-officio.....................L. H. Robinson, M.E.I.C.
G. C. Torrens, A.M.E.I.C.

On motion of A. S. Gunn, A.M.E.I.C., seconded by G. E. Smith, A.M.E.I.C., a vote of thanks was extended the Branch members on the engineering staff of the University of Mount Allison for their work in interesting the students in The Institute. A vote of thanks moved by R. H. Emmerson, A.M.E.I.C., seconded by G. C. Torrens, A.M.E.I.C., was accorded the retiring Branch officers.

ELEVENTH ANNUAL REPORT

The tenth annual meeting of Moncton Branch was held on June 10th, 1930.

The Executive committee held five meetings during the year. There were seven meetings of the Branch, two of which were open to the public. At these meetings papers were read, addresses delivered and business transacted as follows:—

1930

Oct. 14.—A public meeting was held in the city hall. A very interesting illustrated address was given by G. A. Richardson, technical lecturer of the Bethlehem Steel Corporation, Bethlehem, Pa., on "The Manufacture of Structural Steel Shapes and Related Products."

Nov. 18.—A supper meeting was held in the Y.M.C.A. An instructive illustrated address was delivered by F. H. Peters, M.E.I.C., Surveyor General, Department of the Interior, Ottawa, on "Aerial Photographic Surveys."

1931

Jan. 13.—A public meeting was held in the council chamber, city hall. Major H. W. L. Doane, B.Sc., M.E.I.C., gave a very interesting address on "The Allenby Campaign in Palestine."

Feb. 18.—A supper meeting was held in the Y.M.C.A. An exceedingly instructive address on "Commercial Aviation" was delivered by Capt. A. F. Ingram, Manager of the Canadian Airways, Montreal.

Mar. 17.—A combined meeting of Moncton Branch and the Engineering Society of Mount Allison University was held at Sackville. A very interesting illustrated paper on "Municipal Engineering" was read by J. D. McBeath, B.A.I., Chief Engineer, City of Moncton.

Mar. 18.—A supper meeting was held in the Y.M.C.A. James Govan, M.R.A.I.C., Toronto, delivered an interesting and instructive address on "Recent Research Developments in Building Materials."

May 20.—A meeting was held for the purpose of nominating Branch officers for the year 1931-32.

The attendance at all our Branch meetings was good, and particularly so at the two meetings open to the public. At the first of these there were about two hundred present,—at the second, standing room was at a premium—an excellent indication of the service the Branch is rendering, not only to the profession but to the general public as well.

While many outstanding addresses have been delivered before the Branch in past years, it is quite safe to say that never before has such a high uniform standard of excellence been reached. Arrangements were made during the season to have two of our speakers address the other Maritime branches. L. H. Robinson, M.E.I.C., chairman of the Branch, also acted in the capacity of chairman of the Papers committee for the year just closed.

Our total membership shows an increase over last year of more than thirty per cent. There is one application pending and several more are in prospect. A very gratifying feature is the interest being taken in The Institute by the engineering students of Mount Allison University and the Branch should be sincerely grateful to our members on the staff of the university, who have so ably presented the advantages of membership to the students.

The following is a statement of our membership at the present time:—

MEMBERSHIP

	Resident	*Non-Resident*	*Total*
Members	10	2	12
Associate Members	21	5	26
Juniors	2	..	2
Students	26	3	29
Branch Affiliates	2	..	2
	61	10	71

The thanks of the Executive of Moncton Branch are due E. T. Cain, A.M.E.I.C., chairman of the Entertainment committee, for his efficient management of the details of our supper meetings, also the Moncton Tramways, Electricity and Gas Company Ltd. for the loan of a moving picture projector, and the gentlemen who so kindly furnished the musical entertainment for our meetings.

Niagara Peninsula Branch

Paul E. Buss, A.M.E.I.C., Secretary-Treasurer.

A meeting of the Branch was held at Niagara Falls on May 22nd. Reports of the scrutineers were received and the following slate of officers was declared duly elected for the year June 1st, 1931, to May 31st, 1932:—

Chairman.................. Walter Jackson, M.E.I.C.
Vice-Chairman.............. E. P. Murphy, A.M.E.I.C.
Secretary-Treasurer.......... P. E. Buss, A.M.E.I.C.
Executive.................. J. C. Moyer, A.M.E.I.C.
Alex. Milne, A.M.E.I.C.
C. G. Cline, A.M.E.I.C.
H. M. King, M.E.I.C.
W. R. Manock, A.M.E.I.C.
F. L. Haviland, M.E.I.C.
H. D. Davison, A.M.E.I.C.
C. N. Geale, A.M.E.I.C.
L. C. McMurtry, A.M.E.I.C.
Ex-officio.................. E. G. Cameron, A.M.E.I.C.
A. J. Grant, M.E.I.C.
C. H. Scheman, M.E.I.C.

At this meeting reports were received indicating that a stag dinner for the annual meeting would be preferred to a dinner-dance, which had proved so successful in previous years. Accordingly the programme was altered to conform with this desire. After luncheon the executive adjourned to the golf course at Niagara-on-the-Lake, where a feature of the contest was the excellent score card turned in by G. F. Vollmer, M.E.I.C., who, although somewhat of a novice, won easily on his handicap.

ANNUAL MEETING

The annual meeting was held at the General Brock hotel, Niagara Falls, on May 27th. Walter Jackson, M.E.I.C., was chairman and Mr. M. A. Sorsoleil, of Toronto, was the principal speaker of the evening. About eighty members and guests were in attendance.

MODERN TRENDS IN EDUCATION

Mr. Sorsoleil is assistant director of vocational education in the province of Ontario and spoke on the subject of "Modern Trends in Education" in a manner which convinced his audience that great changes were in progress and that careful thinking and planning was being done along these lines.

The word "education" said Mr. Sorsoleil has to-day an entirely different meaning from that in which it was formerly used. It has broadened out until no longer does it denote a mere bookish culture. There have been periods not so long ago when the sole ability to quote Greek or Latin classics was considered to be the mark of an educated man, and when artisans, even engineers, were not among the elite.

Fortunately this conception is a thing of the past and now an educated man might well be defined as "one who functions successfully in his environment." In other words, anyone who can do well the work for which he, or she, is particularly adapted may be termed educated—but only if that work is performed with skill and with the knowledge of how it should be performed.

A skilful cabinet maker, if his education be complete, can turn out a work of merit which will vie with any poem, painting or sonata as a conception of artistic skill and beauty.

Now, continued Mr. Sorsoleil, the vocational departments are recognizing this fact. No longer do they use the term sub-normal to define backward pupils—as a matter of fact very few pupils are mentally deficient in all things. The new way is to study the child and ascertain the particular work for which he is adapted and then educate him along those lines.

The vocational department is also looking ahead to the time, which is surely coming, when the percentage of leisure will be greatly increased. When the workers of the world will have six or eight hours a day for play or recreation and perhaps only five or six hours work. If the worker is not educated to employ this leisure properly he will deteriorate, but if he is taught how to play, to develope hobbies such as gardening, wood working, book study, etc., then will he retain mental equilibrium and remain the best type of citizen.

As an indication of how the world is even now moving in this respect, it may be noticed that the adolescent act of Ontario has raised the school age to sixteen years and many of the educators believe that it should have been eighteen years. However, concluded Mr. Sorsoleil, the most important thing in education is to train the young mind to think for itself.

Of interest to engineers was the fact that quite a few of their number had taken up the special course provided by the department and some eight or nine were already giving vocational guidance in the schools of Ontario. They are proving efficient teachers and this should in future be a splendid field for those of the profession who like that kind of work.

At the close of this talk W. R. Manock, A.M.E.I.C., and H. M. King, M.E.I.C., proposed and seconded the vote of thanks to Mr. Sorsoleil. Messrs. S. R. Frost, A.M.E.I.C., and G. G. Reid, Jr.E.I.C., then entertained the gathering with some very good songs.

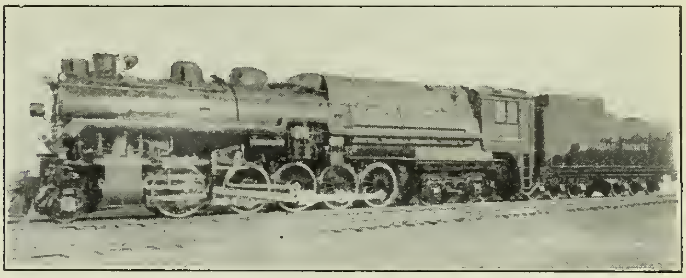
Ottawa Branch

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

FINAL EVENING MEETING OF SEASON

The last evening meeting of the season of the Ottawa Branch of The Engineering Institute was held in the Royal Canadian Air Force projection room, Jackson building, on May 14th. The speaker was W. A. Newman, chief mechanical engineer of the Canadian Pacific Railway Company, who described briefly the underlying principles in connection with the new C.P.R. locomotive No. 8000. His address was followed by moving pictures of locomotive No. 8000, including animated diagrams, prepared by the Associated Screen News of Montreal.

The new locomotive, stated Mr. Newman, utilizes a very novel and interesting system in the generation of steam which offers an improvement in economy. In improving the design of locomotives what is, of course, aimed at is the development of increased power with a decrease in costs. The history of increasing boiler pressures means that water tube boilers must be used, the principal reason being that small tubes can have an ample factor of safety with comparatively thin walls. A disadvantage in water tube boilers is that impurities are left behind as solids when ordinary water is used. These solids stick on the metal surfaces, forming a scale which interferes with the transmission of heat. In marine and stationary plants this is easily overcome by the use of condensers, but with a moving locomotive, weight and space limitations do not allow for the same methods as in stationary plants. The problem then becomes how to construct a water tube boiler without scaling difficulties.



T4a-Class—Multi-Pressure Locomotive.

Cylinders, h.p. (1), 15½" x 28"; Cylinders, l.p. (2), 24" x 30"; Diameter of Drivers, 63"; Tractive effort, 90,000 lbs.

Boiler Pressures: Closed Circuit 1,350 lbs.; High Pressure, 850 lbs.; Low Pressure, 250 lbs.

Weight on Drivers, 219,000 lbs.; Weight of engine, 485,000 lbs.; Weight of engine and tender, 785,000 lbs.

Total Length of engine and tender 99'3".

Water Capacity, 12,000 imp. gallons.

Oil Capacity, 4,100 imp. gallons.

The new locomotive is of the "multi-pressure" type. That is, there are three pressure systems with which three instead of two cylinders are used, and in this way it is radically different from ordinary locomotives.

The three pressure systems are, respectively, the "closed steam generating system," the "high pressure system" and the "low pressure system." The closed steam generating system is a box-like structure built up of a large number of tubes filled to a set level with distilled water and sealed. This system absorbs a large amount of heat to form steam, which when condensed gives out the same amount of heat. This is accomplished by collecting the steam in two longitudinal drums at the top of the firebox and then delivering it to a series of coils placed in the inside of a seamless steel drum and submerged in water. These are called heat transfer coils and the surrounding water condenses the steam and absorbs the heat given out. Condensation is then led from the bottom of the coils back to the lowest point in the closed system and re-evaporated.

In fact, the system has a continuous sponge-like action absorbing and giving out heat and on account of the use of distilled water no scale can accumulate. There is no set pressure although nominally the pressure is 1,350 pounds per square inch with an allowable maximum of 1,750 pounds per square inch.

The high pressure boiler develops pressure up to 850 pounds per square inch and the low pressure to 250 pounds per square inch.

The locomotive burns fuel oil, the capacity of the tender being 4,100 gallons and the capacity for water supply is 12,000 gallons. The Angus shops of the Canadian Pacific Railway were responsible for the construction. Canadian materials being used wherever possible. The total weight of the locomotive is 390 tons and the total length is 100 feet. The maximum tractive effort exerted is 90,000 pounds, but it is not intended for high speed as it was designed for use on some of the heavier grades in the Rocky mountains. The maximum speed is approximately 55 miles per hour.

At the meeting a short film was also shown dealing with the tipping of the obelisk at the Chute à Caron development on the Saguenay river on July 23rd of last year.

A most interesting feature which took place at this meeting was a presentation of a silver vase, by G. J. Desbarats, C.M.G., M.E.I.C., chairman of the local branch, to T. H. G. Clunn, A.M.E.I.C., one of the most popular members, who is retiring from the government service and, as a consequence, leaving the city.

Visit to Chats Falls

On the afternoon of June 6, 1931, the members of the Ottawa Branch of The Engineering Institute of Canada paid a visit to the Chats Falls hydro-electric development, now under construction by the Ontario Hydro-Electric Power Commission and Ottawa Valley Power Company, located on the Ottawa river, about 35 miles above the city of Ottawa. The members travelled by motor car, about one hundred and twenty-five making the trip, and were guests for the afternoon of the owners and of the general contractors, Morrow and Beatty, Ltd., of Peterborough, Ontario.

At the development the members were received by Colonel H. L. Trotter, M.E.I.C., resident engineer; A. E. Rowbotham; N. Malloch, A.M.E.I.C., and J. E. Dion, Jr.E.I.C., representing the owners; and J. Dick, A.M.E.I.C., chief engineer; J. Barrett, general superintendent; A. A. Richardson, A.M.E.I.C., superintendent in charge of work; and G. R.Evans, assistant engineer, representing the general contractors. They were taken direct to the power house by a work-train specially made up for their use and toured the extensive works for three hours after which the party was entertained at supper.

The interprovincial aspect of the development was a feature of particular interest, for the 627-foot long power house is half in Ontario and half in Quebec. The length of concrete and earth dam is approximately 3½ miles.

This is made up of 13,600 feet of concrete structure, including the power house, and 4,300 feet of earth dam, and accordingly is one of the longest dams in Canada. There are four sluice gate openings 40 feet wide by 25 feet high and four stop log dams having a total of 72 sluices 18 feet wide and an aggregate length of 1,752 feet. In connection with the development it has been necessary to divert a line of the Canadian National Railways for a distance of 2½ miles.

At the time of the visit there were some eight hundred men engaged on the work, although at times during the past year there had been upwards of twelve hundred men.

The present intended installation is eight units with an ultimate of ten units. The waterwheels are rated at 28,000 h.p. each and a speed of 125 r.p.m. under normal head of 53 feet.

Special 220,000-volt transmission lines will be erected to carry the power to western Ontario.

Peterborough Branch

F. G. A. Tarr, S.E.I.C., Secretary.
A. R. Jones, Jr.E.I.C., Branch News Editor.

Annual Meeting

The final meeting of the Peterborough Branch for the season was held on May 7, 1931, and took the form of a combined business meeting and social evening.

The various committees submitted very favourable reports of the season's activities, following which the scrutineers announced the result of the ballot for the election of officers as follows:

Chairman	A. B. Gates, A.M.E.I.C.
Secretary	F. G. A. Tarr, S.E.I.C.
Treasurer	B. Ottewell, A.M.E.I.C.
Executive Committee	B. L. Barns, A.M.E.I.C.
	A. E. Caddy, M.E.I.C.
	R. C. Flitton, A.M.E.I.C.
	A. L. Killaly, M.E.I.C.
	H. R. Sills, Jr.E.I.C.
	P. P. Westbye, M.E.I.C.
Ex Officio	R. L. Dobbin, M.E.I.C.
	W. E. Ross, A.M.E.I.C.

The following appointments and committees were also arranged:

Meetings and Papers Committee	H. R. Sills, Jr.E.I.C.
Branch News Editor	A. R. Jones, Jr.E.I.C.
Entertainment	R. L. Dobbin, M.E.I.C.
	W. E. Ross, A.M.E.I.C.
Attendance	D. J. Emery, S.E.I.C.
Membership	W. M. Cruthers, A.M.E.I.C.
	R. C. Flitton, A.M.E.I.C.
Auditor	E. R. Shirley, M.E.I.C.

The Students and Juniors section of the Branch again took an active part in the programme by staging a debate, "Resolved that Great Britain should give India Dominion Status." K. Anderson and E. McKeagan spoke for the affirmative and J. Cameron, S.E.I.C., and W. Brumby, Jr.E.I.C., for the negative.

On a standing vote of those present, the chairman announced that the "noes" had won by the close margin of one vote.

Light refreshments and a round of bridge concluded a very enjoyable evening.

Quebec Branch

M. Boyer, S.E.I.C., Secretary-Treasurer.

The annual meeting of the Quebec Branch of The Engineering Institute of Canada was held on Monday, June 15th, at 7.30 p.m., and presided over by S. L. de Carteret, M.E.I.C., chairman 1930-31.

Following the dinner, James Ruddick, M.E.I.C., and Louis Beaudry, A.M.E.I.C., were appointed scrutineers. While ballots were being counted, the minutes of the last annual meeting were read by Philippe Méthé, A.M.E.I.C., secretary, followed by the report of activities and finances for the year 1930-31.

An honorarium was voted to the secretary for his services during the year.

The following were unanimously elected to the legislating and nominating committees:—

Legislating	Alexandre Larivière, A.M.E.I.C.
	T. F. J. King, A.M.E.I.C.
	Louis Beaudry, A.M.E.I.C.
Nominating	Philippe Méthé, A.M.E.I.C.
	Alexandre Larivière, A.M.E.I.C.
	J. G. O'Donnell, A.M.E.I.C.

Ballot returns favoured the following officers for the year 1931-32:—

Chairman	J. N. Hector Cimon, M.E.I.C.
Vice-Chairman	Alexandre Larivière, A.M.E.I.C.
Secretary	Marc Boyer, S.E.I.C.
Executive Committee	Philippe Méthé, A.M.E.I.C.
	T. F. J. King, A.M.E.I.C.
	J. G. O'Donnell, A.M.E.I.C.
Ex-officio (Honorary President)	A. R. Decary, M.E.I.C.
(Executive Committee)	L. C. Dupuis, A.M.E.I.C.
	Louis Beaudry, A.M.E.I.C.
	A. B. Normandin, A.M.E.I.C.
	A. E. Doucet, M.E.I.C.
	W. G. Mitchell, M.E.I.C.
(Past President)	S. L. de Carteret, M.E.I.C.

It was voted that the ballots should be destroyed.

Short speeches were made by the new and retiring officers, and by several members present.

Topics of general interest to The Institute were discussed, among which was the necessity of a drive for membership.

The meeting adjourned at 10.30 p.m.

Vancouver Branch

W. O. Scott, Jr.E.I.C., Secretary-Treasurer.

Modern Trend in Aviation

On May 20th, 1931, Mr. R. Carter Guest, inspector of Civil Aviation for British Columbia, gave a very interesting informal talk on "Modern Trend in Aviation."

His discussion included such points as—

Inspection. Covering a brief outline of the duties of the staff, markings on planes to distinguish private and commercial crafts, airworthiness certificate and its meaning, number of inspections yearly and special inspections and their scope.

With the aid of a projection lantern pictures from air magazines and actual photographs were shown to illustrate the various types of planes. In this connection also the general design of the plane or planes was given, showing wing construction, bracing, types and positions of the power plant and so forth.

Further discussion brought out a few of the modern features and a number of views were shown of the Schneider Cup machine.

Progress in air mail service was explained by a few comparative figures for 1928 and 1929 for Canada, also for comparison those of United States for the same years.

Considerable interest was shown regarding the western section of the Canadian air mail service over the Rocky Mountains (Calgary to Vancouver).

Commercial uses of the plane today gave quite a large field for discussion and the speaker touched briefly on prospecting, timber cruising, inspection of mining ventures, transportation for game hunting, aerial photography and surveying.

P. H. Buchan, A.M.E.I.C., acted as chairman and thanked the speaker. At the same time he pointed out that such an interesting topic and discussion was worthy of a large turnout.

Victoria Branch

K. M. Chadwick, M.E.I.C., Secretary-Treasurer.

The annual dinner of the Victoria Branch of The Institute was held at West Point Barracks on April 11th, 1931, by kind permission of Colonel J. Sutherland Brown, C.M.G., D.S.O., Affil.E.I.C., and was attended by some forty members. A. L. Carruthers, M.E.I.C., was chairman and short speeches were made by R. A. Bainbridge, M.E.I.C., F. C. Green, M.E.I.C., P. Philip, M.E.I.C., and Colonel J. S. Dennis, M.E.I.C., who now resides in Victoria.

VISIT TO PLANT OF CANADIAN EXPLOSIVES

On June 5th, 1931, eighteen members of the Victoria Branch paid a visit to the Canadian Explosives plant at James island, about 12 miles from Victoria, and were welcomed by the management. The party was shown the various processes used in making modern explosives, also the acid plants, the glycerine mixing rooms, and the packing and shipping rooms, each section of the explosive side of the works being located in separate sheds set 100 yards or more away from each other, so that should an explosion take place it would be more or less restricted to a small portion of the plant.

Kill van Kull Bridge

The following information regarding the Kill van Kull bridge between Bayonne, New Jersey and Port Richmond, Staten Island, New York, is based on the second report of Mr. O. H. Ammann, chief engineer of the Port of New York Authority, published in March, 1931, and describes briefly the erection of one of the first arch spans ever attempted.

This arch involving the placing of almost 17,000 tons of steel necessitated unusual methods of construction, inasmuch as the falsework supports were not allowed to encroach upon the shipping channel which is near the south shore of the Kill van Kull bridge site. The major portion of this work has now been completed, and it is expected that the remainder will be speedily concluded, except for the street approach problem on the Staten Island side which has not been definitely solved.

The Kill van Kull is spanned by a two-hinged parabolic steel arch measuring 1,675 feet between bearing points on the abutments. The arch, which is more fully described in the first progress report, is composed of two arch trusses, spaced 74 feet on centres, with a rise of 274 feet from the centre of bearing to the crown of the lower chord. Each truss has a depth of 37 feet 6 inches at the crown and 67 feet 6 inches at the abutments.

The web members of the arch trusses are arranged in forty panels of equal length. The bottom web is of carbon-manganese steel of a cross sectional area of 980 square inches at the abutment and 580 square inches at the crown. It is designed to carry the greater portion of the dead load of the span, and thrusts against hinges formed by pins 16 inches in diameter which bear upon heavy steel forgings through which the loads are transmitted to the structural shoes. The top chord is of silicon steel varying in cross section from 272 square inches to 421.5 square inches. The web members of the trusses, the bracing between trusses, and the floor beams and stringers, which support the deck slabs, are partly of silicon steel and partly of carbon steel. The central part of the floor system is suspended from the arch trusses by means of wire rope hangers.

The arch was erected in two sections from the abutments. The method of erection was unusual, inasmuch as it involved cantilevering from both ends with the assistance of falsework bents placed successively as erection of the arch proceeded. The ideal procedure would have been to have the two sections meet at the crown of the arch. However, the falsework supports were not allowed to encroach upon the shipping channel, which at the bridge site is near the south shore of the Kill van Kull and therefore involved unsymmetrical arrangement.

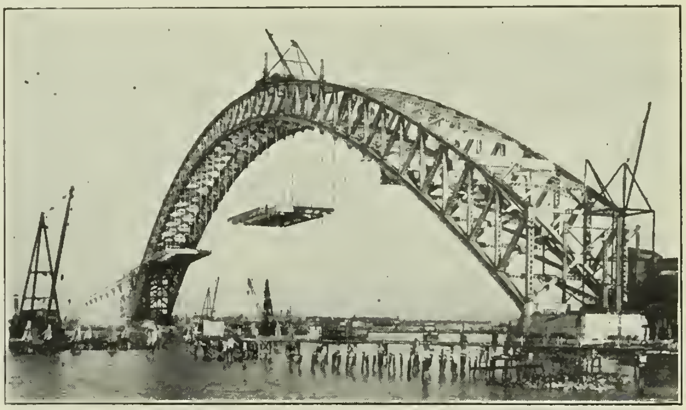
The south arm was completed before undertaking work on the north arm. A single erection traveller which operated on rails along the top chords of the trusses erected both arms. Some of the falsework bents used in erecting the south arm were again used for the north arm and, in general, the same procedure was followed in the early stages of erection of the two arms, except that the first panel of steel in the south arm was erected by a traveller which had been assembled on the abutment, while for the north arm the first panel was erected by floating equipment.

Closure of the arms at panel point 14 south was effected by lowering both sections of the arch simultaneously to bear upon a 16-inch diameter pin in the lower chord, a process which required particular care and close co-ordination. Guide castings were provided to insure horizontal alignment of the trusses upon closing. Possible errors in alignment of as much as six inches were anticipated. The precision in fabrication and erection had been such, however, as to result in an actual error in alignment of less than one inch.

The arch was then in a three-hinged condition. To convert the structure into a two-hinged arch the insertion of a top chord member in each truss was required. The arch had been designed upon the assumption that under the initial condition after closing, it would be three hinged with one hinge in the lower chord at the crown of the arch. A closing upper chord member at the crown would, under such condition, carry no stress. Under any condition of additional loading the arch would act as a two-hinged structure.

Following the completion of arch truss erection the remaining falsework bents and piers were removed, wire rope suspenders were placed and erection of the floor system was started. Main transverse floor beams occur at each panel point. At points where the floor system is suspended below the lower chord of the arch ring four $3\frac{1}{4}$-inch wire ropes attach to each end of a floor beam. These beams are connected by four roadway stringers in each panel. Transverse secondary floor beams are connected by four roadway stringers in each panel. Transverse secondary floor beams support bulb beams which will form part of the reinforcing for the roadway concrete slab. Wind chords, steel roadway curbs, lateral bracing and framing for a sidewalk on the west side of the bridge complete the floor structure. The design of the floor system is such as to provide for the later addition of two lines of rapid transit or for increasing the width of roadway from 40 feet to 65 feet.

The floor system was erected in two principal sections. The traveller on the top chord of the arch began erection one panel south of the crown of the arch and continued south to a point within two panels of the Port Richmond abutment. At the same time the Bayonne approach traveller started at the north abutment and proceeded with the erection of the floor steel of the main span. This traveller was on the floor level and was unable to operate for a short distance within and beyond the portal of the arch. Accordingly auxiliary tackle attached to the truss was used for hoisting the floor steel in this area. Later the traveller "A" frame was lowered and moved through the portal, reassembled at panel point 10 and thence proceeded to join the floor steel with the other section near the centre of the span. All main span floor steel except that required for two panels adjacent to the Port Richmond abutment is now in place.



Kill van Kull Bridge, January 1st, 1930.

The actual mass of concrete required at each abutment to transmit the thrust of the arch to bed rock is comparatively small. The top of the abutment block is only slightly over 20 feet above river level. For architectural reasons the abutments will be carried as solid appearing pillars to a height somewhat above the roadway level. They will actually be built of curtain walls faced with granite after the bridge is opened to traffic. The roadway deck at this location is carried on a skeleton steelwork.

Erection on the Bayonne approach steel was started January 28th, 1930, at West Third street and was completed at the abutment just prior to April 1st, 1930.

The Port Richmond approach construction is similar to that of the Bayonne approach. It consists in general of a series of plate girder spans of 126 feet maximum length on reinforced concrete piers. The transverse floor beams are spaced at approximately 20-foot intervals and carry stringers which will support the concrete slab. Special construction was necessary at Richmond terrace, which is crossed by a span of 183 feet 10 inches. At this location long girders continuous in three spans over four supports were provided. In all spans framing for a sidewalk 6 feet 6 inches wide is provided in temporary location on the west side of the approach only. As in the main span provisions are made for future changes in width of roadway or additions of rapid transit tracks and footwalks.

L. Mundet and Son, 461 Eighth Avenue, New York, N.Y., have published a new bulletin entitled "How to Deaden Machine Vibrations and Noise," which shows and tells how machinery should be isolated by means of natural cork so that noise and vibrations will be eliminated. It explains why natural cork mats are preferable for machinery isolation, gives a table of sizes and shapes of Mundet natural cork mats and also shows curves of compression tests on mats $1\frac{1}{2}$ inches and 3 inches thick. A copy of the bulletin may be obtained from L. Mundet and Son at the above mentioned address.

Preliminary Notice

of Applications for Admission and for Transfer

June 20th, 1931.

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 August, 1931.

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

BATY—EDWARD, of 781 Maplewood Ave., Montreal, Que., Born at Tarraby, Carlisle, England, March 14th, 1893; Educ., 1909-13, Darlington Technical College, England. Stages I, II and III certs., Board of Education and London City and Guilds Institute, in mech'l. engrg. and associated subjects; 1909-14, privileged ap'ticeship, North Eastern Railway locomotive works, Darlington, England, shop and drawing office training in locomotive and machine tools; 1914, dftsman., Smith, Major & Stevens, Northampton, Eng.; 1915, on active service with Royal Artillery; 1916-18, acting chief works dftsman and electrician, North Eastern Railway Locomotive Works, Darlington, England; 1919, process and standards engr., machine tool and jig design and shop methods, Smith, Major & Stevens, Northampton; 1916-18, lecturer, evening classes, machine drawing and design and engrg. science, Darlington Technical College, England; 1920-21, engr. and works mgr., East Anglian Cement Co. Ltd., Cambridge and Walsall, England; 1922-23, gen. mech'l. and elect'l. installns. on own account; 1924, dftsman., boiler and plate work design, Canadian Vickers, Limited, Montreal; 1925-27, engrg. asst., and from 1928 to date, district plant engr., telephone plant design, estimation, installation and mtce., Bell Telephone Company of Canada, Montreal. Also instructor, evenings, in mech'l. drawing and design, Sir George Williams College, Montreal. (1919-21, 2nd Lieut., Corps of Royal Engrs., Retired with permanent rank).

References: W. H. Slinn, H. C. Nourse, A. M. Mackenzie, M. G. Evans, G. E. Templeman.

CAMPBELL—HAROLD MONTGOMERY, of 23 Bellevue Terrace, St. Catharines, Ont., Born at St. Catharines, Ont., Dec. 17th, 1891; Educ., B.A.Sc., Univ. of Toronto, 1914; 1910-13, plant work during vacation periods; 1914 (Apr.-Sept.) and 1919-20, mech'l. dftsman., Welland Ship Canal; 1915-19, overseas, Major, M.C.; 1920-23, production mgr., in charge of production programme of plant engaged in small tool mfg. and special drop forgings, J. H. Williams, Limited; at present owner of Campbell's Hardware, Limited, St. Catharines, Ont.

References: A. J. Grant, C. H. Mitchell, T. R. Loudon, E. G. Cameron, W. P. Near.

HAGGAS—ERNEST, of 305 Cope St., Hamilton, Ont., Born at Lower Kipping, Thornton, Bradford, England; Educ., 1911-16, Technical College, Bradford, England. 1919-22, mech'l. elect'l. engrg. course with Bennett College, Sheffield. 1925-27, corres. study with University College, Cambridge, England, with view to obtaining B.Sc. (Mech.), (did not sit for exams.); 1929-31, 2nd year mech'l. drawing instructor at Wentworth Technical Institute, Hamilton, Ont., for two winter sessions; 1917-19, overseas. Air mechanic in R.A.F.; 1922-25, mech'l. dftsman., English Electric Co. Ltd., Phoenix Works, Bradford, England; 1925-28, senior mech. dftsman., layout and design A.C. and D.C. machines—some centrifugal pump practice, Harland Engineering Co. Ltd., Alloa, Scotland; 1928-29, senior mech'l. dftsman., Crompton Parkinson, Chelmsford, England; August 1929 to date, senior dftsman., A.C. vert. W.W. generators up to 50,000 kv.a., details, layout and design (mech'l), Canadian Westinghouse Co. Ltd., Hamilton, Ont.

References: W. F. McLaren, H. U. Hart, J. R. Dunbar, E. M. Coles, L. W. Gill, H. A. Ricker.

PICHE—ARTHUR, of 1242 Berri Street, Montreal, Que., Born at Montreal, Jan. 14th, 1907; Educ., Civil Engr., Ecole Polytechn., Montreal, 1930; 1928-29 (summers), engr. helper on Welland Canal at Port Colborne; May 1930, dftsman, Truscon Steel Company of Canada; (1930-31 not employed); May 1931 to date, with Anthracite Coal Service Regd., Montreal, technical advisers on heating and combustion problems, also sales promotion work.

References: A. Frigon, A. Duperron, A. Boyer, T. J. Lafreniere, A. Cousineau.

WHITE—WALTER EDMUND, of 4585 Sherbrooke St. West, Montreal, Que. Born at Toronto, Ont., August 5th, 1905; Educ., B.A.Sc., Univ. of Toronto, 1928; 1928-29, meter engr., H.E.P.C. of Ontario, Toronto; 1929 to date, inspection laboratory work, Northern Electric Co. Ltd., Montreal, Que.

References: W. H. Eastlake, J. R. Fenwick, H. G. Thompson, H. Miller, S. R. McDougall.

FOR TRANSFER FROM THE CLASS OF JUNIOR TO A HIGHER CLASS

BECKER—FRED ARTLAND, of 802 Broadway Ave., Winnipeg, Man., Born at Westhorne, Ont., Jan. 10th, 1897; Educ., B.A.Sc., Univ. of Toronto, 1924; 1923 (6 mos), jr. erecting engr., Can. Gen. Elec. Co.; 1924-25 (one year), signal dept., Michigan Central Rly. Co., Detroit, Mich.; 1925 to date, sales engr., Canadian General Electric Co. Ltd., Toronto and Winnipeg. (*Jr. 1928.*)

References: V. A. McKillop, C. T. Barnes, J. W. Sanger, E. V. Caton, N. M. Hall.

KELSEY—ERNEST STARKEY, of Montreal, Que., Born at Bristol, England, Mar. 26th, 1898; Educ., B.Sc., (E.E.), Univ. of Man., 1921. 1921-22, electricity and gas inspection, Dept. of Trade and Commerce; 1922-23, elect'l. dftsman., Manitoba Power Company; 1923-26, telephone engr., and from 1926 to date, technical service dept., Northern Electric Company, Ltd., Montreal, at present asst. to director of technical service. (*S. 1919, Jr. 1925.*)

References: H. J. Vennes, W. C. M. Cropper, A. J. Lawrence, N. L. Dann, W. B. Cartmel, N. L. Morgan, W. V. Cheshire.

McDONALD—JAMES A., of Coral Rapids, Ont., Born at West Zorra, nr. Woodstock, Ont., April 27th, 1898; Educ., B.Sc., Univ. of Alta., 1924; 1917 (3 mos), helper on survey party; 1924 (May-Dec.), asst. highway engr., Alberta Prov. Govt.; 1925 (Jan.-Apr.), mine surveyor's helper, Luscar Collieries, Ltd.; 1925-26, operator's asst., benzol plant, Steel Company of Canada; 1926 (May-Sept.), constrn. work, A. T. Leavitt Constrn. Co., Hamilton; 1923 and 1927 (summers), rock dusting and timbering, Hillcrest Mines, Alta.; 1927 (Jan.-Apr.), mine surveyor's asst., McIntyre Porcupine Gold Mines; 1927-28, asst. chemist, Bunker Hill Smelter, Kellogg, Ind.; 1929 (Apr.-Nov.), asst. chemist, Treadwell Yukon Co., Bradley, Ont.; Dec. 1929 to June 1930, lab. asst., fuel research laboratories, Mines Branch, Ottawa, Ont. (*Jr. 1926.*)

References: C. E. Baltzer, R. E. Gilmore, B. F. Haanel, O. Inskter, R. W. Boyle, R. S. L. Wilson, W. S. McDonald.

OS—HARTVIK, of 347 Grenville Ave., Port Arthur, Ont., Born at Gimsoy, Norway, May 12th, 1898; Educ., Diploma in Civil Engrg., Univ. of Trondhjem, Norway, 1923; 1914-16, ap'tice., machine shop, Narvik, Norway; 1923 (3 mos.), town surveying, Narvik, Norway; 1924 to date, inspection work, dftng., designing and checking plans in connection with terminal grain elevators, C. D. Howe & Company, Port Arthur, Ont. (*Jr. 1925.*)

References: W. H. Souba, R. B. Chandler, J. M. Fleming, B. A. Culpeper, M. W. Jennings, M. J. Spratt.

ROSS—DONALD GRANT, of Saint John, N.B., Born at Saint John, N.B., May 13th, 1896; Educ., B.Sc., Dalhousie Univ., 1922; 1922-23, instr'man., Nova Scotia Highway Board; 1923-25, transmission line constrn., Armstrong Whitworth Co., Newfoundland; 1925-31, chief of party, Fraser Brace Engrg. Co. Ltd., hydro developments at Chelsea Falls and Paugan Falls, Que., and plant engr., Fifteen Mile Falls, Vermont; at present, asst. engr., Saint John Harbour Commnrs., Saint John, N.B. (*Jr. 1924.*)

References: F. S. Small, J. B. D'Aeth, J. H. Brace, C. E. Fraser, A. Gray, V. S. Chesnut.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

GREGORY—HURD ANTHONY FORBES, of Shawinigan Falls, Que., Born at Fredericton, N.B., Oct. 13th, 1902; Educ., B.Sc., (Elec.), McGill Univ., 1927. B.A. (Hons. Maths.), Univ. of Bishop's College, 1923; 1924-25, dftsman., St. Lawrence Paper Co., Three Rivers; 1926 (4 mos.), elect'l. gang, Canada Paper Co., Windsor Mills, Que.; 1927 (4 mos.), engr. on constrn., Murray Bay Paper Co.; 1927-30, control dept., Anglo-Canadian Pulp & Paper Co., Quebec. 1930-31, mill efficiency engr. with same company; at present, engr., Aluminum Company of Canada, Shawinigan Falls, Que. (*S. 1926.*)

References: P. S. Gregory, R. H. Mather, C. V. Christie, L. B. Kingston, F. T. Cole, E. Brown.

HARDCASTLE—SYDNEY, of Montreal, Que., Born at Liverpool, England, Feb. 12th, 1902; Educ., B.A.Sc. (Civil), Univ. of Toronto, 1924; 1921 (summer), rodman, Speight & Van Nostrand, Toronto; 1922 (summer), instr'man., Frank Barber & Associates Ltd., Toronto; 1923 (6 mos.), foreman and field engr., Sullivan & Freed, contractors, Toronto; 1924-25, dftsman., 1925-31, field engr., erection dept., and Feb. 1931 to date, designer, structl. design and estimating dept., Dominion Bridge Company, Limited, Montreal, Que. (*S. 1920.*)

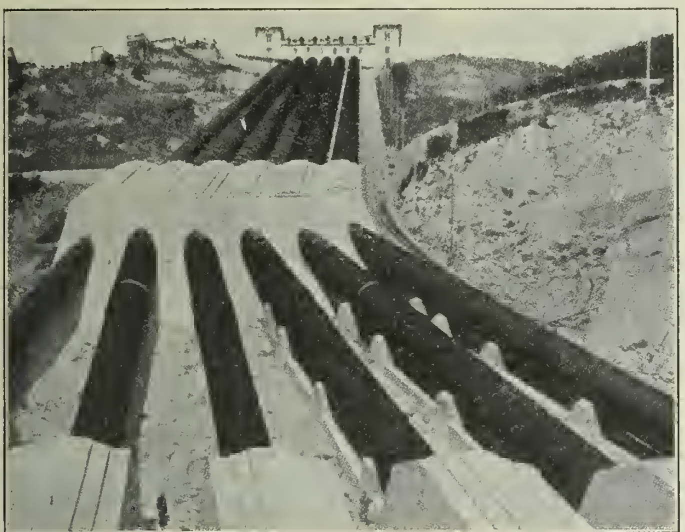
References: D. C. Tennant, G. G. Clarke, D. B. Armstrong, F. P. Shearwood, F. Newell, R. S. Eadie.

MILLER—JOHN JAMES HUTCHISON, of 44 Sunnyside Ave., Westmount, Que., Born at Toronto, Ont., May 24th, 1904; Educ., B.Sc., (Mech.), McGill Univ., 1925; 1925 to date, with Northern Electric Company, Limited, as follows: 1925-28, plant dept., plant estimating, and alterations, bldg. inspection; 1928-29, bldg. engr., acting as company representative on constrn. of new warehouses at Winnipeg and Vancouver; 1930 to date, plant engr. in charge of power houses, permanent fixtures, etc. (*S. 1923.*)

References: J. S. Cameron, J. D. Hathaway, W. H. Eastlake, H. Miller, W. C. Adams, C. M. McKergow, A. R. Roberts, J. J. Humphreys.

The Cardano Water Power Plant

The Societa Idroelettrica dell'Isarco, of Milan, has recently completed a large hydro-electric power station at Cardano, a village about three miles from Bolzano in northern Italy. The station works under a total head of about 541 feet and has at present an installed capacity of 270,000 h.p. (200,000 kw.), the annual output being equal to 550 million kw.h. The plant utilizes the water of the River Isarco, which rises in the Brenner Alps near the Italian-Austrian frontier. The water



is collected by means of a large dam and forebay, whence it passes through a tunnel to a surge tank, thence through the penstocks to the power house.

The forebay has a storage capacity of 63,828,000 gallons; it is located at a height of just over 1,500 feet above sea level and the tunnel is ten miles in length.

There are six penstocks. Five of the pipes, one for each turbine, are about 1,082 feet in length and they vary in inside diameter from 9 feet 2¼ inches down to 6 feet 2¾ inches, the static head being approximately 527 feet. The sixth pipe supplies the water for the turbo-generator set generating power for the operation of the electric trains on the Brenner railway. Five Francis vertical-shaft turbines each develop 45,000 h.p. at 242-250 r.p.m. Two 500-h.p. Pelton turbines were built to work at 500 r.p.m. for the supply of the power required for the station services, while three 14,700-h.p. 250-r.p.m. Pelton turbines are used to supply the railway.—*Electrical Review.*

The Electrical Testing Laboratories of New York have prepared a critical history of the development of rigid conduit, which has just been published by the Trade Extension Committee of the Rigid Conduit Section of the National Electrical Manufacturers Association. The book describes the various attempts made to eliminate hazards that developed in the early days when slightly protected wiring was buried behind plastered walls, in damp places and in positions subject to mechanical abuse. It points out the trial and failure of pasteboard and thin wall metal tubings of various types; the attempt to use a wood lined metal tubing and finally the successful employment of heavy wall mild steel conduit with suitable protective coatings which was approved by the first National Electric Code in 1897, and which has been employed to the present day with practically no changes in form or characteristics. Copies of the report may be secured by writing to George H. Sicard, Secretary, Rigid Conduit Section, National Electrical Manufacturers' Association, Utica, N.Y.

The Airship Service in Britain

The decision at which the government has arrived in regard to the Airship Service has commanded the almost unanimous approval of all parties in the House of Commons.

It may now be, perhaps, a fitting occasion to revert to an aspect of the building of these great airships to which, up till now, less attention appears to have been paid than is deserved. When they were built, the largest previous vessels were little more than half the size of what was proposed, and the methods of design, construction and operation employed in arriving at this great increase were, in many respects, radically new. The measures taken to supply the necessary fresh data were correspondingly far-reaching. All points on which information was wanted in regard to the mechanical construction, and some even in regard to metallurgical treatment, were settled by prolonged series of experiments, in the course of which the ships took some eighteen months more to build than had been anticipated. The mechanical result was according to the highest expectations. As everybody knows who has been on new ships, it is seldom that they are entirely free from what may be called structural stresses, and perhaps the best evidence of the perfection of the mechanical design and workmanship of this enormous structure, over 700 feet long and with a maximum diameter of over 130 feet, was the testimony of the highest authority in this country that the R.101 was the first airship ever built which showed no trace of creaking or vibration. This remarkable result, of the authenticity of which there can be no possible doubt, sums up over-all the care and the success with which the Ministry had tested its mechanical conclusions before putting them into practice, and when the ship took the air the same cautious and scientific spirit directed its earliest operations. In many respects, indeed, the ship had already proved itself, but, as we pointed out when it was first launched, the prospect of further progress in the development of this and other airships seemed to lie mainly in the continuance of the careful exploratory policy that had been pursued until then. It is easy after the event to see what changed this policy. The initial experiments on the vessel were made for the paramount purpose of discovering weaknesses if they were to be found, and thereafter of remedying them.

The catastrophe occurred when the vessel was used prematurely, not to discover weaknesses but to demonstrate achievement. It was known that there was something abnormal in the behaviour of the vessel, but it was decided to proceed without first clearing it up, presuming that it could not be a matter of serious consequence. It is idle now to speculate whether this presumption was adopted spontaneously by the brilliant and prudent staff who for five years had been leaving nothing to chance, or to some less scientific influence. The mistake that was made was in trusting to clearing up an obscurity in the vessel's action by the help of experience which had still to be acquired.

Having regard to the record of the Ministry's technical staff, the balance of probability seems to lie in favour of the hypothesis that they were at the least instigated to waive the more prudent practice of their earlier operations. If this be so, it adds great force to the demand for strengthening the scientific authority of the technical staff, as was in effect suggested by Sir John Simon. A clear distinction must be drawn between matters in regard to which practice is available to resolve questions of doubt and uncertainty, and those in which the practice has still to be acquired. When once the question has passed into the latter stage, it may well be that the supreme decisions should be made by the administrative staff. Until that point is reached, on the other hand, nothing should be done to weaken not only the authority, but the responsibility, of the scientific and technical staff.—*Engineering.*

The Garlock Packing Company, Palmyra, N.Y., have published a folder describing and illustrating Garlock 430 Chevron Packing, a new patented product of the company, which, it is stated, solves satisfactorily the problem of packing the rams and plungers of accumulators, presses, pumps and other heavy duty hydraulic equipment. Copies of the folder may be obtained from the company at the address shown above.

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Situations Vacant

ROAD ENGINEER, with sales ability, speaking French and English fluently, for sales and inspection work in province of Quebec, by a Canadian company manufacturing and marketing road materials. Must be university graduate, not over 30 years of age. Permanent position with good prospects. Apply by letter giving qualifications, references, etc., to Box 729-V.

CHEMIST. Electrolytic chemist for laboratory work. Must have practical experience in this particular class of work. Location, Manitoba. Apply giving full information regarding experience to Box No. 731-V.

Capital to Invest

BUILDING CONSTRUCTION EXECUTIVE, located in New York city, Canadian born graduate McGill University, wishes to locate in Canada, preferably Vancouver, B.C. Will invest $20,000 and services in established construction concern where capital is needed for expansion. Fifteen years field and office experience. Past three years general manager of construction. Apply to Box No. 230-W.

ELECTRICAL ENGINEER. College graduate with about seven years designing experience with large manufacturer of electrical apparatus; would consider junior partnership with electrical contractor or electrical repair firm. Could invest several thousand dollars. Correspondence invited. Apply to Box No. 579-W.

Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., R.P.E. (Ont.), 15 years experience, available on short notice. Experienced surveys, draughting, reinforced concrete design, municipal engineering, construction work, inspection, estimating. Apply to Box No. 107-W.

CIVIL ENGINEER, university graduate 1926, desires employment as junior engineer or instrumentman on construction work. Experience, resident engineer on railway construction, miscellaneous surveys. References. Available any time. Apply to Box No. 149-W.

CIVIL ENGINEER, B.Sc., age 34, is open for a position as construction engineer in charge of construction of hydro-electric plants or paper mills; designing engineer of hydro-electric developments or paper mills. Willing to make small investment. Apply to Box No. 157-W.

ELECTRICAL ENGINEER, B.Sc., McGill 1926. Five years experience in the design of switchboards, layouts and wiring diagrams. Considerable experience in high and low tension switchgear design. Fifteen months experience in switchboard estimating. At present employed; available on short notice. Correspondence invited. Apply to Box No. 247-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.

ELECTRICAL ENGINEER. Graduate '25, wide experience in hydro-electric power stations, desires position on power plant design or related work. Apply to Box No. 278-W.

Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., Canadian, R.P.E., Nova Scotia, 21 years engineering experience, both field and office, in railway, highways, foundations, concrete structures, water power and conservation, electric transmission lines, etc., experience comprising both surveys and construction, desires employment. Single. Will go anywhere. Working knowledge of French and Spanish. Available immediately. Apply to Box No. 327-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. Also some experience in ventilating and heating work and calculators. Accustomed to structural design and details. Good references. Present location Montreal. For interview apply to Box No. 329-W.

CIVIL ENGINEER; age 48; married; A.M.E.I.C., R.P.E., Ontario and New Brunswick; 32 years experience in municipal engineering, on roadways, sewers, waterworks and buildings, desires position with either municipality or as engineer superintendent with contractor. Ten years with City of Toronto, construction engineer on roadway work; four years consulting engineer; three years engineer in charge of construction work; one year resident engineer, Dept. of Public Highways. Available immediately. Maritimes or Ontario preferred. Apply to Box No. 336-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., R.P.E. Ont., with twenty-four years experience embracing dams, wharves, grain elevators, foundations, pile driving, highways, municipal engineering, water power surveys, road locations, inspections and estimating, is open for engagement as engineer or superintendent in construction, operation or maintenance. Location immaterial. Apply to Box No. 358-W.

CIVIL ENGINEER, graduate, age 32, A.M.E.I.C. Ten years experience; seven years on design, construction, erection work and maintenance of paper mill and mine buildings and machinery. Three years on hydro-electric work in charge of surveys and field investigations; associate hydro-electric engineer, U.S. Engineers, on office investigation, design and estimates; desires permanent position in Canada. Apply to Box No. 362-W.

STRUCTURAL AND CIVIL ENGINEER, Jr.E.I.C., age 31, married. Was instrumentman and structural engineer on erection of Royal York hotel, and asst. resident engineer on James Bay Extension, T. & N.O. Rly. Experience includes structural, civil and mechanical draughting and all kinds of instrument work and special work. Qualified as captain in military engineering, R.M.C., Kingston. Available anywhere in Canada, preferably Toronto, for any kind of work. Apply to Box No. 377-W.

ENGINEER ADJUSTER, MANAGER, desires to connect with an industrial concern or department which is not showing a proper return with a view to suggesting more efficient methods and eliminating bad debts. Apply to Box No. 411-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate. Experience as instrumentman on city and railroad construction, desires to enter structural or hydraulic field. Available at once. Will go anywhere. Apply to Box No. 467-W.

Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., age 39, with wide experience on design and construction of reinforced concrete structures, desires position. Apply to Box No. 475-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, Jr.E.I.C., B.Sc., '26. Ten months experience in pulp and paper steam control. Four years experience in detail and design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

CIVIL ENGINEER, B.A.Sc., '29, with experience in supervision of construction and general office engineering, desires permanent position with contractor or engineer. Available at once. Apply to Box No. 524-W.

CIVIL ENGINEER, A.M.E.I.C., with twelve years experience embracing survey and construction, railway, hydro-electric and highways, foundations, pile driving, municipal engineering, water power surveys, road location, inspection and estimating, is open for engagement as resident engineer on construction or other responsible position. Experience comprises both office and outside work. Available immediately. Apply to Box No. 527-W.

MECHANICAL, CONSTRUCTION, AND DESIGNING ENGINEER, with special training in hydro-electric power development, underground steam distribution systems, and the operation of large electrical machinery. Active work desired. Apply to Box No. 528-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc., E.E., 1931, desires to become associated with some branch of electrical engineering offering good opportunity for advancement. Sixteen months experience in draughting of electrical apparatus with large manufacturing concern; including layout work, and making of detail working drawings. Bulk of experience with industrial control apparatus. Location immaterial. Available on short notice. Apply to Box No. 532-W.

ELECTRICAL ENGINEER, married, graduate of McGill University, desires position in Ottawa, Montreal or Toronto. Experience includes four summers with a building concern as instrumentman and assistant engineer, two and one-half years with the Canadian Westinghouse Co., this time being distributed between tests, design and sales. At present employed but available on short notice. Apply to Box No. 533-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C., age 32. Seven years general experience in hydro-electric power investigations and construction. Has been in charge of high power transmission lines location, also in charge extension surveys. Experience in office and field. Thorough knowledge of French. Best of references from former employers. Apply to Box No. 537-W.

STRUCTURAL ENGINEER, A.M.E.I.C., B.A.Sc. Wishes to join established firm of consulting engineers. Age 37. Married. Ten years experience design of reinforced concrete and steel on buildings. Two years practical contracting experience. Apply to Box No. 540-W.

CIVIL ENGINEER, McGill '20, A.M.E.I.C., P.E.Q., age 31, single. Experience includes general engineering, especially reinforced concrete work, and eight years of pulp and paper mill construction and layout. Best of references. Available on short notice. Apply to Box No. 547-W.

Situations Wanted

UNDERGRADUATE ENGINEER, S.E.I.C., junior year standing (Sask.), desires work to complete course. Electrical or mechanical work preferred. Apply to Box No. 553-W.

ELECTRICAL ENGINEER, S.E.I.C., graduating 1931, desires employment in electrical engineering. Sixteen months draughting experience on electrical machines with a large manufacturing company. Work included making layouts and detail working drawings. Available immediately. Location immaterial. Apply to Box No. 555-W.

A.M.E.I.C., graduate of University of Toronto, 1915. Building engineer and superintendent, with considerable experience as installation, sales and promotion engineer. Present connection, four years in responsible position with large utility corporation. Open for immediate connection where he can use his past experience. Location immaterial. Apply to Box No. 560-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, S.E.I.C., graduating this year. Experience in railway maintenance, and instrumentman on location and construction. Desires to enter any branch of civil engineering or industrial work affording technical experience and an opportunity for increasing responsibility. Will go anywhere. Apply to Box No. 567-W.

CIVIL ENGINEER, A.M.E.I.C., ten years experience as mining engineer of a colliery, six years railway construction, including location, construction, bridge construction, and maintenance. Also one year on hydro transmission lines; one year government land surveys. Would consider position in any branch of construction, as resident engineer or instrumentman. Apply to Box No. 569-W.

CIVIL ENGINEER, B.Sc. McGill Univ., Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

MECHANICAL ENGINEER, A.M.E.I.C., experience in the design and maintenance of steel mills, zinc and sulphuric acid plants, cement plants; power house layouts; familiar with shop practices and costs, desires connection. Apply to Box No. 571-W.

YOUNG ENGINEER, Jr.E.I.C., experienced in design, details and erection of steel and concrete structures. Also a good theoretical and practical knowledge of steam, hydraulic and I.C. engine power plant. Good practical mechanical and electrical engineer, able to operate and maintain any type of machinery or power plant. Location immaterial. Apply to Box No. 572-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., (Univ. of B.C., '30), Undergraduate experience in pulp mill. One year's experience, Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

TEMPORARY EMPLOYMENT wanted by an engineer with wide experience in the design and operation of steam power plants and heating system. Apply to Box No. 584-W.

CIVIL ENGINEER, S.E.I.C., 1931 graduate, age 26. Experience in draughting, designing and estimating in structural engineering. Desires to enter structural, hydraulic (including hydrographic) or municipal field affording technical experience. Location immaterial. Available at once. Apply to Box No. 593-W.

ELECTRICAL ENGINEER, graduate Univ. of Alberta, '31, with excellent record, desires connection with electrical manufacturing firm, power or communication company. Good general experience includes one summer railway construction, two summers geological surveys in oil fields of Alberta, planetable topographer and asst. geologist. Available immediately. Apply to Box No. 596-W.

MECHANICAL ENGINEER, age 22, graduate '31, Univ. of Alberta, experience as draughtsman and instrumentman-inspector, is open for a position. Location immaterial. Apply to Box No. 598-W.

MECHANICAL ENGINEER, S.E.I.C., age 21, four years mechanical engineering, Queen's University, desires permanent employment. Experience in wood work, machine shop work, draughting and surveying. Location immaterial. Available at once. Apply to Box No. 600-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building, desires change. Location immaterial. Available on one month's notice. Apply to Box No. 601-W.

ELECTRICAL OR MECHANICAL ENGINEER, B.Sc., '31, S.E.I.C., desires employment which will give experience and lead to advancement. Two summers in a large communication company, including draughting, switchboard and surveying. Available on short notice. Will go anywhere. Apply to Box No. 606-W.

CHEMICAL ENGINEER, S.E.I.C., University of Alberta '30, desires a position in any industry with chemical control. Experience includes three summer vacation periods of five months each as assistant chemist, and ten months as chief chemist with a cement company. Age 29. Single. Available at once. Apply to Box No. 609-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. (C.E.), Univ. of Man. '31, desires temporary or permanent employment on engineering work. Twenty months experience in summers as chainman, rodman and instrumentman on railway grade and bridge construction; also as inspector on reinforced concrete highway bridges. Salary and location immaterial. Available at once. Apply to Box No. 614-W.

DESIGNING ENGINEER, industrial building designer, Jr.E.I.C., age 31, married, capable of taking responsible charge of the structural design and architectural details of steel or concrete manufacturing plants or power houses, also has had considerable experience in the design of office buildings, etc., desires reasonably permanent position. Very highest references from present employers. Location immaterial. Apply to Box No. 615-W.

MECHANICAL ENGINEER, Jr.E.I.C., 5 years apprenticeship on general mechanical engineering; 10 years experience on heating and ventilating and mechanical equipment of buildings. Design, draughting and production. Desires change. Capable of taking charge of engineering department. Further particulars if required. Apply to Box No. 616-W.

POWER ENGINEER, M.E.I.C., age 42. Married. Thoroughly conversant with electrical, steam, mechanical and industrial engineering, desires executive position with large industrial, power or financial corporation. Best of references as to ability and positions held. Apply to Box No. 617-W.

CIVIL ENGINEER, Jr.E.I.C., B.A.Sc. '21, age 35, married. Five years designer and estimator with well-known firm of industrial builders; two years detailing, designing and estimating structural steel for bridges and buildings, also survey and municipal experience. Open for position immediately, will go anywhere. Apply to Box No. 618-W.

CIVIL ENGINEER, A.M.E.I.C., graduate '23, married, eight years municipal engineering experience. Sewerage and sewage disposal, water works, street pavement, etc. Also some experience highway construction. For the past three years engaged by firm of consulting municipal engineers. Desires permanent position. Location immaterial. Available immediately. References. Apply to Box No. 624-W.

ELECTRICAL ENGINEER, B.Sc., N.S. Tech. Coll. '31. Experience in design and construction of rural distribution lines, trouble shooting, inventories and general office work, desires position with public utility or industrial plant. Location immaterial. Available at once. Apply to Box No. 628-W.

The Dominion Hoist and Shovel Company, Ltd., which is jointly owned by the Dominion Bridge Company, Ltd., and Dominion Engineering Works, Ltd., recently completed the first "Dominion Gopher" gasolene shovel manufactured in Canada. The new machine has a bucket of one yard capacity and was built in accordance with the blue prints and specifications of American Hoist and Derrick Company of St. Paul, Minn., which is the American associate of Dominion Hoist and Shovel Company, Ltd. All casting, machine work and assembly was completed either in the Lachine or Longueuil shops of Dominion Engineering Works, Ltd., and in the opinion of experts, the quality and detail of the work are in every way equal, if not superior, to that turned out by the American associate company. It is stated that the manufacture of units of large capacity will be undertaken in the future. In addition, the company will make locomotive cranes, revolving cranes and contractors' hoists.

It is understood from officials of the parent companies that the "Canada First" policy of the Bennett government was an important factor in the decision to undertake the manufacture and sale of this equipment in Canada. In this connection the Dominion Bridge Company recently formed a new subsidiary, Canadian Pipe and Lining Company. This company will make concrete lined steel pipe in accordance with Hume specifications. Carrying the policy of diversification further, Dominion Engineering Works, Ltd., has recently concluded arrangements for the manufacture in Canada of Dominion Farrel-Sykes reduction gearing units.

Link-Belt Company, 910 S. Michigan Avenue, Chicago, Ill., are planning the preparation of a series of data sheets, one to be issued each month. The information and charts presented in this series of sheets will cover phases of material handling and power transmission technical data about which little has been published. Data Sheet No. 1, entitled "Material Handling and Power Transmission" and giving belt conveyor trajectory chart and data, and Sheet No. 2, containing data on belt conveyor horse power and stress, may be obtained from the Link-Belt Company, Chicago, Ill.

Vancouver Machinery Depot Ltd., 1155 Sixth avenue west, Vancouver, B.C., has recently published a booklet entitled "Atlas Excavators" which describes and illustrates this equipment. The company first constructed full revolving half-yard gasoline driven shovels in 1930, and have a number of machines of this size under construction at the present time. Copies of the booklet may be secured from the company at the above mentioned address.

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The Upper Notch Automatic Hydro-Electric Power Plant

R. F. Legget, Jr.E.I.C., Resident Engineer,
P. J. Croft, Electrical Engineer,
J. R. Desloover, Co-ordinating Engineer,
Power Corporation of Canada, Ltd.

SUMMARY.—The Upper Notch plant is located on the Montreal river, 15 miles southeast of Cobalt, northern Ontario, in the centre of Canada's greatest mining district. The equipment consists of two 48-foot head, 6,500 h.p. 125 r.p.m. turbines; and two 6,500 kv.a., 11,000-volt, 25-cycle generators. The switchgear and control equipment are fully automatic and are designed for possible remote control from a distant supervisory point. The switchgear is of the metal clad type. The station output is transformed to 110,000 volts by three 4,500 kv.a. transformers and it is fed into an extensive transmission network by means of a line 32.7 miles long. The existing water storage developments and the possibilities for additional conservation projects on the Montreal river are worthy of note. The geological formation of the Montreal river is quite unusual. The difficulties of unwatering the river and concreting under very severe winter conditions constituted the major construction problems. The plant has been designed and constructed for the Northern Ontario Power Company, Ltd., by the engineering and construction divisions of the Power Corporation of Canada Ltd.

The Era of Automatic Plants

Automatic hydro-electric plants have definitely passed the experimental stage. A few small units were first equipped for automatic operation some ten years ago; since that time progress in the art has been rapid and today no unit is too large to be so controlled.

The Upper Notch plant, recently put into operation by the Northern Ontario Power Company, is one of the largest fully-automatic stations in Canada and represents the latest practice in this type of control. The extensive transmission network to which the plant is tied serves the important mining areas of Timmins, Gowganda, Kirkland Lake, Cobalt, Rouyn and other districts in northern Ontario and Quebec.

The outstanding features of a mining load are its high load factor, averaging around 90 per cent, and its most exacting requirements as to continuity of service. That the power supply must not fail is a cardinal rule in the mining country.

In designing the Upper Notch plant it was realized that a fully-automatic power station would not only offer the usual advantages of such control, but would also provide a standard of protection and reliability difficult to realize in a manually operated plant.

Hydraulic Features of the Montreal River

The area of the drainage basin tributary to the Upper Notch plant is 2,550 square miles. Most of the watershed is wooded and it is covered by a great number of lakes and swamps, a condition which has a considerable bearing on the regulation of the river.

The annual run-off at the plant averages fourteen inches (2,550 c.f.s.), which is rather low, when compared to values obtaining in most parts of the province of Quebec. In spite of the low run-off available, the Montreal river is, comparatively speaking, a well regulated stream. The present storage capacity is 13 billion cubic feet (297,000 acre feet), and it is expected that further conservation projects will increase the total available storage to 25 billion cubic feet (576,000 acre feet).

With this amount of storage used in the most efficient manner, the ultimate regulated flow is expected to reach 2,000 c.f.s. (0.78 c.f.s. per square mile), which is quite a high figure for a river of that size with an average yearly run-off of fourteen inches (1 c.f.s. per square mile).

The Upper Notch plant constitutes the first stage of a two-stage development on the lower portion of the Montreal river. The Lower Notch, or second stage, which will be developed at some future date, is capable of producing 40,000 h.p. at 67 per cent load factor. There already exist on the Montreal river four power plants having an ultimate aggregate capacity of 27,000 h.p. and the stream, when fully harnessed, will develop over 80,000 h.p. in six separate plants.

Geological Features of the Montreal River Valley

The developed head at the Upper Notch is 48 feet and the available undeveloped head at the Lower Notch, eleven miles downstream, is 148 feet. Studies were made to determine the advantages, if any, of developing the entire head of 206 feet in one stage at the Lower Notch, but this proposal was found unsuitable, partly on economical grounds and partly on account of the peculiar geological formation at the Lower Notch.

A geological fault runs up the valley of the Montreal river and close to the Lower Notch it joins the main Temiskaming fault running down the lake of that name. The Lower Notch itself is a gorge about 50 feet wide, caused by the fault, and diamond drilling operations have so far failed to reveal any considerable decrease in the width of the fault for some distance below the river bed.

Under such conditions the building of a dam, capable of creating a 200-foot head of water behind it, would involve problems difficult, though not impossible, to solve.

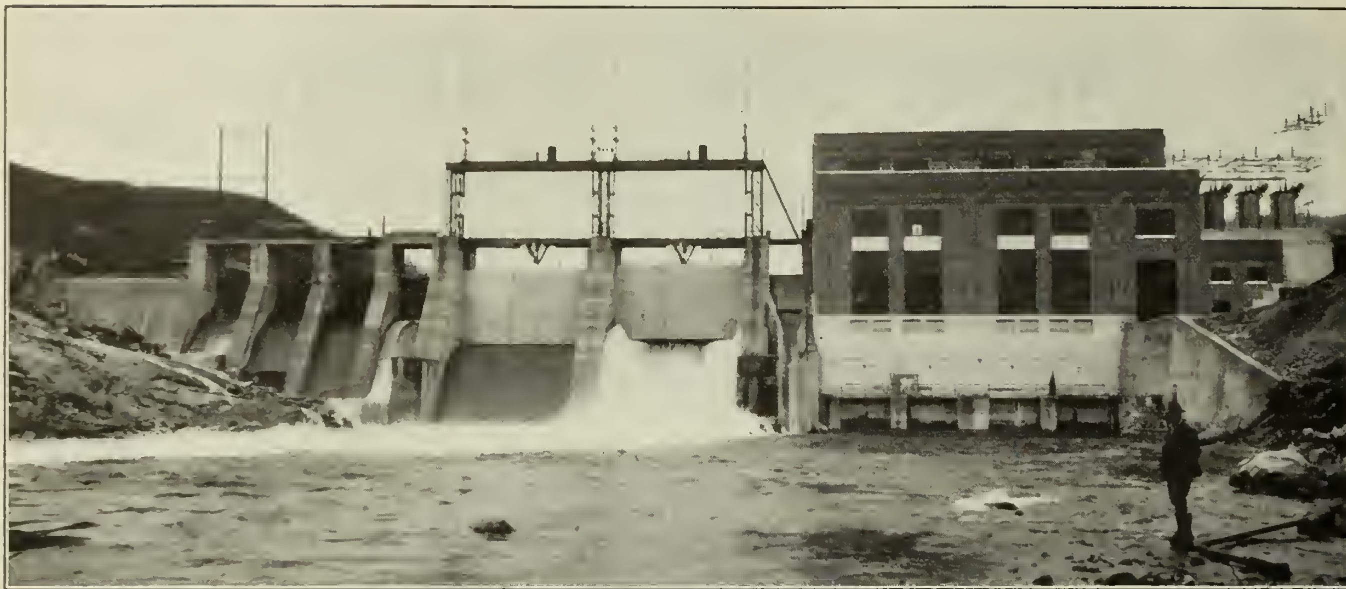

Fig. 1—General View of the Upper Notch Hydro-Electric Generating Station.

By adopting the multi-stage scheme, the difficulties which the lower site presents have been considerably reduced while the upper site presented no unusual foundation problems.

General Arrangement of Structures

The general layout of the development is quite simple, as shown by Fig. 1. The dam is a continuous, concrete, gravity structure, founded on bedrock and built at right angles to the river. It contains about 20,000 cubic yards of concrete and has a total length of 500 feet sub-divided as follows:—

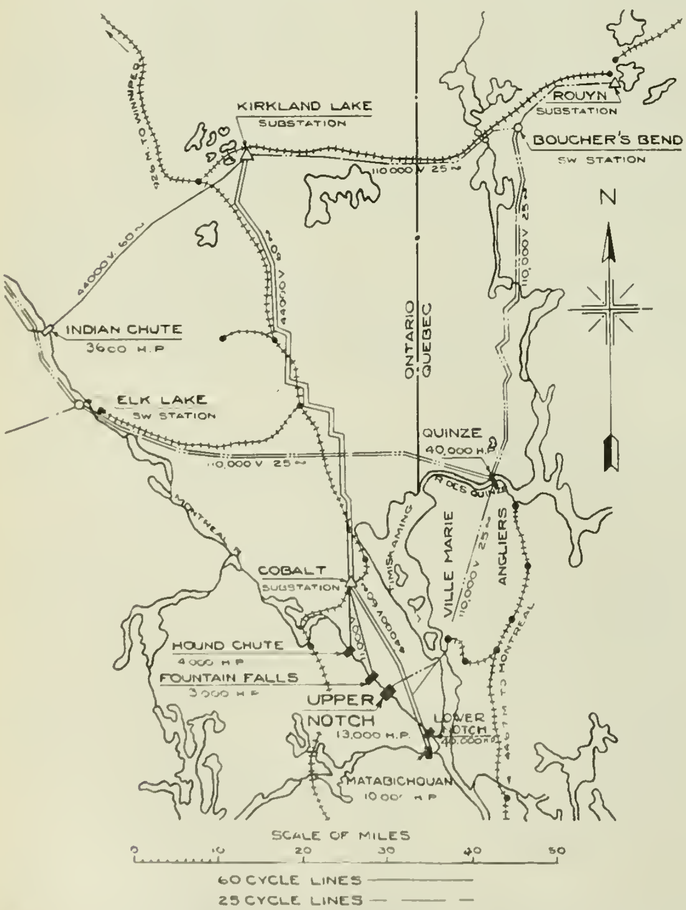

Fig. 2—Location Map of the Upper Notch Plant—Showing Part of the Mining District Served.

1. Beginning at the extreme east end of the dam, a cut-off corewall, 40 feet long.
2. A gravity section, 47 feet long, on which are located the transformer bank and runway to the gatehouse.
3. The power house section—100 feet long.
4. A 10-foot wide adjustable log chute.
5. A sluiceway section consisting of two 40-foot by 24-foot roller type sluicegates.
6. Four 15-foot wide stoplog openings over which are located a bridge and tracks for an electrically operated stoplog hoist.
7. An emergency spillway, 50 feet long, with crest at Elevation 784 (normal high water level).
8. A fishway pier and fishway, and, finally, at the extreme west end, a cut off wall, approximately 50 feet long.

The maximum discharge capacity of the sluicegates is 44,000 c.f.s. These are sheeted on the downstream side and electric heaters have been installed in the body of the gates and in the gains to facilitate winter operation.

The stoplogs are handled by means of an electrically driven hoist, which travels over the four stoplog openings.

The overflow structures have been designed for a maximum combined discharge capacity of 65,000 c.f.s. which corresponds to 25 c.f.s. per square mile of drainage, a figure which is conservative in view of the effect of the large storage reservoirs in reducing the flood flows.

General Arrangement of Power House

Referring to Fig. 3 and Fig. 4, it will be noted that the design is of the conventional type and that economy of space in the generator room is a feature.

The turbine intakes are divided into two openings, each equipped with a headgate and a set of trash racks and emergency gates. The headgates are hoisted electrically and may be operated from a set of control switches on the switchboard. The racks and emergency gates are handled by the 35-ton gatehouse crane.

The spiral scroll cases are of concrete and unlined and the draft tubes are of the elbow type and equipped with stoplog gains in order that they may be unwatered when required.

Turbines and Generators

The 6,500 h.p. turbines have Francis type cast iron runners. The guide bearings are lined with lignum vitae and are water lubricated.

The standard shifting ring and regulating cylinder method is used to operate the turbine gates.

The governors are located on the generator floor, but the pressure and sump tanks are mounted separately and the oil is pumped by motor-driven pumps installed near the tanks.

There is a complete pumping unit and tank for each machine and a spare motor-driven oil pump has also been installed. The three pumping units are interconnected and may be operated separately or in parallel.

The 6,500 kv.a. generators have direct-connected exciters. They have two guide bearings, and one thrust bearing, the latter supporting the weight of the generator, as well as the weight and thrust of the turbine.

The three bearings are lubricated by means of self-contained oil circulation systems operated from pumps geared to the generator shafts. Before entering the bearings the oil passes through oil coolers which are supplied with cooling water.

Each generator is equipped with a set of jacks which are normally used as automatic brakes to bring the unit to rest, but which may also be used to lift the entire unit sufficiently to permit the inspection or renewal of the thrust bearing parts. The jacks are oil-operated and form part of the automatic control.

In view of the fact that help may not be available immediately after a possible failure of the governors to keep the units under control, the generators have been designed to withstand operation at the runaway speed of the turbines (240 r.p.m.) for ten hours.

The principal dimensions and weights of the units are as follows:—

Maximum diameter of turbine runner....... 9.4 feet
Diameter of generator rotor................13.4 feet
Total weight of all revolving parts..........75 tons
Maximum overall diameter of generator.....19 feet

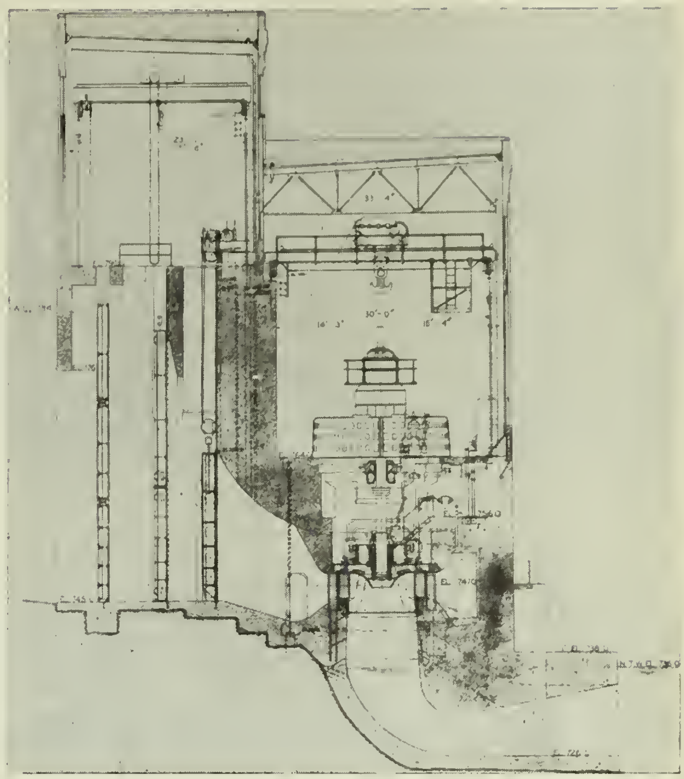

Fig. 3—Cross Section through Power House.

Switchboard and Switching Equipment

The switchboard is located at the east end of the generator room and consists of nine panels on which all the manual and automatic controls are mounted.

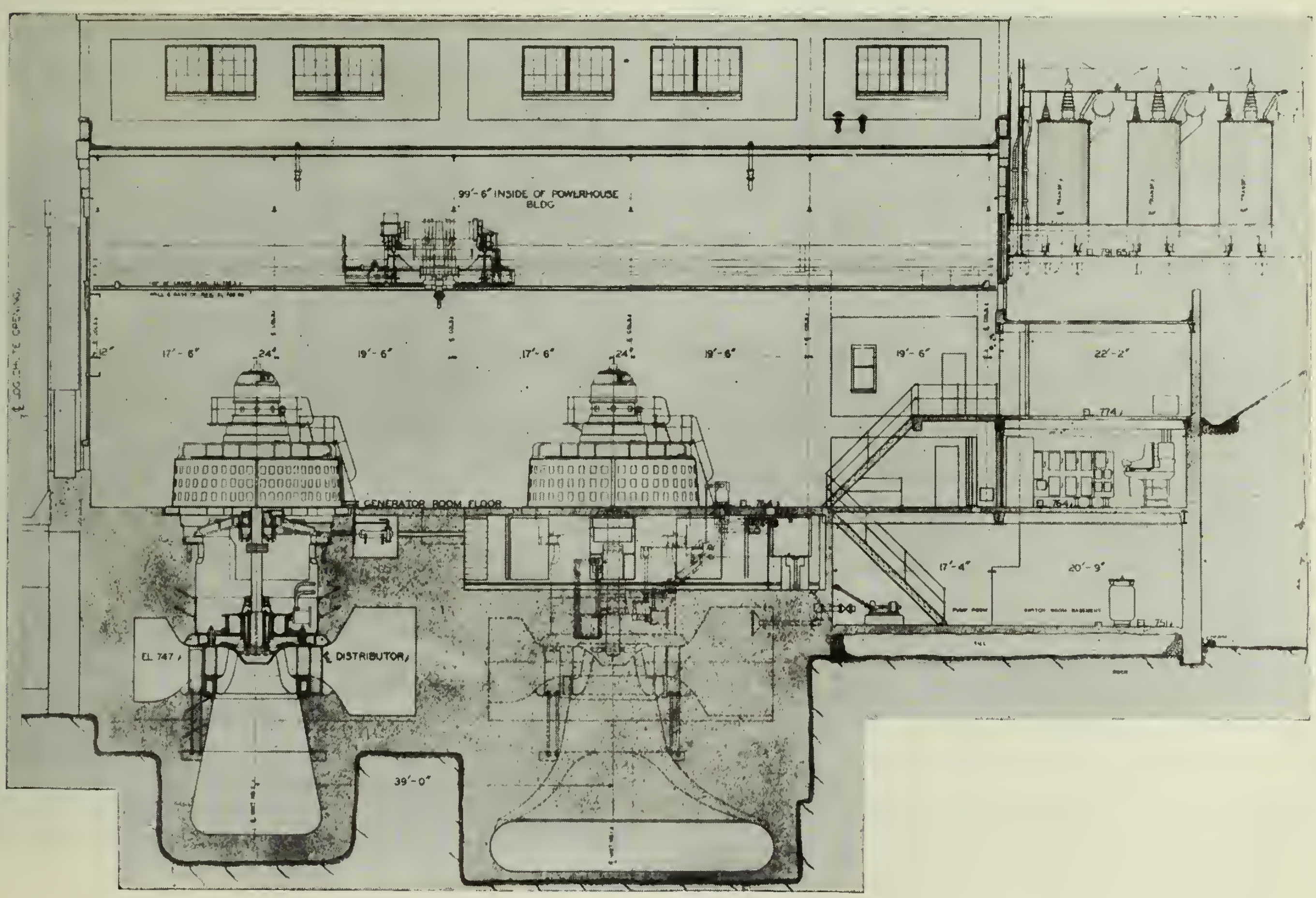

Fig. 4—Longitudinal Section through Generator Room and Switch Room.

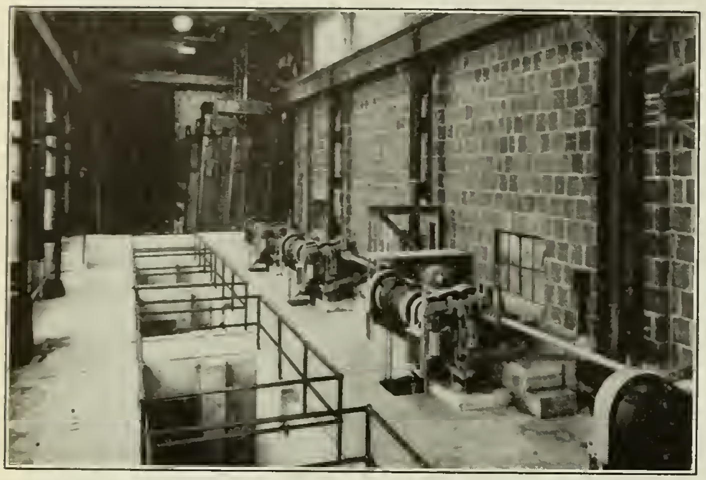

Fig. 5—View of the Gatehouse.

The equipment is described in more detail under "Automatic Operation."

The switchgear is installed in a separate room at the east end of the building. It is of the self-contained metal-clad type and apart from the station service transformer bus there is no bus work, either upon or in cells, anywhere in the plant. Four 250,000 kv.a. rupturing capacity oil circuit breakers are installed at present, one for each generator, one for the power transformers, and one for the station service transformer bank.

Transformers and Transmission Line

The transformers and the high tension switching structure are located outdoors. Three transformers are normally in service and a fourth is held as a spare. They are water-cooled and all oil and water piping enters the tanks through the bottom and is readily accessible from a tunnel located under the transformer platform.

The connections are 11,000-volt isolated delta to 110,000-volt grounded star.

The transformers may be disconnected from the outgoing line by means of an air-break switch, mounted on the switching structure.

The transmission line is 32.7 miles long and is strung with 286,800 c.m. A.C.S.R. on "H" frame wood pole structures. The average span is 450 feet. The telephone line is strung on the same structure and consists of two 20,870 c.m. special A.C.S.R. conductors.

Automatic Operation

The control apparatus in use at the Upper Notch is of the type known as "fully-automatic." Although as at present operated, the starting or stopping indication is given by an attendant, who throws up or down a small tumbler switch on the generator panel, the releasing of brakes, opening of turbine gates, bringing of the wheel to speed, matching of frequencies, and finally synchronizing and connecting to the line are fully-automatic and are beyond the control of the attendant until the full train of operations is completed.

Briefly, the train of operations for starting the plant is as follows:—The generator bus is kept alive at all times (even though both machines may be shut down), from the outer system, the transformer oil circuit breaker being kept closed. Station service is maintained from the generator bus, the breaker feeding the service bank being closed at all times. The main governor oil pump motors run only when required, and maintain pressure at approximately 175 pounds in the pressure tanks of both governors, under the control of a pressure relay and across-the-line starter.

The attendant, after checking all clearances, etc., as a precautionary measure, closes the small starting switch on the panel controlling the machine he proposes to start, completing a circuit through the coil of a master relay "3," provided that:—

(*a*) Generator windings are not overheated due to recent run at continued over-load.

(*b*) Annunciator lockout relays are not in the alarm position due to existence of some fault condition.

(*c*) Governor oil pressure is above the required minimum.

This circuit being completed, relay "3" closes a number of contacts, which control circuits to various parts of the automatic equipment. One of these circuits energizes the control solenoid of the generator brake valve, clearing the electrical interlock on the machine brakes. Another circuit energizes the control solenoid of the turbine governor, which in turn opens a number of oil ports, admitting oil pressure to:—first: the gate-latch cylinder, lifting the latch which locks the gates in the closed position during periods of shut down; second: to the generator brake valve, which, when the gate latch is fully lifted, closes and cuts off oil pressure from the brake cylinders releasing the brakes; and finally: to the pilot valve in the governor head itself, causing the governor slowly to open the turbine gates. A third circuit from relay "3" contacts closes a pilot relay on the pressure tank, short circuiting the pressure maintaining device previously referred to, and causing the pump to run continuously unloading automatically as required.

When the gates come to approximately the 1/10 position, the wheel begins to rotate, the gear-pump on the main shaft immediately taking hold of the lubrication requirements. After about two revolutions of the shaft, the oil stream appears in the gauge glass on the exciter platform, and after a further few seconds, appears also in the sight-flow indicators on the machine piping.

The unit continues to gain speed as the gates slowly open. At 65 per cent full speed, an element of the speed switch on the top of the exciter opens its contacts, clearing the lubricating oil and cooling water flow alarms, which, since they cause the unit to shut down, should the flow

Fig. 6—The Generator Room.

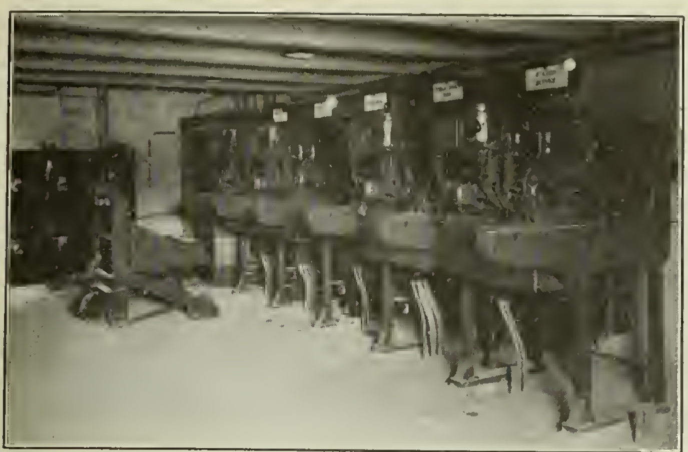

Fig. 7—Switchgear.

become inadequate, must of necessity be short-circuited during the start up, until the flow has been established in sufficient strength to hold their contacts closed.

As the machine gathers speed, voltage on the direct-connected exciter begins to build up, and at the exciter voltage of about 50 volts, a contact-making voltmeter relay (53) completes a circuit to the coils of two auxiliary contactors 40X and 41X on the field panel. These two contactors close their contacts, 41X closing the circuit to the field switch closing coil, and 40X closing the circuit to the lifting coil and field failure relay No. 40. The field switch now closes and the contactors drop out, 41X immediately and 40X after a delay long enough to allow the machine field current to build up and hold the field failure relay 40 in circuit.

The machine field is now excited and the main A.C. voltage builds up on the machine, the voltage coils of the various synchronizing devices becoming energized from the potential transformers connected to the machine leads. The motor driving the governor head begins to rotate, and the governor commences to regulate the speed of the unit. The voltage regulator commences to regulate the voltage of the generator, holding it steady when it reaches the normal value of 11,000 volts. The coils of the automatic synchronizing relays become energized, and the synchroscope begins to rotate at a speed corresponding to the difference between the frequency of the bus and that of the incoming machine.

By a patented system of relay connections, each time the synchroscope needle, travelling in a "Slow" direction, passes the zero-point of the dial, at a speed too great for synchronizing, a short impulse is given to the synchronizing motor of the governor to increase the gate opening. Conversely, each time the needle travelling in the "Fast" direction passes the zero-point too quickly for synchronizing, an impulse is sent to decrease the gate openings. The increase speed impulses are of longer duration than the decrease-speed impulses, so that the machine is rapidly brought to a speed just above synchronous speed, and slowed down by fine-step control. Finally, when the synchroscope needle, travelling in the "Fast" direction only, and at a suitably slow speed, approaches to within a short adjustable distance from the zero-point, a master contact is made to the auxiliary contactor, which closes the oil circuit breaker contacts on the point of synchronism. The auxiliary switches on the breaker disconnect the synchronizing relays as soon as the circuit is closed, and the machine is left running in synchronism, at full voltage and no load.

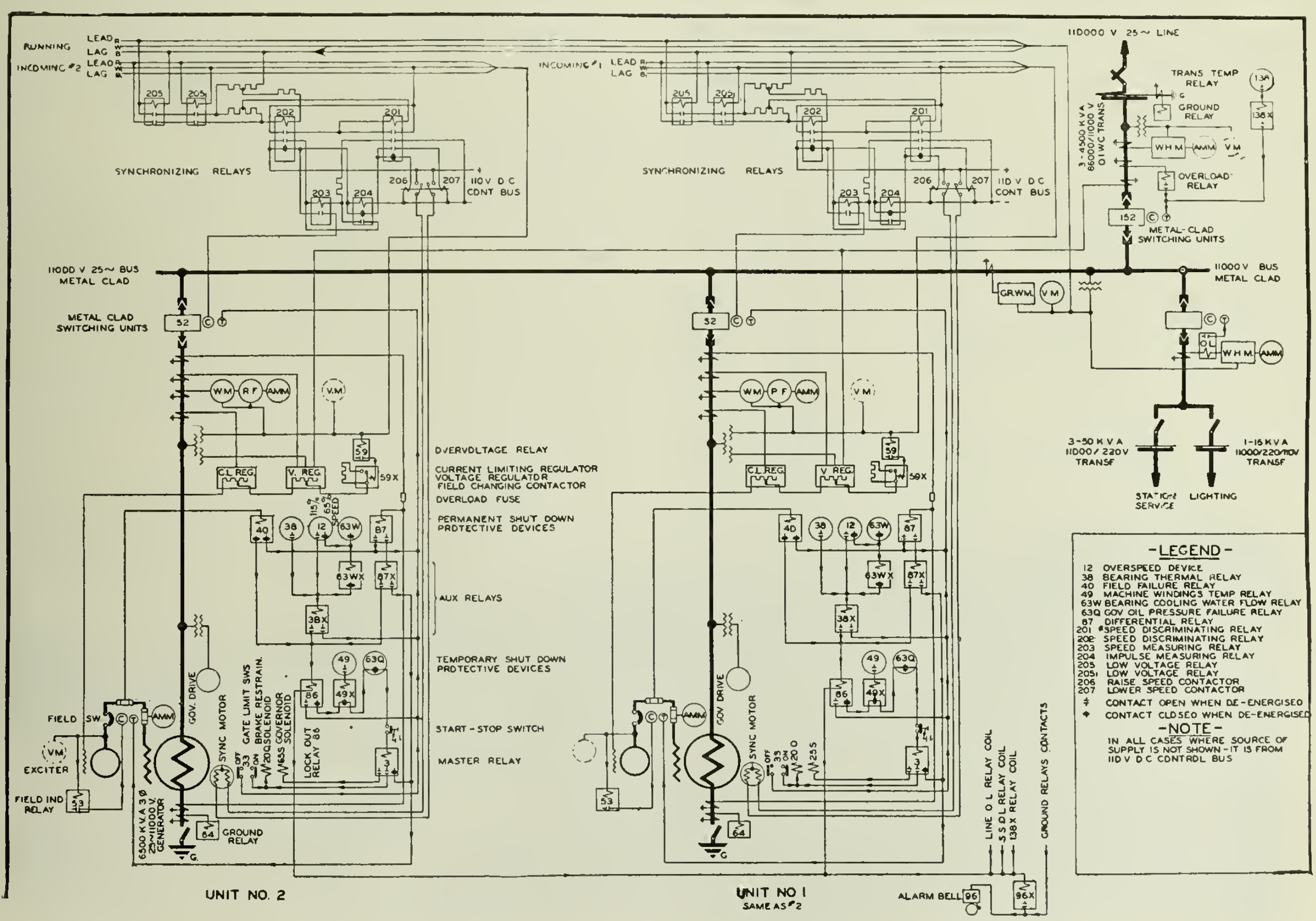

Fig. 8—Single Line Diagram of Automatic Features.

Fig. 9—General View of the Site on June 14th, 1929, showing First Camp Buildings.

At the same time, an auxiliary contact on the oil-circuit breaker sends a continuous impulse to the synchronizing motor to increase the gate opening. The machine takes up load until the governor comes up against its limit stop, which has been previously set for a fixed block of load. Shortly after reaching this point, the synchronizing motor is cut off by the limit switch on the speeder rod, adjusted to suit.

If, as at present, it is desired that the plant shall help in regulating the system, the automatic load-pick-up feature is disconnected, and the unit, after synchronizing, is left without load, until a suitable manual adjustment is made by the attendant. It is the intention that this feature will in the future be supervisorily controlled from a distant plant.

The unit, while running, is protected against a broad range of fault conditions, including winding-breakdown, grounds, overspeed, overvoltage, overcurrent, field failure, hot windings, hot bearings, oil flow failure, cooling water failure (thrust bearing) and loss of governor pressure. Overheated windings, due to a period at an overload not sufficient to operate the overcurrent relays, will cause the machine to shut down, as also will a loss of governor pressure from some cause; in either case the machine will re-start as soon as normal conditions are restored. A rise of voltage above 14,000 volts inserts a block of resistance temporarily into the field circuits, but does not shut down the machine. In all the other cases, the machine is tripped off the bus, shut down, and locked out, a warning signal summoning the attendant should he be away from the plant.

The normal shut-down is practically a reverse of the train described in detail for starting up. The attendant opens the tumbler starting switch, de-energizing the governor solenoid, and placing the pressure-system on the automatic pressure-maintaining cycle. The gates are brought promptly to the "Closed" position, and the gate latch descends into the "Locked" position. A limit switch on the gate rods trips the oil circuit breaker, and an auxiliary switch on the breaker trips the field switch. As soon as the gates are definitely closed, the latch locked and the oil circuit breaker open, the brake valve re-opens admitting oil pressure to the brakes, which bring the machine to rest after a coasting period of a few minutes.

The plant is equipped, in addition to the automatic features, with a full complement of manual gear of orthodox design, so that, if required, at any time, a unit may be started up by hand control or hand pump, and manually synchronized and connected to the line in the ordinary way.

Main Features of Construction

The site of the works was connected by a short spur line, built by the construction force, to the Silver Centre branch of the Temiskaming and Northern Ontario Railway on which runs a service of three trains per week. This was the only means of access to the job, the nearest road head being five miles distant.

Construction work started on July 1st, 1929, when the entire site was covered with untouched second growth bush. Within two weeks twenty acres had been cleared and the development of the construction camp was well advanced. Eventually the camp accommodated about 350 persons; it was operated by the Power Corporation of Canada and throughout the duration of the job it won the approval of the Provincial Sanitary Authority. A recreation hall was provided for the use of the men, and during the winter months a school was run in the evenings in which elementary subjects were taught to the men by a representative of the Frontier College.

Fig. 10—General View of the Site on July 4th, 1930, showing the Result of Twelve Months of Construction Activity.

Power for construction purposes was obtained from Fountain Falls, the nearest power station to the job, being delivered over a temporary 11,000-volt transmission line, the maximum load averaging about 400 h.p.

The dam is founded on close grained Nipissing diabase, a considerable area of that exposed showing marked signs of glaciation. The overburden was typical glacial drift, containing a high percentage of boulders which impeded excavation considerably. On the other hand, glacial action was also responsible for the extensive areas of comparatively level ground adjoining the dam site—approximately at the same elevation as the top of the dam—which served admirably as working areas. The diabase proved to be very hard drilling. At the west end of the dam, it proved to be somewhat fractured, as is so typical of the Cobalt region, but this did not affect the essential soundness of the foundation.

The construction schedule was governed by the fact that power had to be delivered before the end of 1930. As some winter concreting was thus inevitable, it was decided to equip the job for large scale winter work in order to place the main bulk of the concrete in the dam (i.e. that portion occupying the old river bed) in the early part of 1930, the reduced flow at this time being diverted through a special sluiceway left between dam and power house. In this way, the main sluiceways were ready to take care of the spring flood flow in the river with no liability of damage to cofferdams.

The following quantities of material dealt with will give some indication of the nature of the work to be done.

Cofferdams	4,880 cubic yards
Earth Excavation	27,850 cubic yards
Rock Excavation	12,170 cubic yards
Concrete (all classes)	19,890 cubic yards
Reinforcing Steel	482,050 pounds
Lumber used (about)	1,000,000 board feet
Equipment handled (about)	1,000 tons

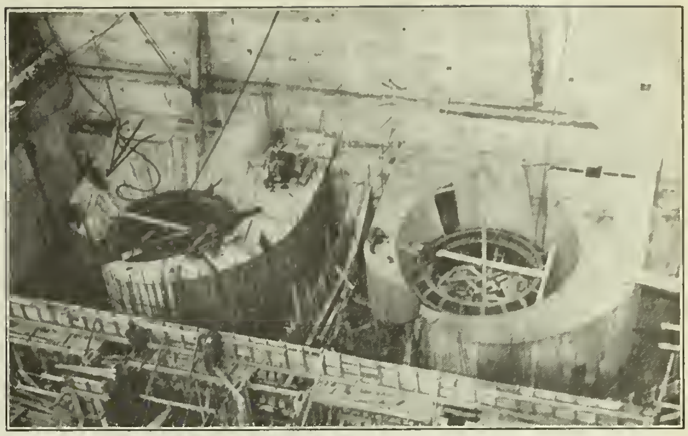

Fig. 11—Power House Substructure showing Forms for Concrete Spiral Scroll Case.

Earth excavation, on both sides of the river, was generally completed before the freeze-up of the 1929-1930 winter set in, sluicing being successfully employed for a great part of this work. Rock excavation in the headrace started as soon as practicable and thereafter proceeded steadily, through power house foundations and tailrace, all the rock excavated being passed through jaw crushers, and conveyed by bucket and belt to a store pile for use as concrete aggregate.

Concreting started on October 25th, the gravity dam east of the power house being first constructed, the gatehouse piers and sluice piers 1 and 3 (lower portions) following. Work on the main cofferdam, spanning between sluice piers 1 and 3, started in December and proceeded concurrently with the concreting of the gatehouse which was completed up to its top level in order to withstand the pressure against it due to the raising of the water upstream by the main cofferdam.

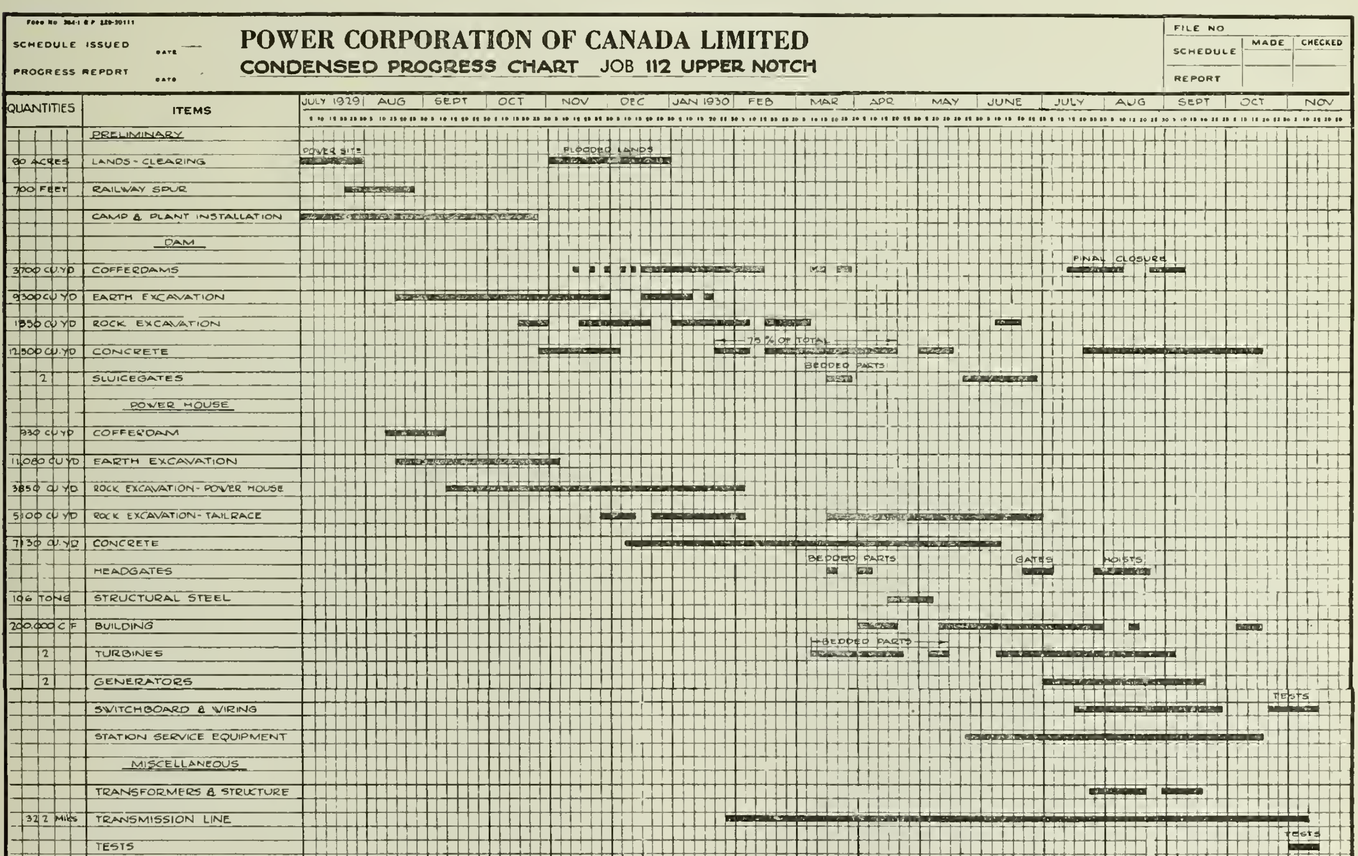

Fig. 12—Condensed Progress Chart Upper Notch Job.

The area enclosed by this cofferdam was pumped dry on February 18th; the pumps were withdrawn on March 11th, five weeks before the spring flood started, 5,615 cubic yards of concrete having been placed between these dates. Concreting of the power house substructure was by this time in full swing, being completed on June 7th, after which the installation of mechanical and electrical equipment proceeded without interruption, the last of the main concreting being done meanwhile at the western end of the dam. The first unit was started up on August 27th, and power was delivered over the transmission line for the first time on November 12th. The works, complete in every respect, were handed over to the Northern Ontario Power Company on December 24th, 1930.

Construction methods were not, in general, unusual, the placing of concrete during winter months, for example, following methods which can now be regarded as almost standardized in Canada. Great care was exercised in the adoption of these methods, as a result of which no concrete froze; no anti-freezing compounds were used; and concrete was deposited with the air temperature as low as minus 40 degrees F.

Careful records were kept of the extra cost involved due to this winter concreting; the increase amounted to one per cent of the total construction cost. This was more than offset, however, by the saving which the general schedule effected in the cost of cofferdams. This saving was due to the fact that the cofferdams had not to be designed for spring flood conditions (although the main cribs had to withstand ice pressure), and that further, the tops of the main cribs were below the sills of the main sluiceways, and there was, therefore, no necessity for them to be removed. All the cofferdams were built as timber cribs, rock filled, and sheeted with either 2″ or 3″ T & G sheeting, the greater part of the 3″ sheeting being salvaged.

All concrete was mixed in a central mixing plant, equipped with a one cubic yard mixer, which discharged directly into what was called a "Dump Hopper." This had a capacity of three cubic yards, and was fitted with a radial gate in the bottom so arranged as to discharge into the two cubic yard dump cars used for transporting the concrete to the dam and power house. This arrangement rendered necessary the use of one concrete "train" of two dump cars only to deliver regularly the output of the mixer, in which all batches were mixed for at least 1¼ minutes; and as proof of its efficacy, it may be recorded that in fifteen working hours, 449 cubic yards of concrete were placed in the dam, at a point over 500 feet from the mixing plant, the time given including that required for starting up and cleaning up the entire concreting system.

Rock excavation methods call for no special mention.

The power house superstructure was constructed of hollow tile built around a steel framework, experience on several previous jobs in the same district having proved that tile withstands the severe climatic conditions of northern Ontario very well. The placing of the tiles was done from platforms suspended by means of patent scaffolds cantilevered out from the steel roof beams, this arrangement proving to be most satisfactory, the entire building being completed in two working weeks. The saving effected by the use of these scaffolds more than offset the freight costs from Toronto.

During the construction of the plant (in June, 1930), an exceptional flood was experienced, caused by a week of heavy rainfall culminating in a fall of five inches in twenty-seven hours. The only damage to the works was the washing away of the tailrace cofferdam, but as demolition of this was just about to commence, the "damage" saved the job a considerable amount of money.

Construction of the 32.7 mile transmission line was carried out during 1930, hauling being done during the previous winter; it followed standard methods, the only special section being the crossing of Lake Temiskaming by a 1,400-foot span between two 150-foot steel towers.

Mr. D. Hutchison was construction superintendent in charge of the construction of all the work herein described, with R. F. Legget, Jr.E.I.C., as resident engineer.

The total cost of the completed plant and transmission line was approximately $1,500,000.

The Corrosion of Metals

Alfred Stansfield, D.Sc., M.E.I.C.,
Professor of Metallurgy, McGill University, Montreal.

An address delivered at a meeting of the Ottawa Branch of The Engineering Institute of Canada, April 9th, 1931.

In prehistoric times, when our ancestors used weapons of bone and flint, such weapons were not affected by atmospheric conditions, although, of course, the wooden handles would decay if exposed to moisture. Coins and ornaments of gold and silver, the so-called "noble metals," are scarcely corroded at all even after centuries of exposure to the atmosphere. In the bronze age, articles of copper or bronze were corroded gradually when exposed to water containing carbonic acid and would become covered with a beautiful carbonate patina, but many such articles of bronze have survived thousands of years and can be seen in our museums today.

The metal iron, although much stronger than the other metals, is corroded far more rapidly when exposed to moisture and, as a consequence, we have very few relics today of the early iron age. In our present steel age the rapid corrosion of tools and structures, accelerated by sulphuric acid fumes in the air resulting from our use of coal, takes a heavy toll of our metallic possessions.

The corrosion of a metal means, in effect, its chemical combination with oxygen or other non-metallic element to form a chemical compound. The affinity of a metal for oxygen may vary from that of gold, which has no affinity, and the other "noble metals," silver, mercury and platinum, which have very little affinity, to metals like magnesium and calcium which have a great affinity for it. The degree of affinity of a metal for oxygen can be measured roughly by the amount of heat given out while the combination is taking place. The tendency of a metal to combine with oxygen and other non-metallic elements and to pass into solution in water as a chemical compound can be measured electrically. The metals can be arranged in order in accordance with these properties. The two lists are quite similar and show the *tendency* of each metal to become corroded, but not its actual corrodibility; thus the metal aluminum has a greater tendency than iron to form chemical compounds, but it does not corrode so readily on account of the strong protecting film of oxide with which it is covered.

The exact nature of rust is extremely difficult to explain. In the corrosion of metals by liquid reagents direct re-action does not usually take place. Thus, if a piece

Fig. 1

of pure zinc be placed in dilute sulphuric acid it will not dissolve, but if a piece of copper is placed alongside, an electrolytic action will take place and the zinc will dissolve. This electrolytic action is the basis of most of the cases of ordinary rusting. Thus, one condition for avoiding corrosion is that the metal should be pure. Zinc may be produced electrolytically with a purity of 99.994 per cent. This zinc when exposed to dilute sulphuric acid or hydrochloric acid will suffer scarcely any corrosion. Also aluminum refined by the Hoopes process may be 99.983 per cent pure, and this metal if sprayed with a 20 per cent salt solution for two weeks, will not lose its bright surface.

It has been deduced from microscopic examination of cast iron that the heterogeneous arrangement of the graphite and pure iron particles tends to produce electrolysis and corrosion. Similar actions take place in the case of other metals. For instance, steel consisting of pure iron with ribs of chemical compounds, carbides, etc., shows the same tendency to rust.

Steel containing about 0.85 per cent of carbon, which has cooled slowly from a red heat, shows when highly magnified a structure termed "pearlite" consisting of alternating bands of "ferrite" or pure iron and "cementite" or carbide of iron as shown in Fig. 1. Steel with a smaller proportion of carbon shows in addition large areas of ferrite or pure iron as shown in Fig. 2.

It is very difficult to get the various constituents in steel sufficiently homogeneously arranged so that electrolytic action will not take place.

The nearest that is possible toward this homogeneity is obtained in electrolytic iron where the atoms throughout each crystalline grain are oriented in a particular direction.

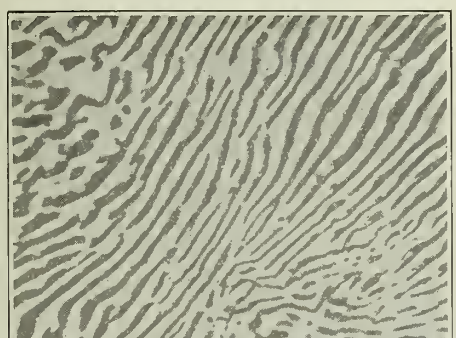

Fig. 2

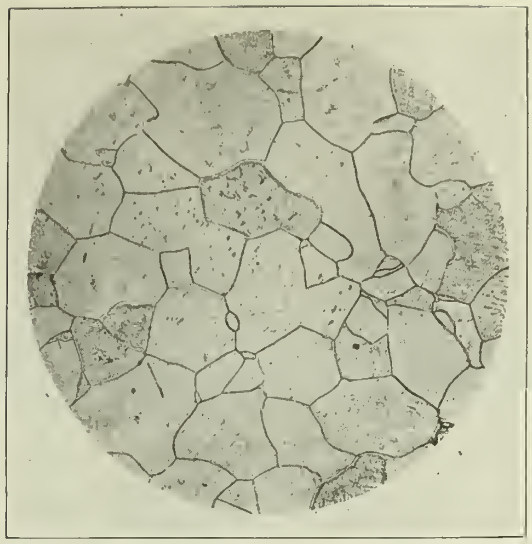

Fig. 3

Fig. 3 is a highly magnified view of pure electrolytic iron. All the grains are equally pure, but owing to differences in orientation some of them appear different after etching with an acid. The joints between the grains are clearly marked.

This form of iron is not so rapidly attacked, although even in this case some electrolysis takes place on account of the fact that the orientation of the atoms in the different grains will be in different directions.

This orientation can be deduced from observation of the diffraction pictures obtained by the use of X-rays. From such pictures the arrangement of the atoms in a metallic crystalline grain can be worked out, the atoms being distributed in regular lattice patterns throughout the crystal.

It is a remarkable thing that the metal is actually stronger at the joints between the various crystalline grains than in the grains themselves, but in spite of the greater strength, which depends on the heterogeneous arrangement of the atoms in these joints, there is a greater tendency for corrosion, possibly on account of electrolysis between the adjacent grains, and the joints are dissolved and made visible when a polished piece of metal is treated with etching reagents as in Fig. 3. Another interesting feature is that in preparing a specimen for microscopic examination the surface is highly polished and in this act of polishing an amorphous layer of uncrystallized metal is smeared over the surface. This layer is more resistant to corrosion on

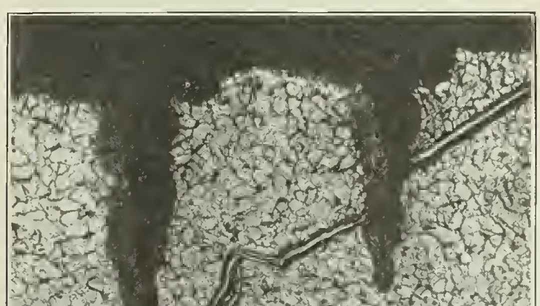

Fig. 4

account of its homogeneous make-up. This it may be stated that polished metals have better rust-resisting properties than unpolishing metals.

If a piece of iron and a piece of copper are placed together in water or in a weak acid solution, an electrolytic action is obtained and the iron is corroded. However, if one-quarter of one per cent of copper is united with iron to produce a copper-steel, there is less liability to corrosion than with iron itself. The copper contained in the steel is not separate from the iron, but exists as "a solid solution," that is, the atoms of copper are spread uniformly throughout the mass of iron and the copper in this combination does not cause electrolysis but to some extent confers its non-corroding properties upon the surrounding metal.

In Monel metal, which consists of 70 per cent nickel and 30 per cent copper, the two constituents form a solid solution, being uniformly mixed in the mass and there is no difference between one crystalline grain and another. The same may be said with regard to stainless steel when it has been given a suitable heat-treatment. Thus, as a summing up, freedom from corrosion may be approximated by having the metals pure or by having the constituents of the metals homogeneous.

Even if the metal itself is homogeneous, electrolysis will be produced if the liquid to which it is exposed has a different composition at different parts, and even a difference in the amount of dissolved oxygen will set up electrolysis and cause corrosion of the metal. In a beaker of water there is usually more oxygen near the surface than lower down, and if a strip of pure iron is placed vertically in the water, electrolysis will be set up, the upper part of the strip acting as a cathode while the lower part acts as an anode. It follows that the upper part, where there is plenty of oxygen, is protected and that rusting takes place at the bottom of the strip where there is less oxygen. This explains the well-known fact that corrosion takes place beneath loose patches of rust and within any small cavities in the metal.

It may be wondered why iron rusts more readily than, for instance, aluminum, when the latter has a much stronger affinity for oxygen than the former. The fact is that aluminum, on account of this strong affinity, becomes immediately covered with an oxide film which prevents further corrosion. The film of oxide which develops over iron, on the other hand, is not as a rule strong enough to prevent corrosion. The film of oxide on the surface of aluminum and even the thinner film on the surface of iron has been isolated by chemical means and examined under a microscope.

As an example of a somewhat unexpected result of corrosion, the piece of boiler plate shown in Fig. 4 may be taken. In this plate cracks had developed, and investigations showed that the apparent cracks were really corrosion lines in the steel. It appeared that scale had formed over the steel and that the warping of the plate had repeatedly cracked the scale, thus enabling corrosion to penetrate deeply at certain points. Such action may be termed "corrosion fatigue." It is supposed that electrolytic action takes place between metal in distress and metal not in distress; this causes corrosion cracks across the direction of mechanical bending.

The irregular line crossing Fig. 4 is a scratch produced by drawing a needle across the polished surface in order to find whether the corrosion cracks were empty or had a solid filling. This test showed that the cracks contained a very hard material resulting from the corrosion of the steel.

The Lighthouse Service of Canada

J. G. Macphail, B.A., B.Sc., M.E.I.C.,

Commissioner of Lights, Department of Marine, Ottawa.

Based on an Address presented before the Montreal Branch of The Engineering Institute of Canada, January 22nd, 1931.

The coastline of Canada extends over 52,800 miles. The Lighthouse Service of Canada is distributed over a large part of that coastline; also over the south and east coasts of Newfoundland and Newfoundland-Labrador. The Service comprises 1,855 lighthouses, 374 fog signals, 11 lightships, 584 gas and signal buoys, and approximately 9,000 unlighted aids to navigation of various kinds, a total of 11,824 aids to navigation of all kinds. In addition to those signals which are picked up directly by the natural senses, the government maintains 12 radio direction finding stations and 18 radio beacons.

Altogether over two thousand persons are employed in the Lighthouse Service of Canada, extending as it does from Cape Race in the extreme east to Queen Charlotte islands in the Pacific ocean.

When one thinks of the Lighthouse Service, he is apt to associate it with some particular light or buoy with which he is familiar: for example, persons living in Montreal and making an occasional steamer voyage, either above or below, will naturally think of those flashing lights, red and white, on the buoys which are passed on either hand. Viewing lighthouse establishments from the deck of a steamer, the individual establishments may appear small and trivial, but those flashing gas buoy lights are quite complex in their arrangement. The buoy itself weighs from 5 to 8 tons; the lantern is equipped with polished cut glass lens and flashing apparatus, the whole costing about $3,000. Gas buoys employed on the open sea coast vary in size up to 19 tons, with an over-all length of 60 feet, and having a draught of 30 feet. They are moored in depths

Fig. 1—Placing Gas Buoy.

of water up to 52 fathoms, the weight of chain mooring being approximately 5 tons.

Fig. 1 shows one of these buoys being placed in position.

The means of illumination is acetylene, the gas being either dissolved in acetone and stored under pressure in steel containers placed in pockets in the buoy, or generated from calcium carbide in the buoy itself. In buoys of this type (as shown in Fig. 2) seawater entering through the bottom valve acts upon the carbide and the gas thus produced expels the water either wholly or in part. As the

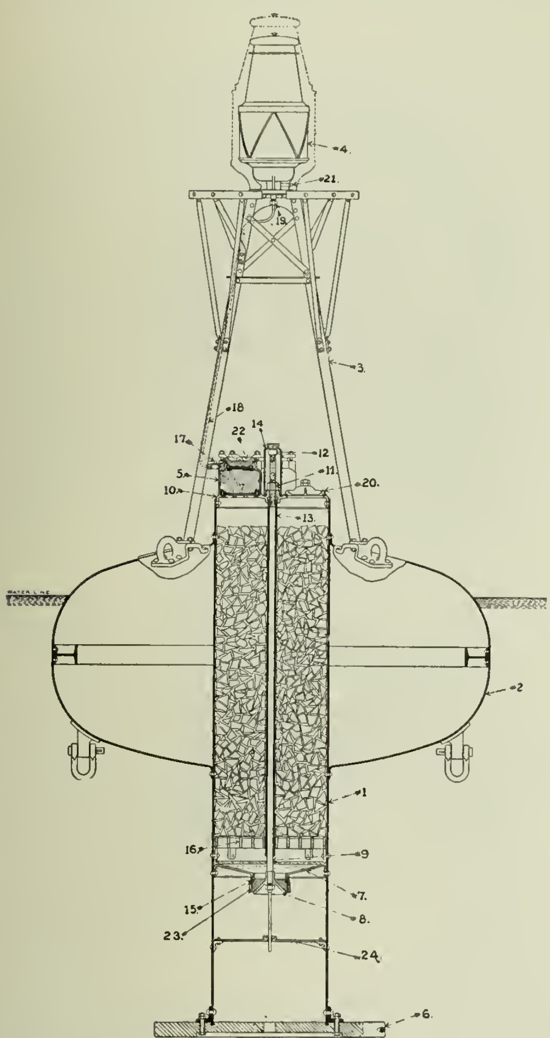

Fig. 2—Diagram of Gas Buoy.

imprisoned gas is consumed in the lantern the seawater gradually rises in the carbide chamber and the operation is repeated over and over again. The carbide charge, depending on the size of the buoys, is from ¾ to 1¾ tons.

The lightships, of which there are twelve in the service, are self-propelling and are equipped with electric lights, fog signals, and some with radio beacons and submarine bells. They are for the most part of the trawler type, while those in the more exposed positions on the Atlantic coast are more powerfully constructed. A lightship carries a crew numbering from eight to fifteen men, depending on the location and type of vessel.

As an example of a principal coast station, possibly Cape Race, being one of the largest and best known in the world, will serve best. It has an electric incandescent light of 1,100,000 candle power which takes 1,500 watts, gives a flash every 7½ seconds and has been seen from a distance of 76 miles. The apparatus and enclosing lantern required

Fig. 3—General View of Cape Race Lightstation.

to produce this result weigh 42 tons and cost $40,000. The tower cost $10,000. The fog signal has been heard 45 miles. Four hundred tons of coal a year are required to develop the necessary power. Four lightkeepers maintain continuous watch. Fig. 3 shows a general view of this station.

There are, of course, important lighthouses on the great lakes. Two of these are shown in Figs. 4 and 5. The light station at Point Abino at the eastern end of Lake Erie is not only a guide for the many vessels making for Port Colborne or Buffalo, but is of interest as it stands in front of an important summer resort. The architectural features of the structure have regard to the aesthetic sensibilities of the neighbouring residents.

A structure of very different type is the Southeast Shoal light, which is built in 21 feet of water on a sand shoal six miles south of the extremity of Pelee Point.

Lighthouse optical apparatus is divided generally into two classes, lens apparatus and reflectors, and each group is divided into several sizes depending upon the requirements of the particular lightstation where it is used. The lens apparatus is built up of lens elements and refracting prisms, and is so designed as to present two or more illuminating faces, which, by revolution around the light source, produces to the ship at sea the effect of groups of one, two, three or four flashes.

The optical apparatus is carried on an annular cast iron float supported in a corresponding annular bath of

Fig. 4—General View of Point Abino Lightstation.

Fig. 5—Southeast Shoal Lightstation, Lake Erie.

mercury, which, in turn, is supported on the pedestal proper. and is revolved by a clockwork driven by a weight. In the case of the largest size, like that at Cape Race, the floating part of the apparatus weighs seven and a half tons, but, by reason of the design of the mercury bath and float, only 950 pounds of mercury are required to float the apparatus. Ball bearings at the bottom and roller bearings at the top prevent undue lateral movement when the tower is swaying under wind pressure.

Fig. 8 shows a horizontal section of a Second Order Triple Flashing Light and the lens arrangement to produce groups of three flashes. The general arrangement of the lantern is shown in Fig. 10; the base "A" consisting of heavy cast iron sections; the glazing "B" of plate glass bent to the curve of the lantern and secured in gun-metal framing; the roof "C" of steel framework, copper covered; and ventilator "D" of the same construction. The whole surrounded by gallery railing "E," and furnished with ventilating pipe "F" to carry off the heat and moisture. These lanterns vary in diameter from ten to eighteen feet.

Illumination is derived generally from kerosene burned as oil vapour under an incandescent mantle. In recent years, electricity is being introduced both from commercial power lines, where available, and by the installation of small plants in the lighthouses.

Inasmuch as the parabolic reflector is familiar to everyone, no description need be given of it, but a very interesting and useful adaptation of the parabolic principle was made some years ago by L. E. Côté, M.E.I.C., now chief engineer of the Marine Department. The parabolic reflector, in its familiar form, is designed with a relatively short focal distance, as shown by curve "A" in Fig. 9. Mr. Côté determined by mathematical calculations that a parabolic reflector of relatively long focal distance, as shown in curve "B" in the illustration, yielded equal reflecting power, and, at the same time, a narrower beam of light, approximating in this respect to dioptric apparatus. But the great advantage of the discovery is that a system of such reflectors can be revolved around a single central source of light and give the effect of groups of flashes, as in the case, also, of dioptric apparatus. The diagram "C" shows such an arrangement for a single flashing light, while

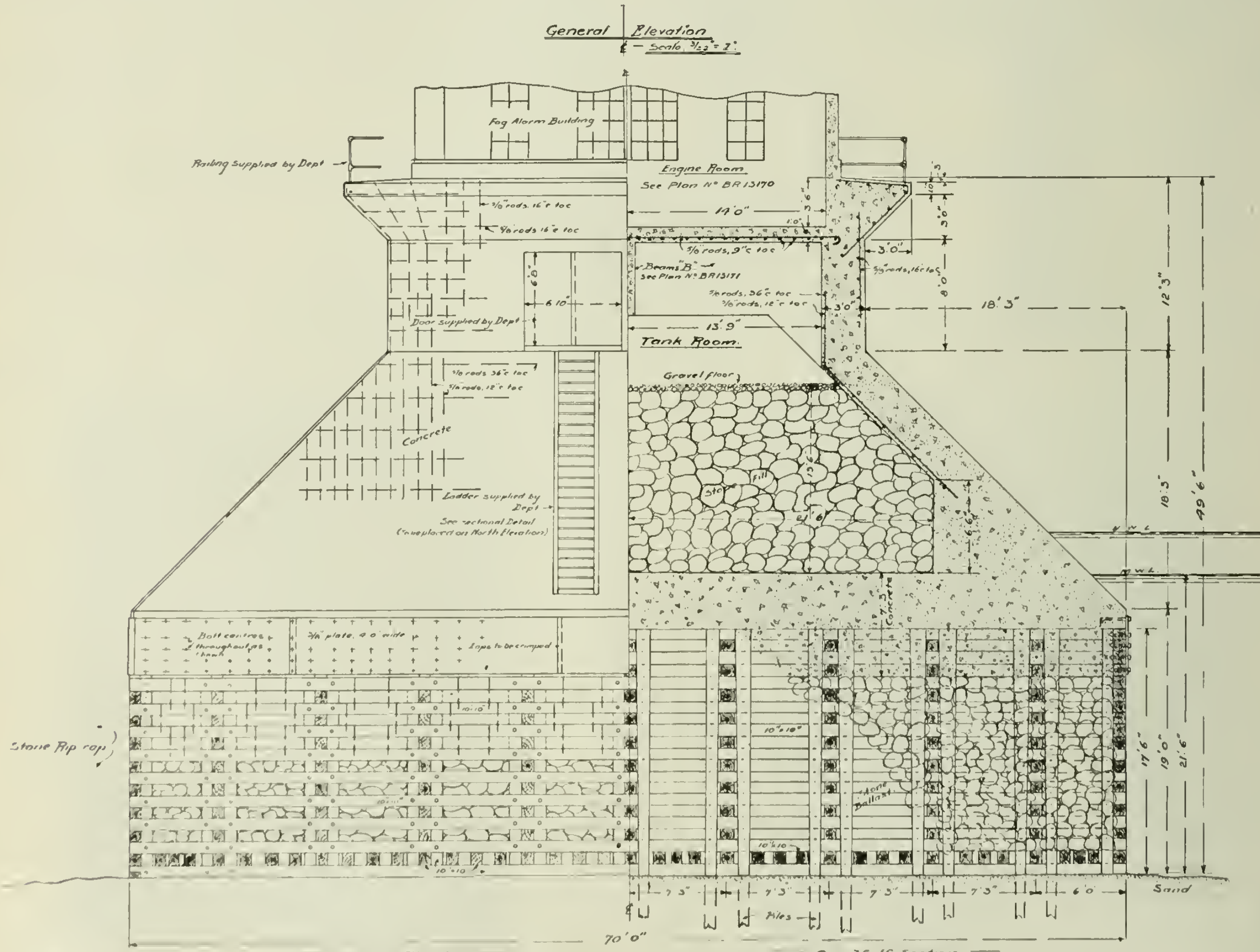

Fig. 6—Elevation and Section, Southeast Shoal Lightstation.

diagram "D" indicates a rearrangement of the same three reflectors to produce a triple flash. In like manner double flash and quadruplicate flash groups may be arranged. In the case of the short focus, or deep reflector, each reflector requires a separate source of light.

The fog signal in general use in the service is known as the Diaphone (see Fig. 11). This consists essentially of a piston reciprocating in a cylinder, in both of which are cut circumferential slots or ports. The piston is fitted with an operating head to which compressed air is admitted first on one side and then on the other, thus producing the reciprocating motion. As the ports in the piston pass and

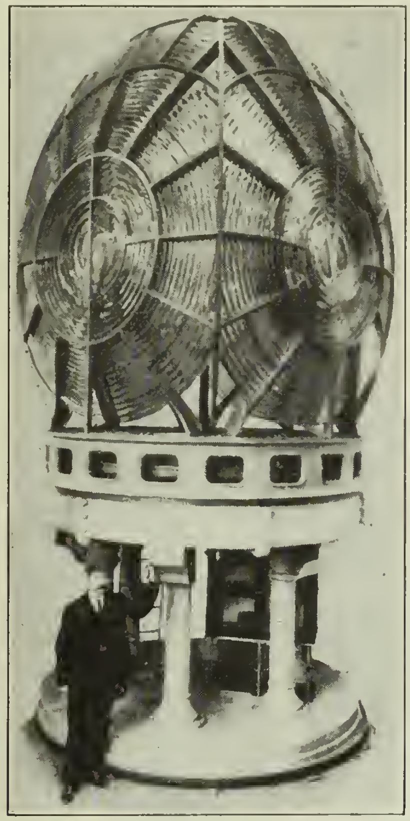

Fig. 7—Optical Apparatus of Lighthouse, Outside View.

repass the ports in the cylinder air at 30 pounds per square inch is admitted, giving 180 vibrations per second. The sound from this instrument has been heard over a distance of 45 miles.

While the lighthouse service is in operation every day in the year, strictly and literally speaking that applies only to the Atlantic and Pacific coasts. But, while the interior services are laid up in December and again placed in operation in April, the actual management of the service is continuous. Before these services are finally laid up in the fall, arrangements must be under way to place them in operation on the opening of navigation. Operations attending the closing and opening of navigation place a heavy strain on the lighthouse service. From the Gulf of St. Lawrence to the head of Lake Superior 2,819 floating aids to navigation must be removed including 8 lightships, 311 gas and signal buoys, and 2,500 unlighted buoys. This work must be accomplished at and after the actual close of commercial navigation. All aids to navigation are maintained in operation until actually threatened by ice, and, after commercial navigation has ceased, the steamers and men of the lighthouse service must do the best they can to recover these floating aids to navigation and place them in

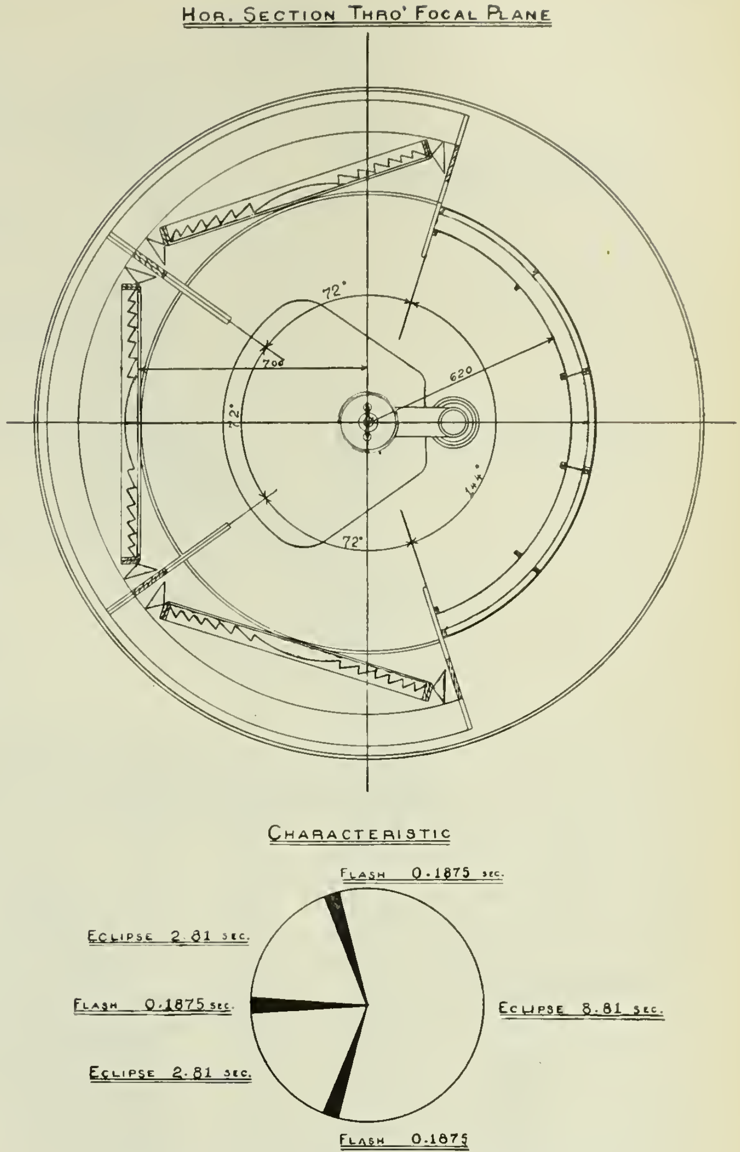

Fig. 8—Section of Second Order Flashing Light.

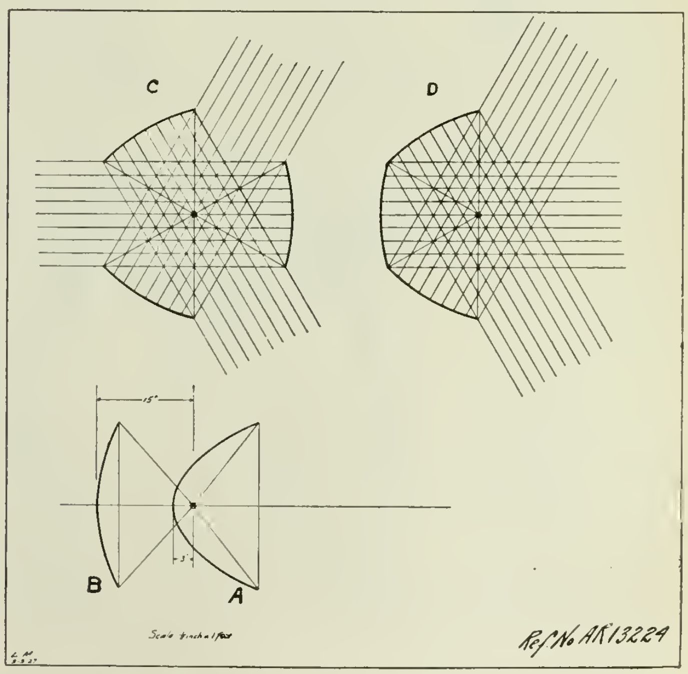

Fig. 9—Diagram of Parabolic Reflector Systems.

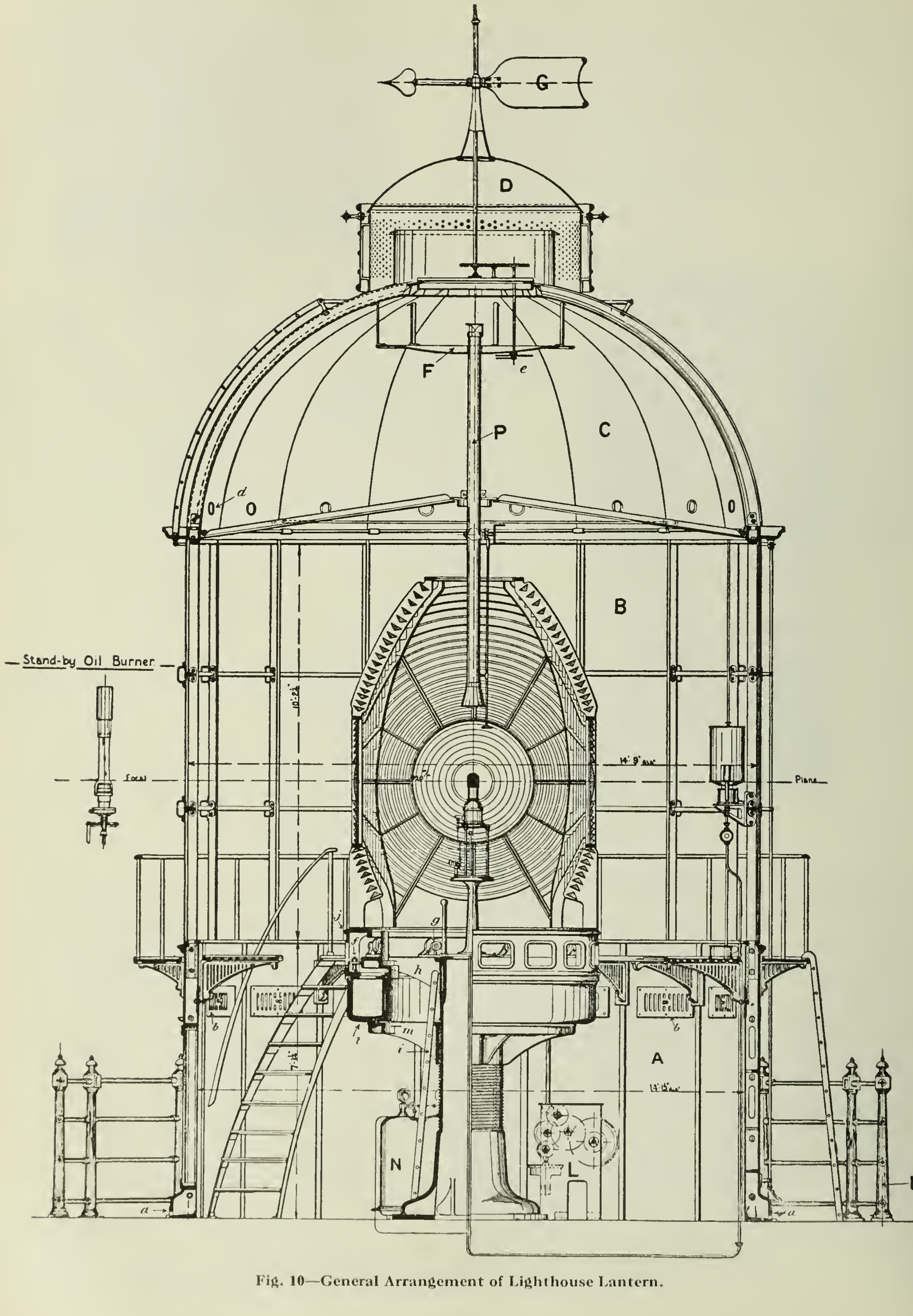

Fig. 10—General Arrangement of Lighthouse Lantern.

winter quarters to be got ready for service on the opening in the spring. Thus, long after commercial vessels are safe in winter quarters, the vessels and men of the lighthouse service are contending against extreme weather and ice conditions in the performance of their allotted tasks.

A discussion of the lighthouse service would perhaps not be complete without some reference to Sable Island, "The Graveyard of the Atlantic." The phrase "Graveyard of the Atlantic" is used because it is a familiar one and doubtless up to forty or fifty years ago was applicable. But, with the passing of sailing vessels, the advent of steam power, the improvement of aids to navigation and the art of navigation, the graveyard aspect of Sable Island is a thing of the past. But occasionally, possibly once in three or four years, a vessel does go ashore there and means are provided for the safety of those aboard. Sable Island is about 18 miles in length, somewhat crescent shaped, consisting wholly of sand, in places 100 feet high and for the most part covered with a rank growth of vegetation. Sand bars extend several miles from each end of the island. In addition to two first class lightstations, one at each end of the island, several watch towers and life saving stations are maintained at strategic points. In clear weather the entire coastline of the island is under observation from the lighthouses and watch towers. When fog or thick weather occurs, mounted men patrol every mile of the coast. All stations are connected by telephone. When a watch tower or patrol man sights a vessel in danger, he communicates by telephone with the superintendent of the establishment. The superintendent lays out his plan of operation, and by telephone calls the life saving crew and equipment of two, three, four, or five stations to proceed to the scene. Thus immediately a vessel is reported in danger or even approaching the possibility of danger several life saving equipments are under way converging to the scene of danger. The equipment consists of Lyle guns, a useful device to fire a projectile to which a cord is attached. The gun is directed over the stranded vessel. The cord is seized and hauled aboard by the crew. The life saving men ashore bend on a line, and, as that line is hauled aboard, they bend on a hawser which in turn is made fast to the mast of the vessel. It is then made fast ashore by the life saving crew and a breeches buoy is rigged whereby the crew and passengers of the vessel may be taken ashore. Self-baling lifeboats also are kept in readiness at all times mounted upon wagons to be drawn by a team of five horses. The Lyle gun and breeches buoy are used only when it is not possible on account of heavy sea to launch a lifeboat, and the rule is that efforts to launch the boat may not be abandoned until three trials have been made, and a trial is regarded as unsuccessful only when the lifeboat has been either swamped or capsized by the sea. A sufficient stock of clothing, blankets, and food is maintained to meet any possible emergency.

To complete the discussion of the lighthouse service, something should be said of the personnel, which includes over two thousand persons, about half of whom are full time employees and to whom the following observations primarily apply.

It must be remembered that the principal light stations are situated in far isolated places. By the very nature of the service, the coast stations must occupy the headlands and the promotories and the islands of the sea, and thus one finds at such a station, many, many miles from other habitation, the keeper and his wife, his assistant and in some cases his wife, and the children of the one or two families. Here, within the compass of an acre of ground, or less, there is full play of every emotion arising out of joy-sorrow, love-hate, sickness-health, life-death, and occasional echoes of these emotions penetrate even to Ottawa. For example, the wife of a keeper, finding herself suddenly widowed, in destitute circumstances, and with infant children, asks to be retained in her husband's place until she can find some other means of sustenance and shelter "for the sake of my little children" she says; the keeper whose children are coming of school age asks transfer to some station where means of education are available; the sick woman or child to whose relief the service does not hesitate to send a steamer smashing through a hundred miles of storm and ice. These are cases where sympathetic considerations are permitted to operate—but, apart from cases of that kind, the lighthouse service is a hard one. It is inexorable. It is in operation three hundred and sixty-five days in the year. It is in operation twenty-four hours every day. Of all public or private services it is perhaps the most insistent. A railroad train may be late, power lines may fail, the telephone may be interrupted, and nothing serious happen. But a thousand ships are traversing our 50,000 miles of coast and river, and, if one light or fog alarm fail for an hour, or, if one of those thousands of buoys be out of place, shipwreck is imminent with a possibility of vast loss of life and property.

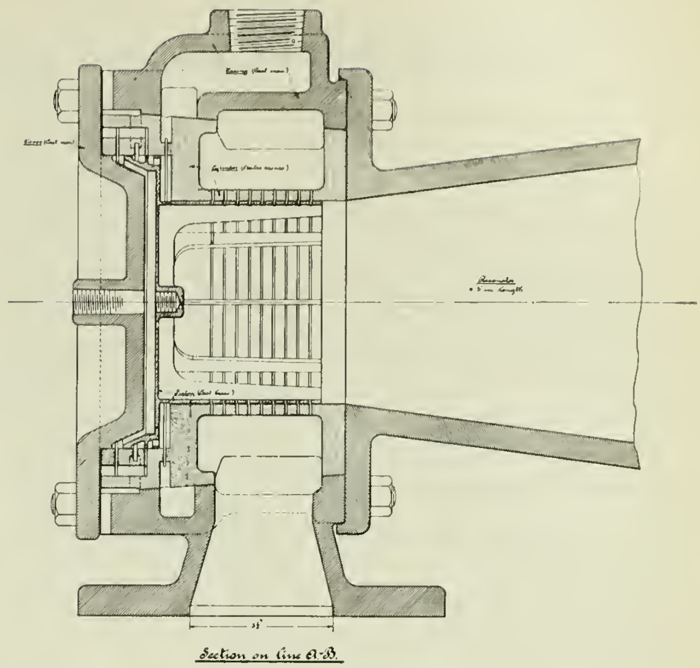

Fig. 11—Diaphone.

Accordingly, no excuse is accepted for neglect of duty—failure is visited by instant dismissal—the principle is well understood. And yet in all that far scattered service few failures are recorded in the year, and none among the principal stations.

One who knows the Lighthouse Service well cannot but marvel at the faithfulness of the men and women of it, those men and women who at this very hour and every hour are standing watch across Newfoundland and Canada, from Cape Race far east in the Atlantic to Langara, far west in the Pacific.

Lieutenant-Colonel John By — A Biography

By Hamnett P. Hill, K.C., Ottawa.

Lieutenant-Colonel John By, of the Royal Engineers, should be remembered in Canada as the officer sent out by the British government in charge of the construction of the Rideau canal in 1826, and as the founder of the little village of Bytown, now the city of Ottawa.

Lieutenant-Colonel By came of a family which had been, for many years, associated with the Custom House in London. His grandfather, John By, resided in Archbishop's walk in the parish of St. Mary Lambeth and held a situation, as Chief Searcher, in the Custom House in London. He had four sons, John, George, Charles and William, all of whom resided in Archbishop's walk, and all of whom held situations in the Custom House in London and all of whom are buried in the Churchyard of St. Mary Lambeth. His second son, George, married Miss Mary Bryan and had three sons and several daughters, Lieutenant-Colonel John By, the subject of this sketch, being his second son. The eldest son, George, obtained a position in the Custom House in London and his younger son, Henry By, was a broker in London.

Lieutenant-Colonel John By was born in the year 1779 and was baptized in the parish church of St. Mary Lambeth. After passing through the Royal Military College at Woolwich, he obtained his commission as Second Lieutenant in the Royal Artillery on 1st August, 1799, but changed his allegiance to the Royal Engineers in December of the same year. His further commissions were dated: First Lieutenant, 18th April, 1801; Second Captain, 2nd March, 1805; First Captain, 24th June, 1809; Brevet Major, 23rd June, 1814; and Lieutenant-Colonel, 2nd December, 1824. After serving at Woolwich and Plymouth, he came in August, 1802, to Canada, where he was stationed for nine years at Quebec. While there, he had much to do with building and extending the fortifications and also was the officer in charge of the construction of a canal that was built at the Cedars on the St. Lawrence river. In January, 1811, he was sent to Portugal and served in the Peninsular war, taking part in the sieges of Badajos in May and June of that year. He was later recalled from the Peninsula and placed in charge of the works at the Royal Gun Powder mills at Faversham, Purfleet and Waltham Abbey, a position he occupied with great credit from January, 1812, until August, 1821, when, owing to reductions made in the establishments of the army, he was placed on the unemployed list. While employed in the powder mills, he designed a bridge on the truss principle for a span of 1,000 feet, and constructed a model of it, which is in the possession of the Royal Engineers at Chatham. A description of the bridge appeared in the "Morning Chronicle" of 14th February, 1816.

Lieutenant-Colonel John By.

During the war of 1812-15, the difficulty and expense of protecting the settlements in the western part of the province of Ontario were very great, and in addition there was the constant apprehension that an army from the United States might be thrown across the St. Lawrence river at any point and effectually prevent troops and supplies going up the river into Lake Ontario to take part in hostilities in the western part of the province. The War Office in London decided, in order to render the necessary protection, that a back water route away from the United States boundary should be obtained, and accordingly it was decided to improve the navigation of the Ottawa river to the foot of the Chaudiere falls, and to utilize the Rideau river and the Cataraqui river to obtain access from there by water to Lake Ontario.

By was selected as the officer in charge of the work on the latter two rivers and in the summer of 1826 came to Canada for this purpose. His instructions were to design and carry out a military water communication from the outlet of the Rideau river into the Ottawa river to the outlet of the Cataraqui river at Kingston.

The country was then in a state of wilderness and unexplored, the only mode of progress being by canoe. On his arrival in Canada he surveyed the route and proceeded with the work. The survey plans and estimates, sent to the Home Government in the spring of 1827, were approved, and By was directed to push forward the work by contract as rapidly as possible without waiting for the usual annual appropriations of money.

The Earl of Dalhousie had, in 1823, purchased from Colonel Hugh Fraser of Three Rivers a block of land fronting on the heights overlooking the Ottawa river and extending from the Chaudiere falls to the Rideau river. Lieutenant-Colonel By was instructed to subdivide this area into lots and to form a village. This he did, and the village became known as Bytown. He made his headquarters there and built himself a house in what is now known as Major's Hill Park. Two companies of sappers and miners were sent from England, and barracks were built on the present site of the parliament buildings.

The canal was opened for navigation in the spring of 1832, when the steamer, Bumper, was able to pass from Bytown to Kingston.

By's instructions were to complete a water communication having a uniform depth of five feet. This was obtained by the erection of dams at various places across the Rideau river, which, in some cases, backed up the water and drowned out small rapids for miles above them. Locks were built to enable boats to pass through the various dams. The same procedure was followed on the Cataraqui river. This required the construction of forty-seven locks, with a total lockage of 446½ feet. The intention of the War Office originally was to build the canal solely for military purposes, but on By's insistence it was altered to permit navigation for mercantile purposes and the locks were increased from the original small size of a width of 20 feet to a width of 33 feet and to a length of 134 feet instead of 100 feet.

The War Office had undertaken the project on a report which had been prepared by Mr. Samuel Clowes, an engineer who had been appointed by the Upper Canada government to make reports on various waterways. Clowes had estimated that the cost of the improvements would be one hundred and forty-five thousand, eight hundred and two pounds. By, shortly after his arrival, reported that it would be impossible to do the work for this figure and that it would cost at least four hundred thousand pounds. His first report to the War Office set out a detailed estimate of cost amounting to four hundred and seventy-five thousand pounds. Owing to changes and unexpected difficulties and the necessity of various additions, the ultimate expenditure was in the neighbourhood of eight hundred thousand pounds. During the progress of the work, the attention of the British government was called to the expenditure and two investigations were held. Both investigations resulted in laudatory references to Lieutenant-Colonel By's efforts and approval of the spirit of economy practised by him, but criticism was directed by the Parliamentary committee to the manner in which the War Office had instituted the work. In the spring of 1832, on the receipt of By's annual report of expenditure and estimate of the amount needed to complete the work, the Lords of the Treasury directed that Lieutenant-Colonel By should be ordered to return to England, that he might be called upon to afford such explanations, in regard to the greatly increased cost, as the Lords of the Treasury might consider necessary. On his return to England, By appeared before a third committee of the House of Commons. The committee, while admitting that the work had been carried out with care and economy and had been well performed, concluded their report with a strong expression of regret at the excess expenditure over the estimate and the Parliamentary Votes.

By, who had expected high commendation, including knighthood, on the completion of this magnificent work in so short a time and under so many difficulties and at a cost by no means extravagant, felt himself extremely ill-used and never recovered from the disappointment. It must be conceded that By was a victim of circumstances and politicians. Every commission and committee of the House of Commons had approved of the work, in some cases highly praising him, and in other cases expressly excepting him from any criticism. Every engineer who had gone over the work had approved of it. During the whole progress of the work not one word of disapproval had emanated from the Ordnance Board under whom By was carrying on the undertaking. A scapegoat, however, had to be found to satisfy the politicians and By was allowed, by the military authorities, to bear this stigma. No one can read the letters and reports in the government Archives at Ottawa without sympathizing with By in the disappointment he suffered and the indignation he felt.

Sir Richard Bonnycastle, in "The Canadas in 1840," says, "If ever man deserved to be immortalized in this utilitarian age, it was Lieutenant-Colonel By. In an unexplored part of the country, where the only mode of progress was the frail Indian canoe, with a department to be organized, workmen to be instructed and many difficulties to be overcome, he constructed a truly remarkable work."

Lieutenant-Colonel By was married twice. His first wife was Elizabeth J. Baines who died shortly after the marriage. He subsequently married, on the fourteenth day of March, 1818, Esther, the daughter of John March of Harley Street, London, by whom he left two daughters, Esther, who married in 1838 the Hon. Percy Ashburnham, the second son of the third Earl of Ashburnham, and Harriet Martha, who died unmarried.

After his return to England, owing to failing health, he was placed on the unemployed list and retired to his estate near Frant, in the County of Sussex, and there died on February the first 1836.

On his tombstone is engraved the following pathetic obituary:

> "Sacred to the Memory of Lieutenant-Colonel John By, Royal Engineers, of Shernfold Park in this Parish, zealous and distinguished in his profession, tender and affectionate as a husband and a father, charitable and pious as a Christian, beloved by his family and lamented by the poor. He resigned his soul to his Maker in full reliance on the merits of his Blessed Redeemer on the first of February, 1836, aged 53 years, after a long and painful illness brought on by his indefatigable zeal and devotion in the service of his King and Country in Upper Canada. This stone is erected by his afflicted widow in remembrance of every virtue that could endear a husband, a father and a friend."

An entry in the Baptismal Register of the parish of St. Mary Lambeth states that John By the son of George By was baptized on August the tenth, 1779, and an entry in the Burial Register of the parish of Frant is to the effect that he was buried there on February the twelfth, 1836, and that his age was fifty-three. It would therefore appear that this entry and the age mentioned on his tombstone are both wrong, as it is obvious that he must have been fifty-six years old at his death.

(*See photograph of Rideau Canal on page 459*)

General Principles of Air Transportation

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Paper presented before Branches of The Engineering Institute of Canada as follows: London Branch, January 15th, 1931; Border Cities Branch, January 16th, 1931; Saint John and Moncton Branches, February 18th, 1931, and Montreal Branch, March 12th, 1931.

SUMMARY.—Success in the operation of air transport depends primarily on effective ground organization. Without this, the intensive use of aircraft on which financial success depends cannot be attained. Conditions for economical operation are discussed, together with the effect of traffic conditions upon economy. Attention is drawn to the very different traffic problems which exist in Europe and in the Dominions, and the author discusses briefly the main items in the balance sheet of an operating company which make up the standing charges and running costs.

General Principles

The problems connected with the operation of air transport services are innumerable and, generally, it will be found in the study of any particular scheme that conflicting issues arise, which it is necessary to weigh carefully in order to arrive at a just balance.

Regularity, reliability, and safety, may be taken as the watchwords to be applied to commercial aviation. These three factors are to a very great extent dependent on the efficiency with which the ground organization of an air route is provided, therefore, the first essential for the successful operation of air transport lies not in the air, but on the ground. The various items which in combination make up ground organization have not yet reached perfection, nevertheless much has been achieved since the first commercial services started, and steady and rapid progress is being made. The main items which are included in the general term "ground organization" are aerodromes, landing grounds, wireless and meteorological services, lighthouses and light beacons, aerodrome and obstruction lights, fog signals, hangars, workshops, stores, offices and quarters (where these are necessary), and customs and immigration facilities.

In studying the possibility of the operation of services on any particular route consideration must be paid to the following points:—

1. Time which can be saved over existing means of transport.
2. Traffic already existing on the route.
3. Proportion of such existing traffic which may be attracted to the air.
4. New traffic which may be created.
5. Nature of the terrain to be operated over.
6. Meteorological conditions to be met with.
7. Length of non-stop stages to be flown.
8. Frequency of service.
9. Cost of labour, imported or native.
10. Cost and supplying of fuel.
11. Customs duties and local taxation.
12. Difficulties involved in salvage.
13. Best position for the establishment of the operating base.
14. How the service will connect with existing forms of transport.
15. Local legislation.
16. Subsidies which may be available.

Other points may arise for consideration in particular instances, but generally speaking, as a result of a close study of the conditions included in the above headings, it will be possible to indicate with regard to a particular service:

1. Whether it shows a reasonable prospect of being or becoming a sound financial proposition.
2. The type and number of machines to be employed.
3. The method of operating the route, for example, the number of services per day, per week, or per month, the position of the operating base, intermediate stations, etc.
4. Whether day or night services or a combination of both should be instituted.

Aviation, supplying as it does a rapid means of transport, the speed of which is so far in excess of anything which exists in any other means of transit, is ideally suited for operation over long distances, especially where either no facilities for transport exist, or where the needs of civilization and commerce are badly served, for here obviously the greatest advantage will accrue.

It may then reasonably be asked, why the operation of air transport has advanced mainly in Europe, which is well served with fast rail communication? That progress has been so amazingly swift is largely to be accounted for by the very fact that the primary work has been carried out in Europe. There the weather conditions are as bad or worse than are normally to be met with in any other part of the globe, there highly organized transport already exists, and there the travelling public has to be inveigled away from the form of travel with which it has grown up, and which in consequence it regards as a normal part of its daily life.

Crossing the Rocky Mountains.

Air transport has consequently had to establish itself in a hard school. It has had to struggle to bring its equipment to the highest pitch of perfection possible in the short time available. It has been necessary to evolve instruments, devices and methods of navigation, in order to render it capable in large measure of defying the elements. It has had to provide comfort of travel and prove that it is safe and reliable, and to overcome the natural prejudice of the average person to leave *terra firma* and embark on an unknown undertaking. While it is true that it has not achieved perfection in all these things, very great progress towards it has been made.

The great strides in the development of air transport which have been made as a result of the operation of European services are also due to the fact that they have been carried out where the designers of the aircraft, engines and equipment have been able to keep in the closest touch with their products. It has consequently been possible for them to discuss with pilots and personnel on the spot weaknesses, failures, shortcomings and defects which have come to light as the result of constant daily use.

Basic Principles of Operation

The first and prime factor in air transport, which must be regarded as the basic principle of operation, is the intensive use of the aircraft. In this respect, at any rate, the problem as to how to employ the vehicle, whatever it may be, whether ship, train, motor lorry or aeroplane, so as to obtain from it the maximum number of hours work in any given period, puts air transport on the same footing as every other form of transport.

One very obvious fact which appears frequently to be overlooked is that a fleet of aircraft represents capital. Capital lying idle cannot earn dividends and, consequently, it is clear that the fleet which represents so much capital must be worked to its fullest capacity. It is equally obvious that since the expansion of a business normally requires the provision of new capital, it is essential if the application of air transport is to be extended, that it must be put on a paying basis within the shortest space of time possible, as new money will not flow into an industry unless, under normal trading circumstances, a return in the form of interest on the capital invested can be assured.

To work aircraft intensively, certain conditions must exist. Firstly, the route to be operated must either be of sufficient length to keep the aircraft working it fully employed, or if of short length, to produce sufficient traffic for the aircraft to operate backwards and forwards more or less continuously. Secondly, the organization of a transport company must be such that machines, while being thoroughly and efficiently inspected and, when need be, overhauled, can be dealt with expeditiously.

On the shorter routes only by frequency of service can machines be used to their fullest capacity, but in order to warrant a frequent service it is necessary that a sufficient volume of passengers, goods and mails is forthcoming; and, in addition, that the traffic is distributed throughout the day. This stage has not yet been reached on the London-Continental airways, where the majority of the passengers desire to travel about midday, and only a limited number of mail dispatches take place.

Here let it be remarked that mere unqualified statistics are sometimes misleading. For instance, returns of travelling public which only show numbers may indicate a steady increase, but if this increase is all centred round about a popular hour of travel, no economic advantage is gained, since the number of machines to cope with the traffic must be increased, instead of it being possible to increase the number of flying hours per machine by a more equal distribution of the travellers throughout the day. Where an increase in traffic occurs in one direction it may happen in the reverse direction at about the same hour, thus calling for a large number of machines, all of which are in operation for a short period with only a small chance of obtaining paying return loads.

Only by the slow process of gradual education of the public to the advantages which accompany the use of air transport will these difficult problems be solved. As the travelling public makes more and more use of the air services and as these become, in increasing measure, a regular feature of daily life, then only will a more even distribution of passengers be obtained. Looking at this question of even distribution of services and intensive use of aircraft from another aspect, it will be realized that since the overhead standing charges involved in the operation of air transport may amount to as much as 75 per cent, or even more, of the total operating costs in cases where only a limited number of services are running, the remaining 25 per cent being due to pure running costs, the surest way of bringing about a more even distribution of the two classes of cost which make up the total is to increase the services, and consequently the running costs, to the highest point which it is possible to do without an increase in the standing overhead charges. For all practical purposes this means running the machines to their maximum capacity. Let us here consider a purely imaginary case and see what is the effect of intensive versus non-intensive operation. Assuming that on a certain route over which a service is operated once daily in each direction, and on which each machine flies on an average six hours per diem, the running costs amount to 25 per cent of the total operating costs, which for sake of example may be put at $100 per diem, then the standing overhead charge will amount to $75 and the running costs to $25. Now assume that the same route is operated on the intensive system to the extent that each machine averages eighteen hours flying per diem, the standing overheads will still amount to $75, while the running charges will have risen to $75, making a total of $150 per diem. For this $150 three return services per diem will be flown, or each return service will cost $50 per diem as against $100 per return service when operated under the non-intensive system. It is obvious that, in actual practice, the results would not come out quite as simply as here stated, but the example gives a sufficient indication of the general effect which will be produced when real intensive operation becomes the normal method of working air transport. Now let us go a step further. An increase in the number of machines in a fleet does not increase the standing charges in direct proportion, and the bigger the aircraft operating organization becomes, the smaller will be the proportionate increase due solely to additions to the fleet. Consequently, it follows that when traffic is forthcoming in sufficient volume, while equally distributed over the twenty-four hours of the day so as to permit the employment of machines in increasing numbers which can be intensively used, the costs of operation will fall, when the charges made for transport will be automatically reduced.

This line of argument naturally leads to consideration of the development of Empire routes and Dominion development. If the remedy for the high cost of air transport is intensive operation, it may be argued, how will it ever be possible to bring about a reduction of costs in territory which, comparatively speaking, is only thinly populated? On the trunk Dominion routes, intensive operation will be provided by the length of line, and increase in fleets will be brought about as the advantages to be gained by making use of rapid means of transport become fully appreciated. On these routes a vast volume of traffic already exists, a very small percentage of which, when diverted to air transport, will provide the means by which it can be put on a self-supporting basis; moreover, since the advantage to be gained in the saving of time over these long routes is so great, the traffic can stand comparatively heavy charges. This is not the case over the shorter routes in Europe, which are already supplied with good and comparatively rapid means of communication, where the charges must bear some relation to fares levied by the older systems of travel either by sea or land, with which air transport is rapidly becoming, if not a serious competitor, at least a factor which must be considered.

Air services in the Dominions and in more or less undeveloped territory, in some cases, even to-day, supply the only practical means of communication. Here the conditions are entirely different from those which exist in thickly populated countries already well supplied with communications, or in the trunk routes which are only waiting to be developed. Where there is no form of regular transport other than, for example, canoe, dog teams or porters, and where a journey which takes, say three or four weeks, or even months, may be carried out by air in as many hours, it is manifest that air transport is in a position to charge fares which would be unreasonable in other parts of the world, and yet effect a saving in expense on a journey. Under these conditions services must be limited and the corresponding cost of transport must be high. In such territories other work could generally be combined with transport, such as air survey, taxi work, etc., which assist in reducing costs, but are unlikely to assist materially in balancing expenditure. This case, however is equivalent to the opening up of new territory by railroads, on which no return is expected during the years which pass while the country is in the process of development.

Here, air transport can, and will, undoubtedly fulfil a most important role, by keeping those far-away districts in touch with the world, supplying the scattered inhabitants with the necessities and some of the comforts of civilization, bringing them medical aid when needed and, in general, by supplying a link with the outside world.

Economic Factors in Operation

It is well to consider in some detail the main items which figure in the balance sheet of an operation company.

These fall under two headings, namely, "Standing Charges," in which category are placed all charges and costs which are independent of the actual hours flown and must be borne whether a large or small amount of flying takes place; and "Running Costs," which comprise those charges which are directly dependent on the amount of flying done. Perhaps the clearest way of indicating the main charges which are relevant to air transport under their respective headings will be to set out a statement of the items as follows:

Standing Charges.

Insurance of aircraft and engines complete.
" " spare engines.
" " equipment.
" " buildings, plant, etc.
" " motor transport.
" " personnel.
Depreciation of equipment.
" " buildings, plant, etc.
" " motor transport.
Obsolescence of aircraft and engines.
Rents, rates and taxes.
Housing fees.
Office expenses, postage, telegram and telephone charges.
Lighting and power.
Cartage, travelling and salvage charges.
Advertisement.
Directors' fees and legal expenses.
Salaries and wages.
Sundry trading expenses.
Interest on capital.

Running Charges.

Gas and oil.
Maintenance of aircraft and engines.
" and running of motor transport.
Pilots' and mechanics' flying pay.
Wireless charges.
Landing fees.

When a company is operating regular services it is customary to pay a yearly rate to cover landing and housing fees, in which case the former charge will be included under the heading of "Standing Charges," and can consequently be omitted from "Running Charges."

Under the heading "Standing Charges," the heavy items of expenditure are:—

Insurance of aircraft and engines.
Obsolescence of aircraft and engines.
Salaries and wages.

With regard to insurance of aircraft, the percentage rate varies according to the type of machine used, the nature of the country operated over, the meteorological conditions existing, the system of maintenance and inspection employed, and the ability of pilots. In addition to this there is at the present day another factor which has an important bearing on insurance rates as a whole, which is the limited field, comparatively speaking, over which risks can be spread. As the number of aircraft in regular operation increases so the field for insurance will increase, with a consequent natural fall in rates.

Given a thoroughly sound operating organization, the factor which plays the most important part in insurance rates is the type of machine used. For example, a single engined machine of sound and reliable construction may call for a rate varying from 12½ to 25 per cent per annum, or even more, whereas an efficient three-engined machine, operated by a reputable company, may cost only 7½ per cent per annum. These rates may be obtained at the present day, and may be expected to be materially reduced as the market for aviation insurance widens.

Another factor which bears considerably on insurance rates is whether aircraft are operated as land machines or sea-going craft. This is obvious, since with the marine type of aircraft, the whole of their routes, lying as they normally do over water, are provided with a natural emergency landing ground from end to end, always assuming that the aircraft concerned is a seaworthy machine. Then again, an important consideration which weighs with aircraft insurance underwriters, is the ease with which aircraft can be repaired in the event of damage. Obviously a machine which, from its form of construction, is costly and difficult to repair, calls for a higher insurance rate than one of which the reverse is true. The influence on rates due to the nature of the country on any particular route, the prevalent meteorological conditions, the system of maintenance and ability of the pilots employed, are too obvious to need any explanation.

As regards obsolescence, no prudent concern equipped with present day aircraft could base obsolescence charges on a longer life than five years, in other words, the value of aircraft must be written down annually at a rate of 20 per cent. At the end of five years, an aircraft of sound construction which in the meantime has been efficiently maintained, would still possess a certain value, but it is doubtful if it would be possible to realize it practically. This charge of obsolescence raises one of the most difficult problems for consideration in connection with the present day operation of air transport. So long as extensive developments in the design of aircraft are likely to occur, these charges must be faced, and constitute an additional reason for the system of intensive operation on which so much stress has already been laid.

The item of expenditure due to salaries and wages requires little comment. There is, however, one aspect which deserves consideration. It has been explained that there are two alternatives, by either of which extensive operation can be achieved, namely, by flying over long routes or by running frequent services backwards and forwards over short routes. The former necessarily calls for the establishment of a number either of main or subsidiary stations, which involves the employment of personnel at each of them, and incidentally of aerodrome equipment additional to that which would be required when operating intensively over a short route.

Dealing now with "Running Charges," the main items of expenditure are centred in fuel consumption and maintenance of aircraft and engines.

Fuel consumption depends mainly on the horse-power of the engines employed, and varies only slightly per unit of power output with the design or type of engine used. This is true with the several types of engines now in use, but will not necessarily continue.

Maintenance constitutes one of the heaviest items of expenditure in the operation of air transport. Even the very best and highest pitch of efficiency which can be obtained is not good enough. The nearest approach possible to absolute perfection is essential, and this obviously costs money. Economy under this heading cannot therefore be obtained by any reduction in efficiency, and must be sought for and effected by faultless organization based on a thorough and sound system.

It cannot be too forcibly stressed that, apart from ground organization, reliability in the operation of air transport is almost entirely dependent on efficient maintenance, and consequently, anything short of perfection in this respect is false economy. It must be remembered that a lack of reliability has a repercussive effect on insurance rates; interferes with the regularity of services, thereby affecting receipts; upsets routine methods of working; and destroys confidence.

A brief study of this question of cost of operation makes it abundantly clear that many factors are in opposition to each other, and that a careful balance must be struck between the various advantages and disadvantages. For example, insurance and obsolescence, both serious items of expenditure, are directly dependent on the capital cost of the aircraft and engines used; cheapness of aircraft may, therefore, appear at first sight to be a primary consideration; against this, however, it may well be that the costs of maintenance may be so much greater for a cheap aircraft than for a more expensive one, that the advantages obtained over lower insurance and obsolescence charges may be outweighed by higher maintenance costs. These and many other problems of a similar nature are continually arising in the study of transport, and require very mature consideration in order that a sound conclusion may be arrived at.

Recent Air Mail Development in South America

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Progress in commercial aviation in South America during the past two or three years has been so rapid and extensive that it is difficult for one who left that country four months ago to state correctly the conditions at this date, therefore, unless otherwise stated, the following remarks deal with the state of development of commercial air mail routes as of January 1st, 1931.

In many ways the most energetic and progressive people of South America are those living in the southern half of the continent: in Argentina, Chile, southern Brazil, Uruguay and Peru, and in these countries the development of air mail routes has been most extensive. Some of the other republics of South America have had regular air mail and passenger lines in operation for years, especially Colombia, but the most extensive operations are in the hands of French, German or North American interests.

The most important commercial centres are: Buenos Aires in Argentina, and Rio de Janeiro and Sao Paulo in Brazil. Buenos Aires—generally known to English speaking people in South America as "B. A."—is one of the finest cities in the world and is by far the largest city south of the equator. It has a population of nearly two and a half million people, and naturally a city of that size needs means of rapid communication with the cities of Europe and North America.

Mail by fast steamers takes seventeen to nineteen days between London and Buenos Aires, or between New York and Buenos Aires, but by air mail the time between the former points has been reduced to eight days and between the latter points to seven days.

It is noteworthy that the air mail from Montreal or New York to Buenos Aires does not travel via the eastern coast of South America but is flown down the Pacific coast to Santiago de Chile and then over the Andes and almost due east across the continent to its destination—over a route about 600 miles longer than the eastern coast route; and the air mail from and to Europe is not flown across the Atlantic but is carried across the water between Africa and Brazil by fast steamers.

At the beginning of 1931 Buenos Aires received and dispatched European air mail once a week and North American air mail twice a week. At that date the large cities of Brazil were six days distant from New York and six and one-half days from London by air mail, while the fastest time possible by mail steamer would be twelve days. Sao Paulo was the southern terminus of the eastern coast route of the North American air mail, but it was expected that this route would be continued to connect with Buenos Aires some time in 1931.

The European air mail service is operated by the French "Compagnie Générale Aéropostale" and its subsidiaries or associated companies in the various South American countries.

The operations of the company are conducted under its own name between Buenos Aires and Natal and in Venezuela, while the S.A. Aeropostal Argentina is the operating subsidiary in Argentina. Passengers, mail and express are transported by these companies over the following routes, totaling 6,914 miles:

Under the Compagnie Générale Aéropostale: (weekly) Natal — Pernambuco — Maceio — Bahia — Victoria — Caravellas — Rio de Janeiro — Santos — Paranagua — Sao Francisco—Florianopolis—Porto Alegre—Pelotas—Montevideo —Buenos Aires, 2,895 miles.

Maracaibo — Maracay — Ciudad Bolivar — Maturin (Venezuela), 689 miles.

Under the S.A. Aeropostal Argentina: Buenos Aires—Mar del Plata, 240 miles.

Buenos Aires—Bahia Blanca—San Antonio del Oeste, Comodoro Rivadavia — Puerto Desecado — San Julian — Santa Cruz—Rio Gallegos (bi-weekly), 1,650 miles.

Buenos Aires—Mendoza—Santiago de Chile (weekly), 750 miles.

Buenos Aires — Monte Caseros — Posadas — Asuncion (Paraguay) (bi-weekly), 690 miles.

The air mail from and to North America is carried over the system of the Pan American Airways, which includes the operations of the Pan American Grace Airways Inc. operating between the Canal Zone and Montevideo, via the Pacific coast, the Pan American Airways Inc., which operates from Miami, Florida, to Para at the mouth of the Amazon river, and Panair do Brazil, the operating company for Brazil.

The Pan American system, which is owned by the Aviation Corporation of the Americas, Inc., during 1929 and up to October 1st, 1930, increased its lines from 216 miles to over 19,000 miles. This was done by the absorption of pioneer companies' lines and their subsequent reconstruction, and by the extension of new lines in practically every American country or island-group south of the United States.

This system is the holder of United States Post Office Department foreign air mail contracts which cover the transportation of air mail from the United States to Latin American countries.

On September 1st (1930) the company's records showed that 5,344,447 miles had been flown; 30,727 passengers, 1,022,730 pounds of baggage and over 580 tons of air mail had been transported on the international routes with northernmost terminals in Brownsville, Texas, and Miami, Florida, and southern extremities at Montevideo and Buenos Aires, and that the volume of traffic of all kinds was increasing rapidly.

The German interests include the Scadta Company (Sociedad Colombo-Alemana de Transportes Aereos), in Colombia, the Sindicato Condor Ltda., of Brazil, and the Lloyd Aero Boliviano, in Bolivia.

The Scadta maintains an air mail service between Colombia, Panama, Ecuador and Peru, supplemented by steamship service to the United States and various other countries. The Condor Syndicate transports mail between Bolivia and the long coastal region of Brazil south of Natal, and connects with German steamers at the Island of Fernando do Noronha. The Lloyd Aero Boliviano maintains an air mail service between the interior cities of Bolivia and connects with lines of other companies carrying mail to the north, south, east and west.

All the aircraft and ground stations of the Pan American Airways, Inc., and of Panair do Brazil, are equipped with two-way radio facilities and the aircraft are in constant touch with at least two ground stations, while in flight. Short-wave radio telegraphy is used and expert operators are always carried. Each plane has a pilot and a relief-pilot, and, where passengers are carried they are attended by a trained steward, speaking English and Spanish or Portuguese, whose sole duty is to look after their comfort. From four to twenty passengers are carried on each plane. The nature of the country determines the general type of aircraft to be used—whether land plane, sea-plane or amphibian. The machines in general use are: Ford tri-motor land planes, Fokker F-10, Sikorsky amphibians, Commodore flying boats and Fairchild land and sea planes.

While the majority of the planes of the Pan American system are multi-motored, those of the French system are single-motored. Much of the flying over the French routes is done at night but without any special lighting of the routes. Planes of both systems cross the Andes through the same pass—between Santiago and Mendoza. The usual altitude for crossing the pass is about 18,000 feet, with higher mountain peaks on each side, one of which goes up to about 23,000 feet above sea-level.

Information given out by the three companies shows the following:—

The passenger and mail routes being operated by the Scadta company, totalling 2,440 miles, in October, 1930, were as follows:

1. *Magdalena Line.*—Barranquilla—Girardot—Bogota (daily), 650 miles.

2. *Inter-Oceanic Line.*—Barranquilla—Quibdo—Buenaventura—Tumaco (Colombia)—Guayaquil (Ecuador) (weekly), 1,200 miles.

3. *Atlantic Line.*—Santa Marta—Barranquilla—Cristobal (Canal Zone), 500 miles.

4. *Trans-Andean Line.*—Bogota—Girardot—Ibague (bi-weekly), 90 miles.

The company states that in 1929, a total of 781,000 miles were flown by its scheduled planes and a total of 5,500 passengers and of 134,400 pounds of mail were transported.

The Condor Syndicate, Ltd. reported that during 1929, 2,146 passengers, 44,447 pounds of baggage, 14,289 pounds of freight and 10,923 pounds of air mail were transported over its lines. The following lines making a total of 2,992 miles were in operation:

Southern Division: Rio Grande do Sul—Pelotas—Porto Alegre—Santos—Rio de Janeiro (weekly), 935 miles.

Northern Division: Rio de Janeiro—Bahia—Natal—Fernando do Noronha Island (weekly), 1,511 miles.

Bolivian Division: Rio de Janeiro—Corumba (Brazil) (weekly), 546 miles.

The Compania Lloyd Aero Boliviano operates a network of seven lines wholly within Bolivia. The routes totalling 2,264 miles are as follows:—

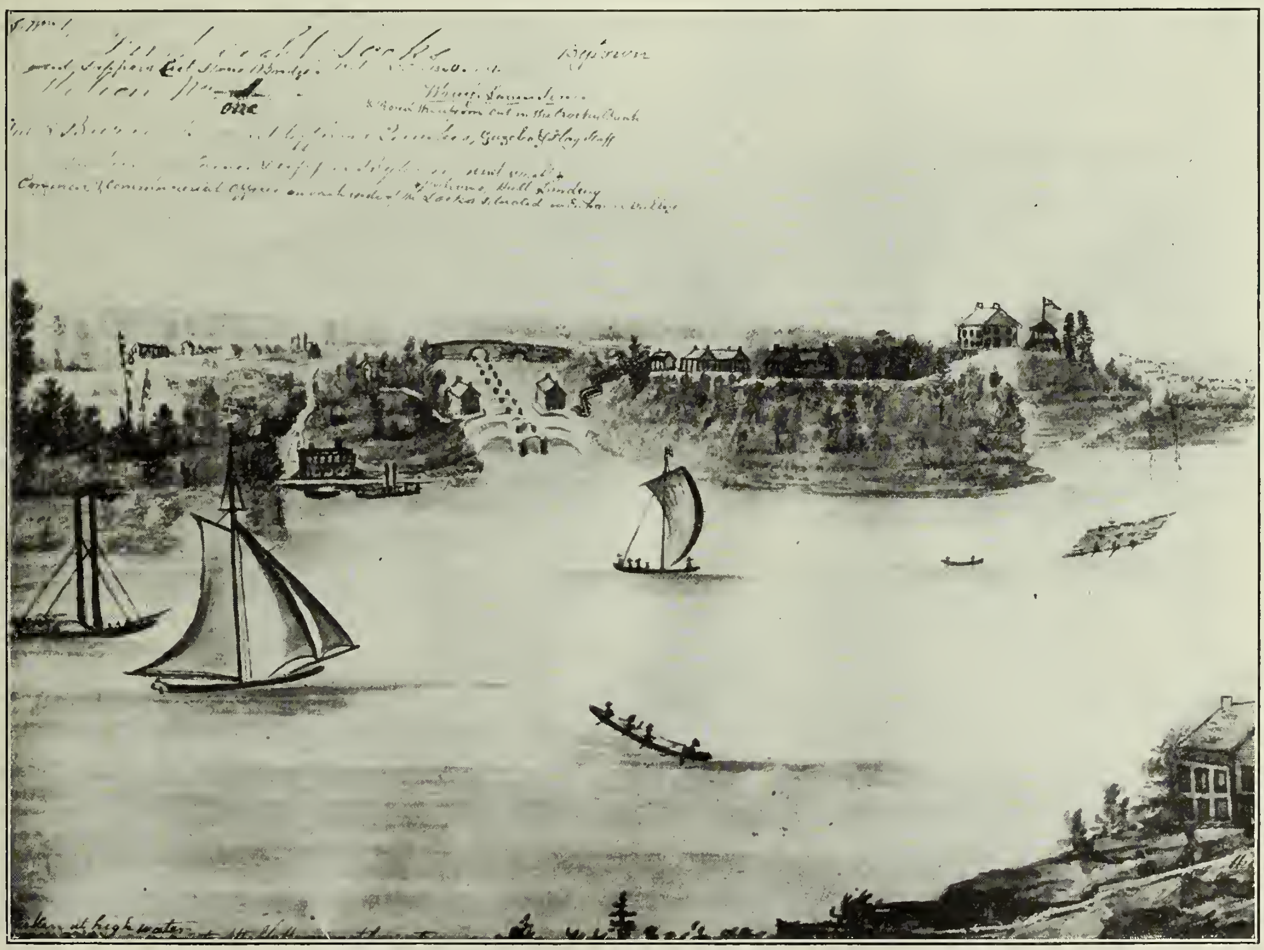
Cochabamba-Vallegrande-Santa Cruz	274 miles
Santa Cruz-Puerto Suarez	469 "
Cochabamba-Sucre	150 "
Santa Cruz-Yacuiba	375 "
Cochabamba-Todos Santos	135 "
Todos Santos-Riberalta	625 "
Cochabamba-Oruro—La Paz	236 "

In addition to these three large systems or groups of interests there are several smaller organizations operating regular air lines. These include the national air lines of Chile—half of which are operated by the Army Air Service and half by the Naval Air Service, and the Faucett Aviation Company of Peru.

Air mail is by far the most important subject of air transportation, due to its benefits to commerce and to the income it furnishes. Canada is now connected by air mail services to the following countries and colonies of Latin America:

Argentina
Bahamas (Nassau)
Brazil
British Guiana
British Honduras
Canal Zone
Chile
Colombia
Costa Rica
Cuba
Curacao
Dominican Republic
Dutch Guiana
Ecuador
Guatemala
Haiti
Honduras
Leeward Islands
Mexico
Nicaragua
Panama
Peru
Porto Rico
Salvador
Trinidad
Uruguay
Venezuela
Virgin Islands
Windward Islands

A letter from Montreal to Rio de Janeiro carried over the international air lines would be flown over 8,000 miles in seven days; across more than twenty-four international frontiers and over people speaking six different European languages.



Entrance to Rideau Canal at Bytown

An early view of the first eight locks of the canal from a print in the Public Archives of Canada.

(*See Biography of Colonel By, page 451*)

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Annual Meeting of The Institute

It is announced that the next Annual Meeting of The Institute will be held at the Royal York Hotel, Toronto, Ont., on February 3rd, 4th and 5th, 1932, under the auspices of the Toronto Branch of The Institute.

Report of the R.101 Enquiry

The report, dated the 27th of March, 1931, of the court appointed to investigate the accident of the airship R.101 is based upon an agreement on all points by the three members of the court, namely:—

Sir John A. Simon,
Lt.-Col. J. T. C. Moore Brabazon,
Professor C. E. Inglis.

The first part of the report deals with the early history of airships, and the circumstances which led up to the 1924 programme of construction of airships. It is pointed out that in undertaking the construction of the two airships R.100 and R.101, the Air Ministry ordered much more complete investigations of all the conditions to be met in the design of these airships than had ever been previously attempted.

These two airships were to be nearly twice the capacity of any previous airships built in England, and more than a third larger than the largest existing Zeppelin. The gross lift was supposed to be 150 tons, of which structure weight must not exceed 90 tons and the useful lift was to be 60 tons. Further the power plant was to operate on fuel that could be carried safely in tropical climates.

The Airship R.101 was designed by the Royal Airship Works at Cardington, although the actual construction of the parts of the ship was carried out by an outside contractor. This work was so well done that erection was made at Cardington without any difficulty.

The R.101 contained a number of experimental features, covering such things as the design and method of construction of the hull framing, the construction of the gas valves, and the design of the gas bag wiring which maintains the gas cells in position and transmits the lifting forces from the gas cells to the frame of the airship. In addition the method of construction and application of fabric covering included a number of changes over previous practice, and finally the use of engines employing a fuel oil instead of gasoline represented a big departure from what had been done before.

By the end of September, 1929, the construction of the R.101 was complete, but by this time it was known that the useful lift of the airship was considerably below the 60 tons originally estimated. Her fixed weights amounted to as much as 113.6 tons, leaving only about 25 tons for useful lift. The increase in the weight was partially due to the engines being overweight, but also due to the weight of the structure being greater than the estimated figure.

Two preliminary trials of 5½ hours and 9½ hours duration were carried out on October 14th and 18th, 1929, respectively. Four more trials took place between November 1st and November 14th. These were all of short duration from 3 to 14 hours, during which very complete data were collected, indicating the care with which these preliminary trials were carried out.

During this time on November 11th the airship rode out a severe gale while at the mast, without damage, but during which it was discovered that there was some chafing of the gas bags due to roll of the ship.

On the 17th and 18th of November an endurance flight was undertaken lasting 30 hours 41 minutes, although it had been intended that the flight should be of 36 hours with a possible extension to 48 hours; turning trials were carried out during this test, but a bridle connecting the gas bag wiring broke just prior to landing. The airship was then put into her shed where she remained until June of the following year, having done a total of 70 hours flying since launching, mainly in good weather and not including any trial at full speed. During these trials she had behaved well.

The question now arose as to how to increase the useful lift to make the voyage to India possible. These discussions resulted in a proposal to lighten the ship as much as possible by removing the servo gear, which supplemented hand steering, and a number of other fixed loads, and to enlarge the gas bag wiring so as to enable the gas bags to occupy more space. In addition it was decided to increase the length of the ship by inserting an additional middle section or bay, which it was estimated would increase the useful lift by nine tons.

When these changes were completed, with the exception of the insertion of the additional bay, the airship was brought out of the shed again on June 23rd, 1930, and was moored at the tower, when a split developed in the outer cover extending to a length of about 140 feet. Weather conditions did not permit putting the ship into the shed, and the tear was repaired in place at the mast. The next day another tear occurred, and it was similarly repaired.

The eighth, ninth and tenth flights took place on June the 26th, 27th and 28th, these being of 4½, 12½ and 12½ hours duration respectively.

Squadron Leader Booth's impression of the flight on June 27th indicated that the ship flying at reduced speed appeared to be bumping rather a lot, and during the day was getting heavier than seemed to be consistent with the temperature and height at which they were flying.

On July 3rd, 1930, the inspector in charge at Cardington reported considerable chafing of the gas bags against projecting parts of the structure, and on July 22nd the insertion of the new bay was authorized. The parts for this had already been received from the contractor.

In all the trial flights up to this time four engines had been used only for driving ahead and a fifth engine had been used for driving astern, due to the fact that the reversible propellers originally proposed had not been delivered. While the airship was being modified it was decided to install two reversing engines, and this and other delays resulted in keeping the airship in the shed until October 1st.

In previous documents Lord Thomson, the Secretary of State for Air, had approved the alterations to the airship, provided that she was ready to go to India by the last week in September. In the first design of this airship considerably more attention than usual had been paid to investigations upon strength and airworthiness of the structure, but although the insertion of a new bay necessitated a complete recheck of these design features, the time available did not permit of this being done, with the result that the consultants employed on this work had not finished their report at the time of the accident and had released the ship on October 1st, mainly upon general considerations rather than specific calculations.

The time fixed for the journey to India had now been passed and conferences took place with the Secretary of State, in order to fix the date of departure. It was decided that as the air business of the Imperial Conference might be put off until about October 20th the airship should start, if possible, on October 4th, giving the Secretary of State time to get back to England in time for the Imperial Conference.

In the early morning of October 1st the R.101 again left her shed and was taken to the mast. Up to this time the airship had not done the 48-hour trial, which was necessary for airworthiness purposes, and it was realized that to carry out a trial of this length would leave insufficient time for preparations before the India flight on October 4th. Therefore, permission was asked from the Air Ministry to reduce the trial flight to 24 hours, if Major Scott was satisfied with the ship's behaviour. If any report was made of this trial it was destroyed with the ship, but from such records as are available it is indicated that it was impossible to carry out the full speed test owing to the failure of an oil cooler in one of the engines. Also flying conditions were very perfect, and under these conditions the ship behaved well.

It is significant that at this point Squadron Leader Booth states that the ship's officers would have preferred a series of further flights had the time permitted. Flight-Lieutenant Irwin, commander of the ship, had particularly stated that he hoped they would fly 36 or 48 hours in bad weather.

Following this trial flight a conference was held at the Air Ministry at which it was decided that the ship would leave on the evening of Saturday, the 4th of October. At this conference it was pointed out that as the ship had not done a full power trial she would do full power tests near home after leaving Cardington for India. Subsequent events proved that this trial was not carried out.

The R.101 started on her flight for India on Saturday evening, October 4th, 1930, leaving Cardington at 6.36 (G.M.T.) in the dark with the wind blowing in gusts increasing in intensity and with the barometer falling.

There were fifty-four people on board, six of whom were passengers, six were officials from the Cardington Airship Works and the remaining forty-two were the officers and crew. Messages were received by wireless from the airship from 8.21 p.m. until 1.28 a.m., indicating that everything appeared to be normal on board the ship, also the watch was changed at 2 a.m., which is assumed to be an indication that all was well, otherwise this change of watch would not have taken place.

About this time the ship was passing to the east of Beauvais, and was seen by a number of citizens from the ground.

The evidence of the survivors shows that a few minutes after 2 o'clock the vessel got into a rather long and steep dive, then was brought out with approximately even keel, then went immediately into a second dive of shorter duration which brought her nose first to the ground, when she burst into flames.

Orders were given before the crash to reduce the speed of the engines. The contact with the ground was not severe, and the ship moved forward about 60 feet before finally coming to rest. It seems to be clearly indicated that no one was injured in the actual crash and that the loss of life was entirely occasioned by the subsequent fire, which is attributed to an electric spark.

The court find that the accident was not due to structural weakness, or to a failure of the control gear, also that the officers and crew were competent in the carrying out of their duties. They find, however, that the disaster was probably caused by a substantial loss of gas in very bumpy weather, this loss of gas being attributed to the failure of one or more gas bags in the forward part of the ship, which in turn might have been caused by some misfortune, such as the ripping of the forward part of the envelope.

Subsequent calculations made by the National Physical Laboratory appear to confirm that the path of the airship under these assumed conditions would be consistent with the evidence obtained.

Publications of Other Engineering Societies

From time to time announcements have appeared in The Engineering Journal and the E-I-C News 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 the same rate as charged to members of those societies. 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 Members	*Rate to Non-Members*
American Institute of Electrical Engineers		
Electrical Engineering, single copies	$ 0.50	$ 1.00
Per year	5.50	10.50
Transactions, per year:		
Paper	5.00	10.00
Cloth	5.00	10.00
Year Book	1.00	2.00
Pamphlets	.25	.50
American Institute of Mining and Metallurgical Engineers		
Mining and Metallurgy, single copies		.50
Per year		3.00
(Plus $1.00 for foreign postage.)		
Transactions, per volume		5.00
(Plus $.40 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
(Plus $1.00 for foreign postage.)		

This Institute gives no preference to members of The Engineering Institute of Canada.

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 $10.00.*

† *If subscription is received before February 1st, otherwise $16.00.*

American Society of Mechanical Engineers

Mechanical Engineering, single copies	.50	.60
Per year	4.00	5.00
Transactions, new, bound, fourteen sections complete (over 300 papers)	12.50	25.00
(Other publications, same rate to E.I.C. members as to A.S.M.E. members.)		

PERSONALS

D. R. Ross, S.E.I.C., has joined the staff of the Consolidated Mining and Smelting Company at Trail, B.C. Mr. Ross graduated from McGill University this spring with the degree of B.Sc.

W. L. Kent, S.E.I.C., who graduated from the University of Alberta with the degree of B.Sc. in the spring of this year, is now connected with the Provincial Department of Public Works, Edmonton, Alta.

K. S. Ritchie, S.E.I.C., is on the staff of the Research Products Engineering Department of the Northern Electric Company, at Toronto, Ont. Mr. Ritchie graduated from the Nova Scotia Technical College in 1931 with the degree of B.Sc.

W. B. Hutcheson, A.M.E.I.C., has been appointed assistant engineer, Department of Northern Development of the province of Ontario, at Kapuskasing, Ont. Mr. Hutcheson was formerly with the Dominion Water Power and Hydrometric Bureau, at Ottawa, Ont.

K. B. THORNTON, M.E.I.C.

K. B. Thornton, M.E.I.C., Honoured

K. B. Thornton, M.E.I.C., general manager of the Montreal Tramways Company, was elected president of the Canadian Electric Railway Association at a recent meeting of that society. When the present owners of the Montreal Tramways took control in 1925, it was found necessary to carry out many major improvements to that property and Mr. Thornton was then appointed assistant general manager, and had charge of the modernization of all departments. The improvements included the renewal of tracks, purchase of new cars, and an almost complete revision of the power supply. The rail services have been supplemented by numerous bus lines, so that to-day the Montreal Tramways is one of the largest operators of buses in Canada. Mr. Thornton has been connected with the Canadian Electric Railway Association for a number of years, having served on the board of directors, and his election to the office of president is the highest honour that can be conferred on an electric railway operator in Canada.

F. C. Tempest, A.M.E.I.C., is now located at Barranca Bermeja, Colombia, South America, as a member of the staff of the Tropical Oil Company. In 1930 Mr. Tempest was construction engineer and plant foreman with the Royalite Oil Company at Okotoks, Alta., and prior to that was with the Imperial Oil Refineries at Calgary, Alta.

K. E. Buchmann, A.M.E.I.C., is now on the engineering staff of Lake Shore Mines, Ltd., Kirkland Lake, Ont. Prior to accepting his present position Mr. Buchmann was with the International Nickel Company at Copper Cliff, Ont., and was at one time assistant to the chief engineer of the Deloro Smelting and Refining Company at Deloro, Ont. He is a graduate of the University of Toronto of the year 1925.

M. S. Blaiklock, M.E.I.C., assistant chief engineer of the Canadian National Railways, has retired after more than fifty years' service. He was for a number of years engineer of maintenance of way, and in 1930 received the appointment from which he now retires. Mr. Blaiklock, who has been active in connection with the co-operative management plan with maintenance of way employees on the national system, has consented to continue as chairman of the General Co-operative Committee of Maintenance of Way employees. Mr. Blaiklock joined The Institute as a Member on June 12th, 1909.

Lieut.-Colonel Charles G. DuCane, O.B.E., M.E.I.C., has been appointed by Council to represent The Institute at the Faraday Centenary Celebrations which are to be held this year. Colonel DuCane, who is well known in Canada, particularly in British Columbia, where he was head of a successful consulting organization, is now associated with the firm of Sir John Wolfe Barry and Partners, London, England. The Faraday Centenary Celebrations which are to take place in London on September 21st, 22nd and 23rd, 1931, commemorate the discovery on August 29th, 1831, by Michael Faraday, which made the dynamo possible, and formed the starting point of the utilization of electric power for the purposes of man.

A. Lariviere, A.M.E.I.C., has been appointed engineer of the Public Service Commission in Montreal in succession to the late F. C. Laberge, M.E.I.C. Mr. Lariviere is a graduate of the Ecole Polytechnique, Montreal, from which he received his degree of B.Sc. and C.E. in 1913, and E.E. in 1916. Immediately following graduation, Mr. Lariviere was engaged on highway engineering for the roads department of the province of Quebec, and for a short period on highway contracting. On the completion of his post-graduate course in electrical engineering in 1916, he joined the staff of the Quebec Public Utilities Commission, with which he has remained until the present time, first as electrical and road engineer, and since 1923 as chief engineer.

H. E. M. Kensit, M.E.I.C., after fifteen years in the Dominion of Canada Civil Service, has retired to enter

H. E. M. KENSIT, M.E.I.C.

private practice. After a number of years on investigation work in Canada and the United States, and on construction work in Canada for Messrs. Smith, Kerry and Chace, Mr. Kensit was appointed to the Water Power Branch of the Department of the Interior, and since that time has been engaged on the analysis of the financial and engineering aspects of power undertakings and the study of power markets in various localities. In 1918-1919 he represented the Department on the Government Water Power Committee and on the water power committee of the Conjoint Board of Scientific Studies, in London, England. On returning to Canada he investigated the power situation in Winnipeg and in Calgary, and took an active part in the preparation of the Dominion Water Power Regulations. Latterly he has been engaged on studies of the power demand and duration of water power resources in the St. Lawrence and Great Lakes basin and other large areas.

S. J. Fisher, B.Sc., M.E.I.C., has recently been appointed to the position of general superintendent in charge of the Riverbend mills of Price Brothers and Company, Ltd., and is now located at Riverbend, Que. Mr. Fisher was for six years sales and service engineer for Babcock and Wilcox, Ltd., and from 1916 for three years was engaged in mechanical engineering work at Ottawa for the Canadian and British governments. At the close of 1921 he entered the newsprint field with the E. B. Eddy Company, Ltd., at Hull, Que., where he was woods manager for four years, and also supervised the engineering, installation and start of operation of the new Eddy newsprint mill. In 1926 he joined the staff of John Stadler, M.E.I.C., in charge of the drawing office of the Lake St. John Power and Paper Company, Ltd. After supervising the installation of the machinery in the new newsprint mill at Dolbeau, Mr. Fisher was appointed mill manager, and started up and operated the mill for over three years.

BOOK REVIEW

Transactions of the Second World Power Conference, Berlin, 1930

Volume I: Uses of Electricity

Published by VDI-Verlag, GmbH, Berlin, 1930, cloth, 6 x 9½ in., 640 pp., figs., charts, tables. Agents: Percy Lund, Humphries & Co. Ltd., £2.0.0.

This is Volume I of the series of twenty volumes forming the set of publications of the Second World Power Conference. Eighteen of these volumes are each devoted to one of the Conference sections and give in convenient form for reference the papers presented and discussed at the Second World Power Conference held in Berlin in June, 1930. The papers are printed in either English, French or German, as the case may be, these being the three official languages of the conference.

The first volume of transactions contains twenty-eight of the three hundred and seventy-six papers presented at the conference, being those devoted to the uses of electricity. An introduction gives a general account of the Second World Power Conference and its proceedings, this being followed by a list of the distribution of the papers according to sections, and then the papers themselves, divided into two sections, Electricity in the Household and in Agriculture, and, Electricity in Crafts and Industry. At the conference, the whole field covered was divided among thirty-four such sections.

The discussions which arose are not given in detail but to each section of the volume is appended a brief summary in German of the discussion which took place on the papers it contains, together with a general report of the proceedings in each section.

Section 1 includes contributions on electrical supply in the house and on the farm, in Canada, Great Britain, Germany, France, Italy, Norway, Sweden, Greece, Japan, and the United States, while Section 2 contains papers on the applications of electrical power to electro-chemistry, electro-metallurgy, electrical heating, lighting, and gas purification, in most of the principal industrial countries of the world.

The volume is admirably printed and produced, and indicates that the whole series of eighteen volumes will be a most valuable addition to the shelves of public or institutional libraries, while individual engineers will find the volumes dealing with their special interests well worthy of perusal.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

American Welding Society: Year Book, August, 1930.
International Federation for Housing and Town Planning: International Housing and Town Planning Congress, Berlin, 1931: Part 1: Papers.
Ninth Annual Asphalt Paving Conference: Addresses, Papers and Discussions, December 1-5, 1930.
Canadian Institute of Mining and Metallurgy: Transactions, Vol. 33, 1930.
Corporation of Professional Engineers of Quebec: List of Members, June, 1931.
The Institution of Mechanical Engineers: List of Members, May, 1931.

Reports, etc.

DEPT. OF THE INTERIOR, TOPOGRAPHICAL SURVEY, CANADA:
[Map of] Winnipeg, Manitoba.
[Map of] Fort Assiniboine, Alta.
[Map of] Calgary Northwest.
[Map of] Calgary Southeast.
DEPT. OF TRADE AND COMMERCE, MINING, METALLURGICAL AND CHEMICAL BRANCH, CANADA:
Manufactures of the Non-Ferrous Metal in Canada, 1927.
NATIONAL RESEARCH COUNCIL, CANADA:
Thirteenth Annual Report, 1929-30.
CIVIL SERVICE COMMISSION, CANADA:
Twenty-Second Annual Report for the Year 1930.
DEPT. OF MINES, EXPLOSIVES BRANCH, CANADA:
Rapport de la division des explosifs du ministère des mines pour l'année civile, 1930.
DEPT. OF LABOUR, CANADA:
Investigation into an Alleged Combine in the Motion Picture Industry in Canada: Report of Commissioner, April 30, 1931.
DEPT. OF LANDS, FOREST BRANCH, BRITISH COLUMBIA:
British Columbia Woods and a Variety of Finishing Treatments.
HARBOUR COMMISSIONERS OF MONTREAL:
Annual Report for the Year 1930.
IMPERIAL CONFERENCE, GREAT BRITAIN:
Report of the Conference on Standardization, 1930.
DEPT. OF COMMERCE, DIVISION OF PUBLICATIONS, UNITED STATES:
List of Publications of the Dept. of Commerce, May 15, 1931.
BUREAU OF MINES, UNITED STATES:
Manganese and Manganiferous Ores in 1929.
Gold, Silver, Copper, Lead and Zinc in California and Oregon in 1929.
Sand and Gravel in 1929.
Mica in 1929.
Gold, Silver, Copper, Lead and Zinc in Idaho and Washington in 1929.
Copper in 1929.
Lead and Zinc Pigments and Salts in 1929.
Bauxite and Aluminum in 1929.
Mineral Resources of the United States, 1928: Part 1: Metals; Part 2: Non-Metals.

Technical Paper 498: Part 2: Factors Governing the Entry of Solutions into Ores During Leaching.
Bulletin 335: Quicksilver.
Bulletin 338: Quarry Accidents in the United States during the Calendar Year 1929.

St. Mary's Falls Canal, Michigan:
Statistical Report of Lake Commerce Passing Through Canals at Sault Ste. Marie, Michigan and Ontario, during Season of 1930.

The Port of New York Authority:
Second Progress Report on Kill Van Kull Bridge, March, 1931.

University of Michigan, Dept. of Engineering Research:
Eng'g Research Bulletin No. 18: The Surface Decarburization of Steel at Heat-Treating Temperatures.
Eng'g Research Bulletin No. 19: The Design of Capacitor Motors for Best Starting Performance.
Eng'g Research Circular No. 5: Research Service for Industry.
Eng'g Research Circular No. 6: Engine Performance at High Compression Ratios.

Ohio State University:
Eng'g Experiment Station Bulletin No. 61: Effect of Calcium Chloride as an Admixture in Portland Cement Concrete.
Eng'g Experiment Station Circular No. 23: How to Use Ohio Coal in School Heating Plants.
Eng'g Experiment Station Circular No. 24: Smoke and its Prevention.

Dept. of Registration and Education, Division of the State Water Survey, Illinois:
Bulletin No. 30: Laboratory Studies of Sludge Digestion.

Rensselaer Polytechnic Institute:
Eng'g and Science Series No. 31: An Investigation of Pressures and Vacua Produced on Structures by Wind.

National Electric Light Association:
Lamp Committee: Report, June, 1931.
Customers' Records Committee, Accounting National Section: Credits and Collections.
General Records Committee, Accounting National Section: Preservation and Destruction of Records.
Purchasing and Storeroom Committee, Accounting National Section: Handling, Disposal and Accounting for Obsolete and Sub-Standard Material.
Purchasing and Storeroom Committee, Accounting National Section: Public Utility Salvage Methods.
Purchasing and Storeroom Committee, Accounting National Section: Merchandise Stores Accounting.
Purchasing and Storeroom Committee, Accounting National Section: Application of Machine Methods to Stores Accounting.
Prime Movers' Committee, Eng'g National Section: Foreign Developments.
Meter Committee, Eng'g National Section: Summary of Public Utility Commission Rules and Regulations for Electricity Meters.
Meter Committee, Eng'g National Section: New Developments in Electrical Measuring and Auxiliary Testing Devices.
Motor Transportation Committee: Motor Transportation Operating Costs and Accounting Records.
Motor Transporation Committee: Electric Trucks.
Motor Transportation Committee: Utilization of Transportation Equipment

Kenya and Uganda Railways and Harbours:
Report of the General Manager on the Administration of the Railways and Harbours for the Year ended 31st December, 1930. Part 1.

Technical Books, etc.

Presented by D. Van Nostrand Co., Inc.:
Applied Kinematics, by J. H. Billings. 1931.
Principles of Electricity, by L. Page and N. I. Adams. 1931.

Presented by Northern Electric Co. Ltd.:
Monographs B534-B550, B553-B557.

Presented by Carnegie Steel Co. (United States Steel Products Co.):
Carnegie's Pocket Companion. Abridged edition, 1931.

Presented by Engineering Index Service:
Engineering Index, 1930. (2 vols.)

Presented by Federation of British Industries:
Fuel Economy Review, Vol. 10, 1931.

Presented by Major K. Weatherbe, M.E.I.C., and Major H. B. Stuart, A.M.E.I.C.:
From the Rideau to the Rhine and Back: The Sixth Field Company and Battalion Canadian Engineers in the Great War, Compiled by Major K. Weatherbe.

Presented by Ohio Brass Co.:
Insulation of Some of the Higher Voltage Lines [41 pp.]. (Paper presented at International High Tension Congress, Paris, June 18-27, 1931.)

Presented by Universal Oil Products Co.:
The Cracking Process in Roumania [20 pp.].—Reprinted from Gas and Oil Journal, March 6, 1930.
Safety and Cost Chief Factors in Considering Alloy Steels for Cracking Equipment [14 pp.].—Reprinted from Refiner and Natural Gasoline Manufacturer, April, 1931.

Purchased:
Handbook of Aeronautics, 1st ed., 1931.—Published under the authority of the Council of The Royal Aeronautical Society.

Catalogues

International Nickel Co., Inc.:
The Curtiss and Wright Engine [12 pp.].
Bulletin No. 208: Ni-Resist—A Corrosion and Heat Resistant Nickel-Copper-Chromium Cast Iron [11 pp.].

Priestman Bros. Ltd.:
Priestman Grabs and Steam-Grabs for Sand, Ballast, etc. [4 pp.].

Dodge Manufacturing Co. Ltd.:
Design and Operation of Belt Conveyors [7 pp.].—Materials Handling News, May, 1931.

Garlock Packing Co.:
Garlock-430 Chevron Packing.

Vancouver Machinery Depot:
Atlas Excavators [12 pp.].

The Canadian-Ingersoll-Rand Company, Ltd.:
Progress in a Canadian Metal Working Industry [29 pp.].

Combustion Engineering Corporation:
Catalog SG-1: Combustion Steam Generator [20 pp.].

Dominion Engineering Works:
An Improved Dominion Winder [4 pp.].

Worthington Pump and Machinery Corporation:
Worthington Centrifugal Pumps, Type-D (Monobloc) [8 pp.].

Enamel and Heating Products Ltd.:
A Chronicle of Achievement [48 pp.].

Canadian Limestones for Buildings

Canadian builders and architects are turning to the deposits of native stone for the material with which to build the finest structures within the Dominion. The Canadian limestones are ousting imported stones from the domestic market. Evidence of this may be seen in most of the principal cities from coast to coast wherever important buildings are being erected. The new store of the T. Eaton Company in Toronto is being faced with Tyndall limestone from Manitoba. This building covers eight acres of ground and will contain one million cubic feet of stone. The imposing new customs house in Toronto is faced with Queenston limestone. The head office buildings of the Royal Bank of Canada and of the Bell Telephone Company of Canada in Montreal, are faced with limestones brought from Queenston, Ontario, and St. Marc, Quebec. A similar combination of these two Canadian limestones is used in the fine new building of Price Brothers in Quebec city. Hamilton, Ontario, contains several fine structures in which both Queenston and Tyndall limestones have been used.

The cities of western Canada, especially Winnipeg, contain many structures of Tyndall limestone. The beautiful parliament buildings of Manitoba and Saskatchewan exemplify the architectural possibilities of this stone in the monumental type of building. Both the new post office in Calgary and the recently completed administration building of the government of Alberta in Edmonton are faced with Tyndall limestone. The same stone was used in the construction of the Hall building, Vancouver, and for the trim of the new wing of the Empress hotel in Victoria.

During 1930, the value of dimension-stone produced from Canadian limestone quarries was the highest ever recorded—$1,726,413—an increase of 42 per cent over 1929. This record production was concurrent with a decrease of nearly 30 per cent in value of building permits and a decrease of 20 per cent in imports of foreign limestone. A further increase in production is anticipated for 1931.

The principal quarries from which limestone for building purposes is obtained are located in three widely separated localities: St. Marc, 50 miles east of Quebec city; near Queenston in the Niagara peninsula of Ontario; and at Garson, 30 miles northeast of Winnipeg. The Queenston stone is a beautiful silver-grey. The St. Marc limestone is also grey. The Garson quarries produce the mottled Tyndall limestone, of which there are two varieties—one having a grey base, mottled with grey-brown, the other a buff base with buff-brown mottlings. All the Canadian stones are used for interiors as well as exteriors of buildings—particularly the Tyndall stone which, on account of its unique and handsome mottling, is commonly used as a decorative interior stone; a prominent example of its use for this purpose being the interior of the Houses of Parliament at Ottawa.

A very necessary quality in a building stone for exterior work is ability to resist the action of the weather and other agencies which cause decay. Researches by the Mines Branch, Department of Mines, Ottawa, and examination of structures erected many years ago, demonstrate that from the limestone deposits within the Dominion, building stones can be produced which are superior in strength and durability to any limestone imported into the country.

BRANCH NEWS

Ottawa Branch

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

Self Preservation in the Wilds

On Friday, 26th of June, at 8.15 p.m., in the lecture room of the Royal Canadian Air Force Photographic section, the Aeronautic section of the Ottawa Branch listened to a very interesting paper by Inspector A. H. Joy, of the Royal Canadian Mounted Police, on the subject of "Self Preservation in the Wilds."

Inspector Joy has had many years of experience in the Northwest Territories and in the eastern Arctic archipelago. Some of the personal experiences which he related in order to illustrate special points in his address proved that he was a master of his subject.

The matters upon which he spoke are vital to aviators who fly over the unoccupied territories of the north of Canada. After the lecture the Royal Canadian Air Force Photo Section showed a film illustrating the building of an Eskimo igloo and of an Eskimo dog sleigh.

Professor J. H. Parkin, M.E.I.C., of the National Research Council of Canada, was in the chair.

Sault Ste. Marie Branch

A. A. Rose, A.M.E.I.C., Secretary-Treasurer.

The regular meeting of the Branch was held in the Windsor hotel following a dinner. The speaker of the evening was Mr. Russel Wiber of the contracting firm of McLartys, Harten and Wiber, Ltd., who had taken as his subject "Construction Features of the New Windsor Hotel, Sault Ste Marie, Ont."

The New Windsor Hotel, Sault Ste Marie

The structure of this hotel is "reinforced concrete on the so-called pan system," that is, the columns, beams, joists, floors, etc., are of reinforced concrete, the joists being separated by pans over which the concrete is poured. Joists are placed two feet on centre and are continuous from front to back. The beams and lintels (outside beams) run across the building from east to west.

For the concrete a compression test was specified. As a very wet mix was necessary in order to work the concrete down around and into close contact with the reinforcing, some difficulty was anticipated in getting a mix that would fulfil requirements, but using screened gravel, sand and cement it was readily obtained.

The reinforcing steel was produced and bent by the local mill. That for the columns was assembled on the ground and then hoisted and dropped into place inside the forms. That for the beams and joists was fabricated in place. The floors were reinforced by round rods and expanded metal. A floor was poured in one day and construction was restricted to two storeys per week to give the concrete time to develop necessary strength.

The excavation is 14 feet below the sidewalk level, 10 feet of this being in solid rock. Piers are anchored in pockets. The rock was all hand quarried as it makes good building stone.

The outside walls are 8-inch tile, faced with brick, the tile being built in between the lintels and the whole wall carried by the framework from floor to floor, the brick work being tied into the lintels and tile. The partition walls are gypsum blocks except for bathrooms where they are terracotta.

The metal lath was put down before the concrete and is secured mainly by the grip of the concrete. There are suspended ceilings in the bathrooms, rotunda and dining-room. The hangers were left in the concrete between pans; to these channel irons were attached and lath applied to the channels.

A number of wells about two feet by four feet extending from bottom to top of the building take care of all plumbing, heating, etc. The wiring is all above the metal lath in the ceiling and below the concrete floor.

The stairs are of the service type, built of reinforced concrete. The window frames are yellow pine and the door frames are metal. The terrazzo floors were the only part of the building constructed by other than local artisans. The electric elevators are all manually controlled.

The roof is concrete slab, the same as the floors, with insulation and roofing. Another feature is the steel smoke stack, the lower 30 feet of which is lined with fire brick.

The rotunda finish is imitation travertine being first an ordinary three-coat plaster job on metal lath and after thorough drying a thick coat of "Gyptex" (powdered gypsum and plaster of paris) applied with heavy brushes and on partial hardening struck down with a steel trowel. The tinted effect is obtained by colour, integral with the Gyptex while in mortar state.

A hearty vote of thanks was tendered Mr. Wiber for his interesting paper. To add to the pleasure of the evening, Messrs. W. and E. Fulcher, of the Chateau Films, showed the Canadian National moving picture "Fishing Across Canada," which was greatly enjoyed by all.

Methods of Treating Roads

The regular June meeting of the Branch was held in the Windsor hotel on June 26th following the regular dinner.

The speaker of the evening, Mr. H. F. Coon, of the rotar department of the Alexander Murray Company of Toronto, being unable to be present, forwarded his paper, which was read by J. Hayes Jenkinson, A.M.E.I.C.

This paper described various methods of treating roads with tar products to make a durable dustless surface low in first cost and economical in upkeep. This was of special interest to those present, as the city plan to do some work of this type during the present season, and considerable discussion followed the reading of the paper.

Their Royal Highnesses the Prince of Wales and Prince George in Brazil

During their recent visit to Brazil, Their Royal Highnesses the Prince of Wales and Prince George visited the Sao Paulo-Parana Railway which is under construction by Macdonald, Gibbs and Company (Engineers) Ltd., and the lands of Parana Plantations Ltd., London.

The Institute is indebted to C. B. R. Macdonald, A.M.E.I.C., for the accompanying photographs, the first of which shows the triumphal arch erected in honour of Their Royal Highnesses by Macdonald, Gibbs and Company, and the second, the Prince of Wales returning to base camp after a 16 kilometer "stroll" over the partly finished railway line. Accompanying the Prince are: Lieut.-Colonel H. C. Macdonald, D.S.O., M.Inst.C.E., M.E.I.C., Lord Eldon, The Master of Lovat, C. B. R. Macdonald, A.M.E.I.C., Mr. Storrier, Scotland Yard. In the foreground are Captain T. D. Hamilton, M.C., M.Inst.C.E., Superintendent of the Sao Paulo Parana Railway, A. H. M. Thomas, Managing Director, Cia Tinas Notre de Parana.

Arch Erected in Honour of the Prince of Wales and Prince George.

Prince of Wales returning to Base Camp after a 16 kilometer Walk.

Committee on Trail Smelter Smoke Investigation of the National Research Council

Co-operating Organizations: British Columbia Department of Agriculture, Dominion Department of Agriculture and Dominion Forest Service

An international problem of some importance has arisen through the proximity to the Washington state line of the smelting and refining plants of the Consolidated Mining and Smelting Company of Canada, situated at Trail, B.C., in the Columbia river valley. It has been alleged by residents of the valley immediately south of the international boundary that smoke from the smelter is blown down into that territory, and that it has caused serious damage to forests, farm crops, livestock, exposed metal, and even to the soils of that area. The question was brought to the attention of the respective federal governments which asked the International Joint Commission to investigate and recommend a basis upon which settlement should be effected. The Dominion government instructed the National Research Council to make a scientific investigation of the effect of smelter smoke in that area, and field studies were accordingly begun in the spring of 1929. Obviously, no detailed report of that investigation can be issued until a settlement has been made, but something may, nevertheless, be said as to the method followed in the scientific studies.

The works of the Consolidated Mining and Smelting Company at Trail constitute one of the most important metallurgical plants in the world, one which, from the point of view of tonnage of metal produced, actually occupies the leading position. The company has some thousands of employees, both at Trail and at the principal mine and concentrator at Kimberley, B.C., and many more thousands are indirectly dependent upon the operations of this company for a livelihood. Its continued operation is therefore a matter of great importance, not only locally but also to the industrial life of the Dominion. During the last six years the operations of this company have been greatly expanded and improvements in metallurgical practice have been effected which not only have resulted in marked economies in operation but also have reduced, in some cases practically to the point of complete elimination, those constituents of the smelter gases which might have an adverse effect upon animal or plant life. In this respect also, the company has kept well in advance of the usual metallurgical practice. This has been fully borne out by an independent report made by G. L. Oldright, metallurgist of the United States Bureau of Mines.

Unfortunately, sulphur dioxide, which is one of the constituents of smelter smoke, is not readily eliminated from it, and has passed into the atmosphere in quantity up to 600 tons per day. This gas, in sufficient concentration, is harmful to vegetation and its action has therefore been the subject of the most careful study. Pursuing its established policy of advanced practice, the company has taken steps to convert a large part of this gas into sulphuric acid, which it proposes to use in the manufacture of super-phosphate and other fertilizers. This development will require an expenditure in excess of $10,000,000 for the first unit, which it is expected will be brought to completion in 1931, and the operation of which will, it is hoped, greatly reduce any present effect of the smelter smoke upon vegetation in the vicinity.

Field crop studies in the Northport district have been carried out for the National Research Council by Dr. G. H. Duff of the University of Toronto. Careful observations have been made both within and without the area in which it is claimed that damage has been caused by smelter smoke. A study has been made of farming practice, including the need for and use of fertilizers, irrigation, the prevalence of plant diseases and other related questions. A similar study of orchards in the district has been made by M. S. Middleton, horticulturist of the British Columbia Department of Agriculture. Soil conditions have been investigated by Dr. F. A. Wyatt, of the University of Alberta, who has determined the amount of plant food available, the activity of those micro-organisms necessary to plant life, the acidity of the soil and its content of soluble sulphate, a possible source of which might be the sulphur dioxide of the Trail plant.

Dr. S. Hadwen, recently of the University of Saskatchewan, and now in charge of veterinary research for the Ontario Research Foundation, has made a careful study of livestock in the district. Many animals found to be diseased or in poor condition were slaughtered and examined to determine the cause. Stock was inspected at points outside the area and where kept in immediate proximity to the smelter, and the condition of stock, fed on hay grown in the area where sulphur dioxide was frequently observed, was noted.

An extensive study of forests in the Northport district was made by A. W. MacCallum, forest pathologist, and R. Hopping, entomologist, both of the Dominion Department of Agriculture. In addition to the careful examination of the forests over a large area for evidences of sulphur dioxide markings, plots were selected both within and without the district, and a census was made to determine not only the condition of every living tree, but also, where dead trees were found, the cause of death. In this way a reliable comparison was secured between conditions prevailing in the zone of damage and those where sulphur dioxide is never found. In addition, some 3,600 trees were bored and the cores obtained were measured for annual growth by the Dominion Forest Service. The detailed study and interpretation of these measurements was undertaken by F. E. Lathe of the National Research Council. This study was somewhat complicated by the fact that for years there was operated in the town of Northport itself, a smelter which was the source of a considerable quantity of sulphur dioxide. A second factor of importance was that in the Northport area the precipitation is so low that under ordinary conditions it is the controlling factor in forest growth. In spite of these difficulties it nevertheless proved possible to determine the area within which retardation of growth has occurred, due to the operation of the two smelters, and to form an approximate estimate of the amount of retardation.

As a further check on the effect of sulphur dioxide in the district, the percentage of this gas present in the atmosphere was accurately determined, both by the extensive use of a portable apparatus with which a large territory could be readily covered, and by the installation of automatic recorders at two points where determinations were made every twenty minutes over a period of many months. Observations were made of the prevailing conditions of humidity, temperature, sunlight, wind direction and other known factors affecting sulphur dioxide presence and damage. In addition, the sulphur content of the vegetation was determined by analysis of samples obtained over a wide area, in order to detect any abnormal conditions. This chemical investigation was carried out by Dr. G. S. Whitby, Director of the Division of Chemistry in the National Research Laboratories, and by Dr. Morris Katz of his staff.

The results of these investigations to date have been presented to the Dominion government in the form of a report prepared by the president of the National Research Council, and also in testimony given by the scientific staff before the International Joint Commission in session in Washington, D.C., in January and February, 1930. It is proposed to continue the field investigations until a settlement of the case has been effected.

—*Thirteenth Annual Report of the National Research Council.*

International Business Machines Corporation announce that they have exclusive world rights to the Filene-Finlay Translator, a method of multiple, simultaneous translation, which provides for equipment to be installed in convention halls or other assembling places either in temporary or permanent form. When necessary, amplifiers throughout the hall insure that the whole audience may easily hear the speech delivered from the platform or the questions from the floor, microphones being provided at both points. In addition, however, a telephone line from these microphones carries the speech to a translators centre which may be a separate room, a series of soundproof stalls or merely a row of desks in some part of the auditorium. At the translators' centre are a number of highly trained translators, one, of course, for each language which is to be presented to the audience. Each translator wears a telephone headset, through which he hears the speech being delivered. In addition, each translator has a microphone before him, and all of these microphones are connected by a system of telephone cables to every seat in the auditorium. In cases where a speech is made in a language which all of the translators do not understand, one of them becomes a master translator. He receives the speech and translates to the other translators in a language which all understand.

The system is largely made up of standard telephone and radio units. Radio amplifying units are used to increase and control the volume of sound from the loud speakers as well as that delivered to the translators and from them to the audience. A special type of microphone has been developed for the use of the translator, so that no sounds other than his own voice can enter the instrument and the sound of his speaking is not heard by those working next to him. By this means, it will be possible for translators to work in the open hall instead of sound-proof booths for each man being required.

The Ohio Brass Company, Mansfield, Ohio, has recently succeeded in developing a new line of light weight malleable iron suspension clamps which will accommodate all sizes of conductors from 2-0 to 795,000 c.m. These clamps, it is stated, are well suited to A.C.S.R. conductor with armour rods and will equally well accommodate other types of conductors of comparable size requirements. Made of O-B Flecto malleable iron, the new clamps, while conforming to the same general design principles of former O-B clamps, have a number of new and valuable features. A smooth conductor seat of proper curvature to best serve the cable; much lighter weight at no sacrifice to strength; "J" or "U" bolts, depending upon the grip required; high resistance to corrosion, and general compactness are a few of the outstanding features.

Link-Belt Company, 910 S. Michigan Avenue, Chicago, Ill., announces the publication of Material Handling and Power Transmission Data Sheet No. 3, entitled "Selecting the Positive Drive," and containing suggestions which may aid in determining which type of positive drive will give most satisfaction. Copies of the sheet may be obtained from the company at the above mentioned address.

Preliminary Notice

of Applications for Admission and for Transfer

July 17th, 1931

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, 1931.

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

HOGG—SIDNEY, of 32 Sydney Street, Saint John, N.B., Born at Dundee, Scotland, January 1901; Educ., 1917-22, Dundee Technical College (Naval Architect); Member, Assn. Prof. Engrs., N.B.; 1918-21, dftsman., arrangement, steel and piping, 1921-22, designing, shiplines, stability, trim, etc., 1922-23, squad leader, Dundee Shipbldg. Co. Ltd.; 1923-24, struct'l. steel detailer, 1926-28, asst. struct'l. steel designer, Canadian Vickers, Ltd.; 1924-25, struct'l. steel detailer, 1925-26, checker, struct'l. D.O., Canadian Bridge Co. Ltd.; 1928-31, designing engr., Saint John Dry Dock & Shipbldg. Co. Ltd., at present in charge of struct'l. design dept., bridges, bldgs., tank and plate work. (Also responsible for design of highway bridges for Prov. Govt. of N.B. during past three years—Prof. R. E. Jamieson, McGill, and design of steelwork for pulp mill, F. O. White).

References: R. E. Jamieson, J. N. Flood, H. Thorne, J. Portas, V. S. Chesnut, A. A. Turnbull, H. J. A. Chambers.

KERRY—ARMINE JOHN, of Quebec, Que., Born at Montreal, Que., Aug. 6th, 1905; Educ., Diploma (Honours), R.M.C., 1927. B.Sc.(Civil) McGill Univ., 1929; 1924-25 (summers), asst. to plant engr., Canadian Paperboard Co., Frankford, Ont.; 1926 (summer), asst. to camp engr., Petewawa Camp; 1927-28, regimental employment, R.C.E., Halifax, N.S.; 1929-31, regimental duties in conjunction with various courses at the School of Military Engineering, Chatham, etc.; at present, Works Officer, M.D. No. 5, Quebec, Que. (Capt., R.C.E.)

References: E. J. C. Schmidlin, A. R. Whitelaw, J. H. L. Bogart, J. Weir, R. DeL. French, J. P. B. Dunbar.

MARLATT—VICTOR EGERTON, of Fort Churchill, Man., Born at Winnipeg, Man., June 20th, 1905; Educ., B.Sc. (C.E.), Univ. of Man.), 1930; 1922, 23 and 25, rodman, C.P.R.; 1926-29; instr'man., C.N.R.; 1930 to date, instr'man., Dept Railways and Canals, Fort Churchill, Man.

References: J. N. Finlayson, G. H. Herriot, E. P. Fetherstonhaugh, G. Kydd, W. L. Mackenzie.

FOR TRANSFER FROM THE CLASS OF JUNIOR TO A HIGHER CLASS

CLARK—GEORGE S., of Outremont, Que., Born at Lachute, Que., Mar. 5th, 1898; Educ., B.Sc., McGill Univ., 1922. 1922-23, sales and service engr., Bailey Meter Company; 1923-26, design and testing engr., Nfld. Power and Paper Co. Ltd.; 1926-29, responsible designing in connection with mill alterations and extensions, Price Bros. & Co. Ltd.; 1929-31, charge of machy. installn. for new board mill, and later asst. mill supt., Donnacona Paper Co. Ltd.; at present, mech'l. supt., Molson's Breweries, Ltd., Montreal, Que. (*S. 1919, Jr. 1925.*)

References: W. G. Mitchell, A. A. MacDiarmid, J. Stadler, R. L. Weldon, C. A. Buchanan.

McLENNAN—GORDON RODERICK, of Port Arthur, Ont., Born at Ottawa, Ont., Mar. 25th, 1898; Educ., B.Sc. (Mech.) 1922, (Elec.) 1923, McGill Univ.; 1923-24, test course, 1924-25, engrg. dept., Can. Gen. Elec. Co. Ltd.; 1925 to date, elect'l. engr. with C. D. Howe & Company, Port Arthur, Ont., design of elect'l. systems for terminal grain elevators, heating, ventilating, power generation and general engrg. work in connection with grain elevators. (*S. 1921, Jr. 1925.*)

References: C. D. Howe, R. B. Chandler, C. E. Sisson, J. G. Hall, F. C. Graham.

THOMPSON—TREVOR CREIGHTON, of 3955 Cote des Neiges Road, Montreal, Que., Born at Toronto, Ont., July 4th, 1898; Educ., B.Sc., McGill Univ., 1920; 1916 (summer), ship's Marconi operator; 1920, elect'l. repairs, Laurentide Paper Co., engrg. dept., Brompton Pulp & Paper Co.; 1921-23, dept. of physics, McGill Univ.; 1923-24, asst. mech. engr., Crosby Steam Gauge & Valve Co.; 1924 to date, with the Bell Telephone Company of Canada, Montreal, engrg. dept., divn. foreign wire relations engr., and at present, divn. transmission engr., Quebec Divn. (*Jr. 1921.*)

References: G. A. Wallace, J. L. Clarke, A. Lariviere, R. V. Macauley, R. H. Mather, J. L. T. Martin, F. S. B. Heward.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

ABBOTT-SMITH—HENRY BANCROFT, of 3610 Durocher St., Montreal, Que., Born at Montreal, Jan. 11th, 1902; Educ., B.Sc., McGill Univ., 1923; 1923-24, test course, Can. Gen. Elec. Co. Ltd., Peterborough, Ont.; 1924-25, power house operator, 1925-28, meter tester, and 1928 to date, asst. meter engr., Shawinigan Water & Power Company, Montreal, Que. (*S. 1923.*)

References: C. V. Christie, P. S. Gregory, G. A. Wallace, G. R. Hale, A. B. Rogers.

ARCHAMBAULT—JOSEPH U., of Quebec, Que., Born at Montreal, July 8th, 1904; Educ., B.Sc., Ecole Polytechnique, Montreal, 1927; Summers, 1925-26, instr'man., Quebec Streams Commn.; 1927-28, ap'tice course, Shawinigan Water & Power Company; 1928-29, engr., Quebec Telephone and Power Corpn.; 1929 to date, engr., Quebec Public Service Commission, Quebec, Que. (*S. 1925.*)

References: A. Lariviere, H. Cimon, L. Beaudry, P. Methe, A. B. Normandin.

GILLETZ—COLLY COLLIN, of 652 McEachran Avenue, Outremont, Que., Born at Cape Town, South Africa, Nov. 10th, 1903; Educ., undergrad., McGill Univ., 1922-25; Summer 1923, dftsman., Dominion Bridge Company; During all summer vacations, and from 1925 to date, with J. Gilletz & Company, bldrs. and gen. contractors, Montreal, estimating and in full charge of various jobs. (*S. 1924.*)

References: P. Bailey, C. S. Kane, L. H. Birkett, D. C. Tennant, A. Peden, F. P. Shearwood.

HARGROVE—PAUL, of Alcomdale, Alta., Born at Red Deer, Alta., April 18th, 1902; Educ., B.Sc. (Civil), Univ. of Alta., 1928; Summers—1926, rodman for city engr., Edmonton; 1927, instrumentman, city engr.'s dept., Edmonton; 1928, engr. in charge of grading, gravelling and boulevarding contract, City of Edmonton; 1928-29, asst. field engr. for the Calgary Power Company during constrn. of Ghost River power project, Cochrane, Alta.; 1929-31, engr. for waterworks dept. of same company at Edmonton; 1931 to date, transitman, Lethbridge Divn., C.P.R. (*S. 1927.*)

References: A. W. Haddow, R. S. L. Wilson, G. H. Thompson, H. J. McLean, H. R. Miles.

HOVEY—LINDSAY MANSUR, of Winnipeg, Man., Born at Rock Island, Que., July 8th, 1902; Educ., B.Sc., McGill Univ., 1925; 1918-19, dftsman. machinist, Butterfield & Co., Rock Island, Que.; 1923-24 (summers), experimental work at Kelvin School, Winnipeg; 1925-26, dftsman., 1926-28, junior engr., and 1929 to date, asst. elect'l. engr., Winnipeg Electric Company, Winnipeg, Man. (*S. 1921.*)

References: E. V. Caton, F. H. Martin, E. P. Fetherstonhaugh, N. M. Hall, J. N. Finlayson, J. W. Sanger.

HUNT—ALBERT BREWER, of Montreal, Que., Born at London, Ont., June 15th, 1902; Educ., B.A.Sc., Univ. of Toronto, 1928; 1925 (summer), Canadian Westinghouse Company; 1926-27 (summers), Bell Telephone Co. of Canada; 1928 to date, with Northern Electric Co. Ltd., as follows: Dec. 1928 to Jan. 1930, engr. in charge of development and manufacture of theatre equipment apparatus; Jan. 1930 to Jan. 1931, engr. in charge of vacuum tube manufacture; Jan. 1931 to date, asst. operating supt. (*S. 1926.*)

References: C. H. Mitchell, R. W. Angus, T. R. Loudon, E. V. Buchanan, W. H. Eastlake, H. Miller, S. R. McDougall.

O'DAY—MARTIN FREDRICH, of Sudbury, Ont., Born at Winnipeg, Man., Feb. 21st, 1902; Educ., B.Sc. (Civil), Univ. of Man., 1926; Summer work: 1920-21, instr'man., Good Roads Board; 1922-26, carpenter's helper, carpenter, and engr., for Fraser Brace Ltd., on various jobs; 1927-28, plant engr., La Quiebra Tunnel, Colombia, S.A.; 1929, engr., Island Falls, 1930, gen. carpenter foreman, Ontario Refining Contract, Copper Cliff, and at present, engr. at Frood, Ont., for Fraser Brace Engineering Company, Ltd. (*S. 1924.*)

References: J. H. Brace, J. N. Finlayson, N. J. Kayser, P. C. Kirkpatrick, E. P. Fetherstonhaugh.

SIMON—ROBERT CARLETON, of 4583 St. Catherine St. East, Montreal, Que., Born at Britonville, Que., Aug. 24th, 1902; Educ., B.Sc., McGill Univ., 1926; with Imperial Oil Limited, as follows: 1920 (Mar.-Nov.), machine shop work; 1921-22, dfting office; 1926 (June-Oct.), combustion dept.; 1926-28, designing and estimating; 1929, engr. on constrn.; 1930 (Jan.-June), in charge of rewriting plant account for Montreal East Refinery; 1930 (July-Oct.), inspr. of tankage, Quebec district; Nov. 1930 to date, designing, estimating, and instrument work at Imperial Oil Refineries, Ltd., Montreal. (*S. 1925.*)

References: C. M. McKergow, A. R. Roberts, F. C. Mechin, J. E. Letson, C. B. Leaver, H. G. Thompson.

EMPLOYMENT SERVICE BUREAU

This Service is operated for the benefit of members of the Engineering Profession and 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

All notices intended for publication must be received not later than the Tuesday of the week preceding the date of the issue in which they are to be inserted.

Situations Vacant

Assistant Commissioner of Works

ASSISTANT COMMISSIONER OF WORKS for the City of Ottawa, Ontario. Should be a graduate of the Faculty of Engineering in a recognized university, have complete and comprehensive knowledge of theory and modern practice of engineering, at least five years engineering practice, preferably municipal engineering experience, have held positions of professional responsibility and been in charge of work as principal or assistant engineer. Salary $4,000.00, increasing to a maximum of $4,500.00 per annum. Application forms may be obtained from the Headquarters of The Engineering Institute of Canada, 2050 Mansfield Street, Montreal, Que., and should be forwarded to the Board of Control, Transportation Building, Corporation of the City of Ottawa, Ontario. Applications will be received up until twelve o'clock noon (D.S.T.) August 18th, 1931.

CHEMIST. Electrolytic chemist for laboratory work. Must have practical experience in this particular class of work. Location, Manitoba. Apply giving full information regarding experience to Box No. 731-V.

PRODUCTION ENGINEER, for industrial plant in Quebec province, age about thirty-five, must speak French and English fluently, at least ten years experience in mechanical engineering, automatic machinery and general production work. Must have had actual experience in plant operation in a supervisory capacity, and able to introduce planning and production methods and maintain them. Apply to Box No. 738-V.

Capital to Invest

BUILDING CONSTRUCTION EXECUTIVE, located in New York city, Canadian born, graduate McGill University, wishes to locate in Canada, preferably Vancouver, B.C. Will invest $20,000 and services in established construction concern where capital is needed for expansion. Fifteen years field and office experience. Past three years general manager of construction. Apply to Box No. 230-W.

ELECTRICAL ENGINEER. College graduate with about seven years designing experience with large manufacturer of electrical apparatus; would consider junior partnership with electrical contractor or electrical repair firm. Could invest several thousand dollars. Correspondence invited. Apply to Box No. 579-W.

Situations Wanted

CIVIL ENGINEER, A.M.E.I.C., R.P.E. (Ont.), 15 years experience, available on short notice. Experienced surveys, draughting, reinforced concrete design, municipal engineering, construction work, inspection, estimating. Apply to Box No. 107-W.

CIVIL ENGINEER, university graduate 1926, desires employment as junior engineer or instrumentman on construction work. Experience, resident engineer on railway construction, miscellaneous surveys. References. Available any time. Apply to Box No. 149-W.

CIVIL ENGINEER, B.Sc., age 34, is open for a position as construction engineer in charge of construction of hydro-electric plants or paper mills; designing engineer of hydro-electric developments or paper mills. Willing to make small investment. Apply to Box No. 157-W.

ELECTRICAL ENGINEER, B.Sc., McGill 1926. Five years experience in the design of switchboards, layouts and wiring diagrams. Considerable experience in high and low tension switchgear design. Fifteen months experience in switchboard estimating. At present employed; available on short notice. Correspondence invited. Apply to Box No. 247-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.

ELECTRICAL ENGINEER. Graduate '25, wide experience in hydro-electric power stations, desires position on power plant design or related work. Apply to Box No. 278-W.

CIVIL ENGINEER, A.M.E.I.C., Canadian, R.P.E., Nova Scotia, 21 years engineering experience, both field and office, in railway, highways, foundations, concrete structures, water power and conservation, electric transmission lines, etc., experience comprising both surveys and construction, desires employment. Single. Will go anywhere. Working knowledge of French and Spanish. Available immediately. Apply to Box No. 327-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. Also some experience in ventilating and heating work and calculators. Accustomed to structural design and details. Good references. Present location Montreal. For interview apply to Box No. 329-W.

CIVIL ENGINEER; age 48; married; A.M.E.I.C., R.P.E., Ontario and New Brunswick; 32 years experience in municipal engineering, on roadways, sewers, waterworks and buildings, desires position with either municipality or as engineer superintendent with contractor. Ten years with City of Toronto, construction engineer on roadway work; four years consulting engineer; three years engineer in charge of construction work; one year resident engineer, Dept. of Public Highways. Available immediately. Maritimes or Ontario preferred. Apply to Box No. 336-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., R.P.E. Ont., with twenty-four years experience embracing dams, wharves, grain elevators, foundations, pile driving, highways, municipal engineering, water power surveys, road locations, inspections and estimating, is open for engagement as engineer or superintendent in construction, operation or maintenance. Location immaterial. Apply to Box No. 358-W.

CIVIL ENGINEER, graduate, age 32, A.M.E.I.C. Ten years experience; seven years on design, construction, erection work and maintenance of paper mill and mine buildings and machinery. Three years on hydro-electric work in charge of surveys and field investigations; associate hydro-electric engineer, U.S. Engineers, on office investigation, design and estimates; desires permanent position in Canada. Apply to Box No. 362-W.

STRUCTURAL AND CIVIL ENGINEER, Jr.E.I.C., age 31, married. Was instrumentman and structural engineer on erection of Royal York hotel, and asst. resident engineer on James Bay Extension, T. & N.O. Rly. Experience includes structural, civil and mechanical draughting and all kinds of instrument work and special work. Qualified as captain in military engineering, R.M.C., Kingston. Available anywhere in Canada, preferably Toronto, for any kind of work. Apply to Box No. 377-W.

ENGINEER ADJUSTER, MANAGER, desires to connect with an industrial concern or department which is not showing a proper return with a view to suggesting more efficient methods and eliminating bad debts. Apply to Box No. 411-W.

CIVIL ENGINEER, S.E.I.C., 1930 graduate. Experience as instrumentman on city and railroad construction, desires to enter structural or hydraulic field. Available at once. Will go anywhere. Apply to Box No. 467-W.

CIVIL ENGINEER, A.M.E.I.C., age 39, with wide experience on design and construction of reinforced concrete structures, desires position. Apply to Box No. 475-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment

Situations Wanted

and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

MECHANICAL ENGINEER, Jr.E.I.C., B.Sc., '26. Ten months experience in pulp and paper steam control. Four years experience in detail and design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

CIVIL ENGINEER, B.A.Sc., '29, with experience in supervision of construction and general office engineering, desires permanent position with contractor or engineer. Available at once. Apply to Box No. 524-W.

CIVIL ENGINEER, A.M.E.I.C., with twelve years experience embracing survey and construction, railway, hydro-electric and highways, foundations, pile driving, municipal engineering, water power surveys, road location, inspection and estimating, is open for engagement as resident engineer on construction or other responsible position. Experience comprises both office and outside work. Available immediately. Apply to Box No. 527-W.

MECHANICAL, CONSTRUCTION, AND DESIGNING ENGINEER, with special training in hydro-electric power development, underground steam distribution systems, and the operation of large electrical machinery. Active work desired. Apply to Box No. 528-W.

ELECTRICAL ENGINEER, S.E.I.C., B.Sc. E.E., 1931, desires to become associated with some branch of electrical engineering offering good opportunity for advancement. Sixteen months experience in draughting of electrical apparatus with large manufacturing concern; including layout work, and making of detail working drawings. Bulk of experience with industrial control apparatus. Location immaterial. Available on short notice. Apply to Box No. 532-W.

ELECTRICAL ENGINEER, married, graduate of McGill University, desires position in Ottawa, Montreal or Toronto. Experience includes four summers with a building concern as instrumentman and assistant engineer, two and one-half years with the Canadian Westinghouse Co., this time being distributed between tests, design and sales. At present employed but available on short notice. Apply to Box No. 533-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C., age 32. Seven years general experience in hydro-electric power investigations and construction. Has been in charge of high power transmission lines location, also in charge extension surveys. Experience in office and field. Thorough knowledge of French. Best of references from former employers. Apply to Box No. 537-W.

STRUCTURAL ENGINEER, A.M.E.I.C., B.A.Sc. Wishes to join established firm of consulting engineers. Age 37. Married. Ten years experience design of reinforced concrete and steel on buildings. Two years practical contracting experience. Apply to Box No. 540-W.

CIVIL ENGINEER, McGill '20, A.M.E.I.C., P.E.G., age 31, single. Experience includes general engineering, especially reinforced concrete work, and eight years of pulp and paper mill construction and layout. Best of references. Available on short notice. Apply to Box No. 547-W.

UNDERGRADUATE ENGINEER, S.E.I.C., junior year standing (Sask.), desires work to complete course. Electrical or mechanical work preferred. Apply to Box No. 553-W.

Situations Wanted

ELECTRICAL ENGINEER, S.E.I.C., graduating 1931, desires employment in electrical engineering. Sixteen months draughting experience on electrical machines with a large manufacturing company. Work included making layouts and detail working drawings. Available immediately. Location immaterial. Apply to Box No. 555-W.

A.M.E.I.C., graduate of University of Toronto, 1915. Building engineer and superintendent, with considerable experience as installation, sales and promotion engineer. Present connection, four years in responsible position with large utility corporation. Open for immediate connection where he can use his past experience. Location immaterial. Apply to Box No. 560-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 561-W.

CIVIL ENGINEER, S.E.I.C., graduating this year. Experience in railway maintenance, and instrumentman on location and construction. Desires to enter any branch of civil engineering or industrial work affording technical experience and an opportunity for increasing responsibility. Will go anywhere. Apply to Box No. 567-W.

CIVIL ENGINEER, A.M.E.I.C., ten years experience as mining engineer of a colliery, six years railway construction, including location, construction, bridge construction, and maintenance. Also one year on hydro transmission lines; one year government land surveys. Would consider position in any branch of construction, as resident engineer or instrumentman. Apply to Box No. 569-W.

CIVIL ENGINEER, B.Sc. McGill Univ., Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

MECHANICAL ENGINEER, A.M.E.I.C., experience in the design and maintenance of steel mills, zinc and sulphuric acid plants, cement plants; power house layouts; familiar with shop practices and costs, desires connection. Apply to Box No. 571-W.

YOUNG ENGINEER, Jr.E.I.C., experienced in design, details and erection of steel and concrete structures. Also a good theoretical and practical knowledge of steam, hydraulic and I.C. engine power plant. Good practical mechanical and electrical engineer, able to operate and maintain any type of machinery or power plant. Location immaterial. Apply to Box No. 572-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., (Univ. of B.C., '30), Undergraduate experience in pulp mill. One year's experience, Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

TEMPORARY EMPLOYMENT wanted by an engineer with wide experience in the design and operation of steam power plants and heating system. Apply to Box No. 584-W.

CIVIL ENGINEER, S.E.I.C., 1931 graduate, age 26. Experience in draughting, designing and estimating in structural engineering. Desires to enter structural, hydraulic (including hydrographic) or municipal field affording technical experience. Location immaterial. Available at once. Apply to Box No. 593-W.

Situations Wanted

ELECTRICAL ENGINEER, graduate Univ. of Alberta, '31, with excellent record, desires connection with electrical manufacturing firm, power or communication company. Good general experience includes one summer railway construction, two summers geological surveys in oil fields of Alberta, planetable topographer and asst. geologist. Available immediately. Apply to Box No. 596-W.

MECHANICAL ENGINEER, age 22, graduate '31, Univ. of Alberta, experience as draughtsman and instrumentman-inspector, is open for a position. Location immaterial. Apply to Box No. 598-W.

MECHANICAL ENGINEER, S.E.I.C., age 21, four years mechanical engineering, Queen's University, desires permanent employment. Experience in wood work, machine shop work, draughting and surveying. Location immaterial. Available at once. Apply to Box No. 600-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building, desires change. Location immaterial. Available on one month's notice. Apply to Box No. 601-W.

ELECTRICAL OR MECHANICAL ENGINEER, B.Sc., '31, S.E.I.C., desires employment which will give experience and lead to advancement. Two summers in a large communication company, including draughting, switchboard and surveying. Available on short notice. Will go anywhere. Apply to Box No. 606-W.

CHEMICAL ENGINEER, S.E.I.C., University of Alberta '30, desires a position in any industry with chemical control. Experience includes three summer vacation periods of five months each as assistant chemist, and ten months as chief chemist with a cement company. Age 29. Single. Available at once. Apply to Box No. 609-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. (C.E.), Univ. of Man. '31, desires temporary or permanent employment on engineering work. Twenty months experience in summers as chainman, rodman and instrumentman on railway grade and bridge construction; also as inspector on reinforced concrete highway bridges. Salary and location immaterial. Available at once Apply to Box No. 614-W.

DESIGNING ENGINEER, industrial building designer, Jr.E.I.C., age 31, married, capable of taking responsible charge of the structural design and architectural details of steel or concrete manufacturing plants or power houses, also has had considerable experience in the design of office buildings, etc., desires reasonably permanent position. Very highest references from present employers. Location immaterial. Apply to Box No. 615-W.

MECHANICAL ENGINEER, Jr.E.I.C., 5 years apprenticeship on general mechanical engineering; 10 years experience on heating and ventilating and mechanical equipment of buildings. Design, draughting and production. Desires change. Capable of taking charge of engineering department. Further particulars if required. Apply to Box No. 616-W.

POWER ENGINEER, M.E.I.C., age 42. Married. Thoroughly conversant with electrical, steam, mechanical and industrial engineering,

Situations Wanted

desires executive position with large industrial, power or financial corporation. Best of references as to ability and positions held. Apply to Box No. 617-W.

CIVIL ENGINEER, Jr.E.I.C., B.A.Sc. '24, age 35, married. Five years designer and estimator with well-known firm of industrial builders; two years detailing, designing and estimating structural steel for bridges and buildings, also survey and municipal experience. Open for position immediately, will go anywhere. Apply to Box No. 618-W.

CIVIL ENGINEER, A.M.E.I.C., graduate '23, married, eight years municipal engineering experience. Sewerage and sewage disposal, water works, street pavement, etc. Also some experience highway construction. For the past three years engaged by firm of consulting municipal engineers. Desires permanent position. Location immaterial. Available immediately. References. Apply to Box No. 624-W.

ELECTRICAL ENGINEER, B.Sc., N.S. Tech. Coll. '31. Experience in design and construction of rural distribution lines, trouble shooting, inventories and general office work, desires position with public utility or industrial plant. Location immaterial. Available at once. Apply to Box No. 628-W.

Konel*

A Substitute for Platinum

A man set out to find a cheap substitute for platinum. He was so successful that for almost a year his results were not taken seriously. Oxide-coated filament for radio tubes was known as early as 1904; platinum as a core appeared to be the best material for life, strength, and emission of electrons. In 1925, five years after radio broadcasting had aroused public imagination, tubes were being made, in ever-increasing quantities, with platinum or platinum-iridium core filament. Platinum people were overjoyed; but not makers of tubes. Material for filaments was costing $186 an ounce.

Dr. E. F. Lowry, Research Physicist of Westinghouse Research Laboratory, undertook a search for a cheaper substitute. He was not a metallurgist, but as a physicist he knew something about behaviour of electrons and characteristics of a cathode in radio tubes. Others had tried. Iron, nickel, nichrome, tungsten, various ferrous alloys were already pronounced worthless. All had a poisonous effect on emission or had proved mechanically weak. But nickel looked good to Lowry, and he tried it in spite of preponderant opinion that on account of mechanical frailty nickel was impossible.

The first filament of pure nickel gave surprising results. Emission appeared as good as with platinum cores; nickel gave no more trouble from mechanical failures. It was too successful. Scientists, tube manufacturers, even colleagues hesitated to believe that the first attempt had succeeded when hitherto undisputed authority had pronounced nickel no better than other metals. Against claims that nickel filaments should have a life of only eighty hours, Lowry produced tubes on life tests for 1,500 hours and still burning. But none of his nickel filaments were manufactured commercially.

Convinced that he was working in the right direction and failing to convince others by the very simplicity of his methods, he decided to employ the wisdom of the serpent to drive home a simple idea: a nickel alloy with a new name might be more psychologically successful.

He tried 20% cobalt; the crystalline structure was unsatisfactory and it could not be drawn. The case looked hopeless, when he thought of the qualities of cobalt-ferrotitanium (a compound of iron and titanium) wire used in experiments several years previously. The first filament of nickel, cobalt and ferrotitanium, in proportion of 80, 20, and 10, gave results better than ever before. It seemed incredible that the first proportions tried could be the best possible. Even the discoverer began to hesitate, but scores of experiments failed to produce a better filament. Hundreds of experiments have since been made, but the alloy used today is essentially the same as that produced by Lowry's first attempt.

He named the new metal Konel, and in December, 1926, persuaded the Westinghouse Lamp Company to make fifty commercial tubes with it as filament core. About the same time the manufacturers discovered that Lowry was right also about nickel and started to use that for filaments. Within a year every manufacturer ceased the use of platinum in radio tubes! And none has used it since. Platinum-iridium cost $1,600 a pound; Konel costs a few dollars; a penny now buys what a dollar used to.

But for the discovery of a satisfactory substitute for platinum, development of radio tubes would be far behind its present status. Use of Konel not only appreciably increased tube life (operating 175 degrees colder than platinum filament), but also showed definitely that the filament core had a marked influence on emission. A new theory of electron emission from oxide filaments has been formulated; on this work the discoverer is now engaged.

Konel is harder to forge than high-speed steel, is very tough at high temperatures, when most metals lose their strength. Its ultimate strength is more than 60,000 pounds per square inch at 600 degrees C., compared with 40,000 pounds for stainless iron, 28,000 pounds for nickel and 35,000 pounds for chrome-nickel steel. It is extremely resistant to most acids, does not sputter, does not scale like iron under heat, and has a high electrical resistance. These unusual characteristics give promise of many uses outside radio tubes: valves for gas or Diesel engines, turbine blades, or other structural pieces which must withstand temperatures equal to red heat.

It is an electric-furnace product of extreme purity. For filaments it is produced in 20-pound ingots, forged, cold-rolled, drawn into wire, and then rolled to a ribbon of requisite dimensions. The smallest filament, rolled from a wire .001 inch in diameter, is .002 by .0005 inch, and must not vary by more than .0001 inch. Of this fairy-like ribbon, 57 miles would weigh only one pound.

—*Research Narratives of The Engineering Foundation.*

*Based on information supplied by Erwin Foster Lowry, Ph.D., Research Physicist, Westinghouse Research Laboratory, East Pittsburgh, Pennsylvania.

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The Diesel Electric Suction Dredge "General Brock"

B. G. Flaherty,
Chief Engineer, General Dredging Contractors Ltd., Montreal, Que.

An address delivered before the Montreal Branch on January 15th, 1931, and before the Ottawa Branch on May 7th, 1931.

SUMMARY.—This paper describes the successful employment of suction dredges in excavating difficult boulder-strewn material in the St. Lawrence ship channel between Montreal and Quebec, and deals with the arrangement and construction of the latest Diesel-electric dredge "General Brock," which has proved very efficient at this type of work. The author discusses the advantages of installing a self-contained power plant for such duty as compared with the purchase of electric power. The mechanical and electrical equipment is described including the main pump, the cutter and cutter drive and the machinery for handling and manoeuvring the dredge.

The past quarter of a century has been a period of improvement, refinement and the finding of new applications for materials and machines rather than of production of new or original ideas or methods. This is as true of dredging as of most other lines. Practically every kind of machine that we have to-day, or at least their prototypes, existed a quarter to a half a century ago. The first suction dredge was suggested and the idea patented by a German as long ago as 1857, and some were actually built and used in the harbour waters of Holland in the '60's. Later, this class of dredge was adopted more fully in America on the Mississippi river bars, and the California harbours and rivers.

The cumbersomeness (i.e. the excessive size and weight per horse power) of the primary power units of those early days, however, as well as the lack of development along other lines, made it so that, while these dredges could handle large quantities of water or mixtures of soil and water at low velocities through a pipe line, they could only handle comparatively fine material like silt or fine sand with any success. From that time the hydraulic suction dredge became (and remains to this day) fixed in the lay mind which has not seen the later developments, as a "sandsucker" or a "mudsucker." Nevertheless, improvements in this line have kept pace with those in most other lines until, to-day, this is one of the most practical, economic and efficient tools available, where large quantities of almost any kind of material except solid bedrock are to be moved and placed. This, in spite of the apparent paradox that the suction dredge must move from five to fifty volumes of water as a carrying medium for every volume of solid material moved into place through the same distance. Suction dredges now dig and pump solid shale, coral beds and marl, or pump heavy sand and gravel to distances of three miles from the borrow ground, and in some cases elevate the material as high as a hundred feet above the level of the water from which the material is dug.

Suction dredging along the St. Lawrence river under the old or "sandsucker" idea, practically had its beginning and ending with the "J. Israel Tarte" which did a great deal toward opening up the 30-foot depth channel through Lake St. Peter, and established some records for its time. Considerable work of this class has been done, of course, on the Great Lakes, the Welland canal, and the harbours of the Maritime provinces, but the St. Lawrence valley has always been considered a difficult, if not impossible, field for this type of dredge, on account of the prevalence of numerous boulders left by the icebergs when they melted in this glacial age inland sea.

The first real attempt at tackling this boulder strewn and embedded river bottom was when the 24-inch electric hydraulic suction dredge "General Wolfe" started in July, 1926, at Wolfe's cove, Quebec, to excavate in the proposed new harbour, and to fill in valuable areas along the shore line with the excavated material. This machine has just closed its fifth successful season at this work, and will soon finish the work laid out for it there. The success of the "Wolfe" led to the design and construction of the all-steel 24-inch electric hydraulic dredge "General Montcalm" which, in June, 1929, began a very difficult filling job for the Harbour Commissioners of Montreal, at Sections 56 and 57, completing a fill behind the wall in ten weeks, on which loading began immediately afterward, a valuable feature of the hydraulic fill. This dredge has finished its second season, with a good record for performance, under very difficult conditions.

When the contract for deepening of certain portions of the St. Lawrence river channel to 35 feet was let last March, it was felt that enough experience of conditions in this river district had been gained to provide for the design of an hydraulic suction dredge to do a major share of this work. Consequently, the design was authorized to go ahead; the steel was laid for the hull in Sorel in April, 1930, and the dredge "General Brock" went to work on Longueuil shoal, September 28th, 1930.

Following this brief résumé of dredging history on the St. Lawrence, we will proceed to analyze some of the problems that arose in the design of the latter plant in the order in which they occurred. Without wishing to bring up at this time a detailed discussion of the cost of power from various sources for a certain specific work, we do wish to state the proposition in general, thus: the laws of economics determine that, over a period of years, the cost of power

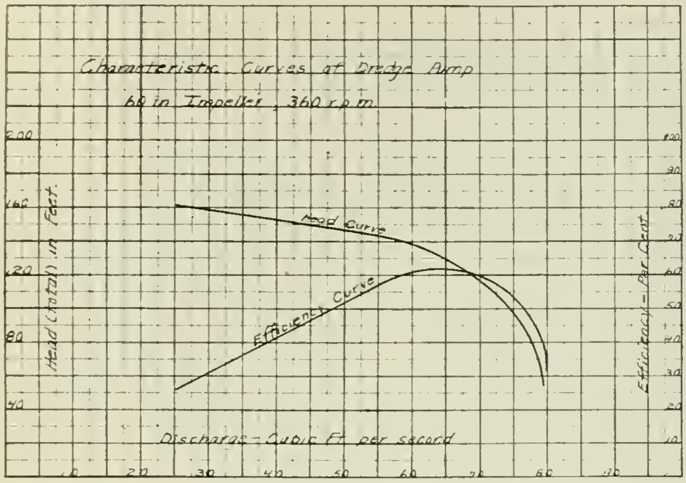

Fig. 1—Characteristic Curves of Dredge Pump.

per unit to be used in a certain definite place or way will be practically the same, whatever the means or manner of producing that power may be. Rather fine distinctions need to be drawn to-day to determine the difference between the cost of power obtained from hydro-electric systems, from external combustion (steam, etc.) plants, or from internal combustion engines, it being granted that the best modern practice is considered in each case. The argument might be endlessly prolonged to show that either one or the other method is most efficient or economical.

This being granted as a general statement, it becomes evident that the particular application determines in each case the best power to use. Purchased power shows to the advantage of the dredging or earth moving contractor only where large quantities (millions of cubic yards) are to be moved in a single locality, for the following reasons:—

1. The cost of the set up or connection is absorbed by the large yardage without appreciable effect on the unit cost.
2. Lower operation and maintenance costs, as less skilled help is required and greater part of plant cost is already absorbed in power price.
3. Less plant involved results in less fixed and standby charges.
4. Reliability is as good or better than in self-owned power plant. Thus for certain specific jobs, the purchase of power is desirable for suction dredges.

For the general dredging contractor, operating over a large territory, however, a self-contained power plant on the dredge is very necessary. First, the cost of moving from one set up to another and connecting up to the work is much less and there is no power connection charge; second, it is not dependent on variations of local power supply as to cycles, phase, voltage or capacity; third, utilization of the power can be made more efficient so as to get more work done with the same quantity of power used.

This latter feature is the most important single item to be considered in the application of power to dredging, and we must here enter into a short discussion of the centrifugal dredge pump and its drive in order to make clear just why this is so. The suction dredge pump is merely a rather crudely designed centrifugal pump, such as all are familiar with; necessarily crude because it must have large, unobstructed passages and clearances, and so built that wearing surfaces on the interior can be easily, quickly and cheaply replaced. Wear on these parts when handling certain classes of materials is very rapid, and they must be repaired often if any efficiency at all is to be maintained. The head and efficiency curves of such a pump are shown in Fig. 1, from actual operating data. This is the same type of pump, designed especially for dredging service, as those used on the last three dredges mentioned above.

For each kind of material that is to be handled by such a machine by suspension in water, there is a certain velocity of the mixture which will carry it most economically through the system. If the power applied to, and the speed of, the pump is too low to produce this velocity, the material will tend to settle out of suspension, and will then drag slowly along the pipe line, greatly reducing the output of useful spoil. If more power and speed is applied than needed, the power lost in friction in all the passages increases as the third power of the velocity, while the output (assuming a fixed percentage of load) increases only as the first power, resulting in a greatly increased unuseful power demand, without any appreciable increase in output.

In all dredging of this kind, the length of the discharge line and the static head to which pumping is done is continually changing with the natural shifting of operations. It is evident that to maintain the best efficiency, the speed and power applied should change with the changes in delivery conditions.

Alternating current motors operated from purchased power systems, such as are used by practically all electric dredges, are essentially constant speed machines (except as resistance is used to some extent in reducing the speed of wound rotor induction motors, a very inefficient and uneconomical practice for constant load service.) It is at once seen that with such a machine and a given diameter of impeller, there is only one condition of the delivery line which is truly efficient, there being an unusual loss either of output or of power for any change in discharge status. Of course, it is possible to convert the purchased A.C. to direct current and thus achieve complete speed regulation, but the initial cost then becomes practically equal to that of the self-powered dredge, without added advantages of mobility and flexibility of the whole plant, and also with a sacrifice of approximately 20 per cent of the power bought. The self-contained power plant generating direct current is perfectly adapted to this type of drive, for the distances of transmission are very short, and direct variation of speed of the main pump is obtainable without the necessity of varying the speed of the prime mover.

Having reached this point in our problem, we are faced with the necessity of making a choice of the kind of power to use in the self-contained plant. Practically the choice for electric generating purposes rests between the steam turbine and the Diesel engine. The capacity of the plant is the determining factor in making this decision. Where the total amount of power to be developed is less than 5,000 h.p. the Diesel engine has a decided advantage over

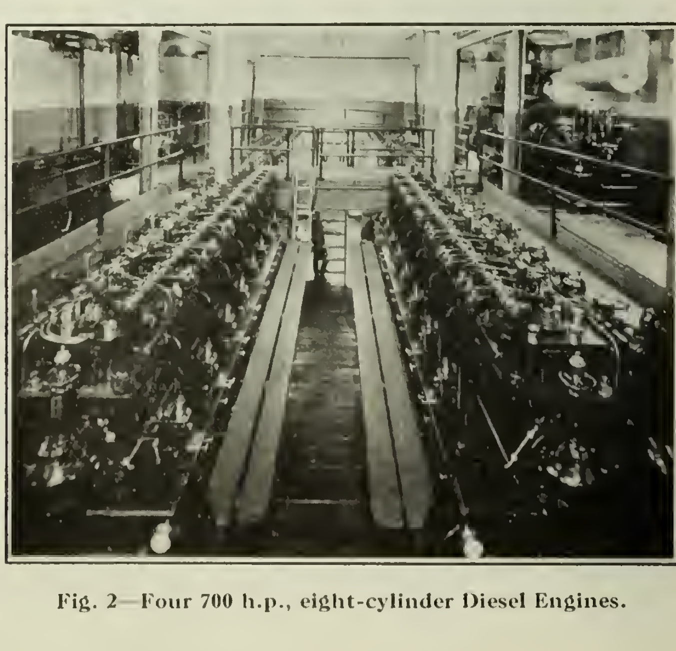

Fig. 2—Four 700 h.p., eight-cylinder Diesel Engines.

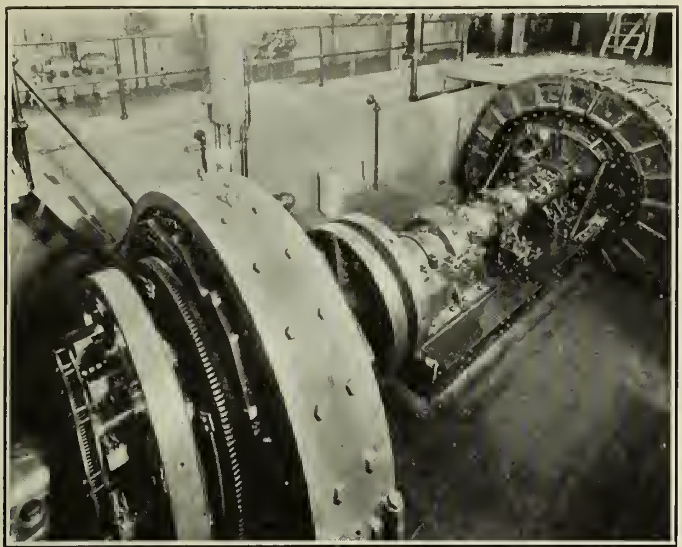

Fig. 3—Main Pump and Drive Motor.

the steam turbine in fuel economy, operating, fuel handling, attendance and standby cost. As the plant is increased beyond this point the steam turbine gains rapidly in all these points and becomes the logical choice for large power. Only a few years ago the steam plant held a more favourable position because of less first cost for a given output in units of any appreciable size, but to-day this advantage has disappeared due to the improvements in design and materials, and increased production, until now Diesel engined generating plants can be installed for approximately the same cost per horse power as steam plants, and have the added advantage of much better fuel economy.

Direct drive of dredge pumps by Diesel engine is not suitable because of the possibility of many complications arising in the combination, from critical speeds which may shift their position considerably with changing conditions in the dredge pump itself and the undesirability of running the engine at varying speeds for the same reason. A multiplicity of critical speed conditions may arise in such a combination that can hardly be predicted, or be protected against.

The main power plant and scheme of operation of the dredge "General Brock" was laid out with all these points, and some other minor consideration in mind. It consists of four (4) M.A.N. (Maschinenfabrik-Augsburg-Nürnberg)

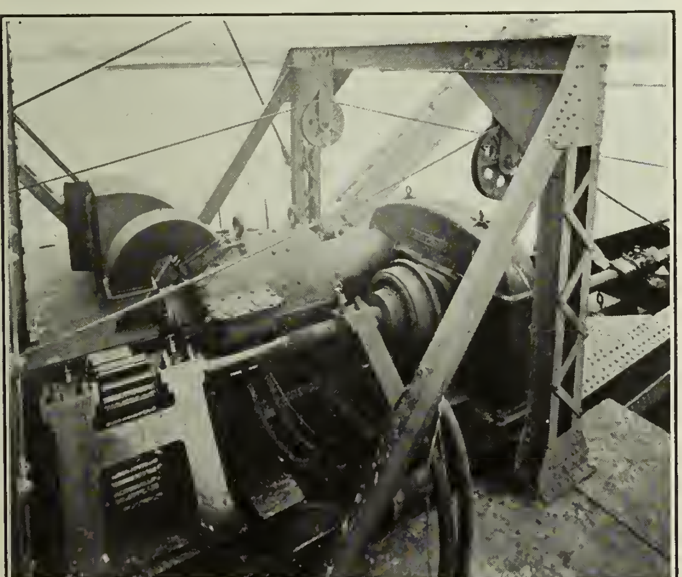

Fig. 4—Cutter Shaft Drive.

G Vu50 airless-injection, four-cycle, 8-cylinder full Diesel engines (see Fig. 2) rated 700 h.p. at 315 r.p.m. direct connected to 400-k.w., 250-v., D.C. generators of Canadian General Electric Company make. Great care and careful checking was used by both parties to the manufacture of these units to avoid proximity to critical speed points at the rated revolutions of engine and generator combination. The generators have a single outboard self-aligning bearing, and the engine end of the rotor shaft (flanged) is carefully fitted to a counter bore in the engine flywheel hub, and securely fastened thereto with fitted bolts. They are fitted with both shunt and series windings and may be operated either shunt or compound wound as explained later in describing the dredge operation and control. An auxiliary generator set consisting of a 3-cylinder M.A.N. Diesel engine of a similar type to the above, rated 95 h.p. at 450 r.p.m. direct connected to a Siemens-Schuckert 250-v., D.C. 60-k.w. generator is provided for standby power when the main plant is shut down. This set has its own independent circulating water and lubricating oil pumps so that it can operate without the necessity of running the general service pumps which furnish cooling water for the main units.

Four cylindrical fuel storage tanks with a combined capacity of about 600 barrels are placed below decks in the

Fig. 5—Pilot House.

outside holds of the dredge. These are all interconnected and the fuel handling pumps (electrically driven and furnished in duplicate) deliver oil from any or all of them to the daily service tanks, which latter are carefully graduated so that a careful check on the fuel consumption can be obtained. Filling connections to the interconnecting piping system are provided on either side of the dredge, air vents from each tank to above the house roof, and oil level indicators for each tank are furnished.

Lubricating oil tanks (duplicates) with a combined capacity of about 20 barrels, are located on the upper deck, above the level of the engines, furnishing gravity feed to each engine lubricating system. A lubricating oil centrifuge with electric heaters and electric driven pumps to draw the oil from the engine sump tanks and return it to the system is placed in the lower outside compartment next to the engine room.

Cooling water for the main engines is supplied from the general service water system, which is furnished by 1,500 gallons per minute Cameron centrifugal pumps (in duplicate) at 40 pounds pressure direct driven by 40-h.p. 1,750 r.p.m. 250-v. compound wound motors. This cooling water is drawn from a sea well with well screened intake in the outer hold, and may be discharged overboard, or turned

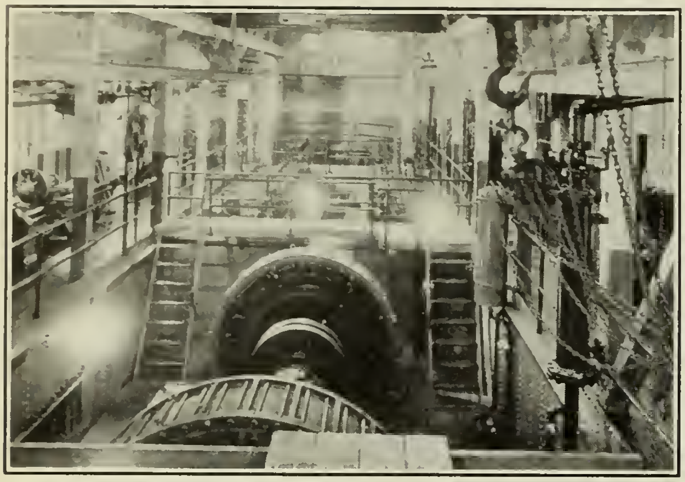

Fig. 6—General View of Interior of Dredge.

through the outer casing of the engine silencers to provide hot water on board if desired.

The bulk of power used by an hydraulic dredge is of course consumed in the drive of the main dredge pump and with varying conditions this may at times be as much as three-quarters of the total. Switching arrangements on this dredge are such that any number of the main units may be operated as separately excited shunt generators in parallel to drive the main pump motor. Any other one unit is of sufficient capacity to operate all the other machinery on board, usually termed the auxiliaries. The unit selected for this service operates as a flat compound wound generator, furnishing constant voltage and the excitation for all the other machines, including the main motor.

This arrangement practically provides a simple electrical coupling between the engines chosen (variable at the operator's discretion) for the main pump drive and the pump itself. It also provides a simple easy method of paralleling as many of the generators as desired and avoids some of the minor difficulties of paralleling compound wound generators driven by Diesel engines. The main control bus from which the excitation is taken is provided with a potentiometer type of rheostat which acts on the fields of all the generators which are paralleled so that their voltage may be reduced practically to zero for starting the main motor and raised or lowered as the operator desires to control the speed of the latter.

The main motor is rated 1,200 h.p. at 300 r.p.m., 1,500 h.p. at 360 r.p.m. and may be operated up to 400 r.p.m. by reducing the strength of its shunt field. It is direct connected through a link and pin type flexible coupling and a Kingsbury thrust bearing to the main shaft of the pump. (See Fig. 3.) No control apparatus is required in the main motor circuit other than a single pole solenoid operated circuit-breaker of 6,000 amp. capacity which opens and closes the positive side, the negatives of all generators being solidly connected together through the D.P.D.T. 2,000 amp. lever switches which select the service for which each of the latter is to be used.

Fig. 7—Diesel Electric Suction Dredge "General Brock."

Each generator has a 2,000 amp. solenoid-operated circuit-breaker in its positive circuit on its own individual panel at the engine room floor level, and a k.w.h. meter for measuring its total output. Indicating ammeters for each are provided on its panel in the main control switchboard on the main deck, where the rheostat control wheels for each are also located. Beside the control panels for the generators is the main motor control panel with a tachometer indicating its speed at all times and the rheostat wheels for varying the latter. Pull switches on the main control board operate all solenoid circuit-breakers. Two panels beside the control board provide distribution of the auxiliary power through fused lever switches, and switching for the auxiliary standby generator set.

Fig. 8—Ladder and Cutter.

After the main pump, the most important user of power is the cutter drive. In some dredges the motor for this is placed in the forward hold and drives through a chain of spur and bevel gears along the centre line of hinge of the ladder to the cutter shaft, but in the "General Brock" the motor is mounted on the ladder itself. This results in the use of a completely enclosed, ventilated motor capable of operating at an angle of 45 degrees or more to the vertical equipped with ball and roller bearing and thrust bearing. This is a 250-h.p., 250-v. compound wound motor 375/750 r.p.m. with speed variation by shunt field control from master control in the pilot house. It drives through a C.H. No. 28 magnetic clutch to the drive pinion of a completely enclosed, single reduction forced oil lubricated Citroen helical gear. This gear is also equipped with ball and roller bearings allowing it to operate at an angle of 45 degrees to the vertical. The slow speed shaft of this gear reduction drives through a Wellman Bibby flexible coupling to an intermediate shaft and pinion, which latter drives the main gear on the upper end of the cutter shaft. This gives full flexibility and isolation of both gear box and motor from shocks due to the cutter striking heavy obstructions on the bottom and torsional movements of the ladder frame itself. The speed relation between the motor and cutter shaft is 12 r.p.m. of the latter at 375 r.p.m. of the former. (See Fig. 4.)

The operation of the cutter is controlled in the pilot house by a master controller which, through a contactor panel in the lower hold and a shunt field resistance, gives starting resistance speed regulation on three points, and field regulation above 375 r.p.m. on 18 points. The horse power rating is constant at 250 h.p. continuous above 375 r.p.m. Ventilation is provided by a blower motor inside the hull, which is connected across the motor terminals so as to start automatically with the latter.

The hoisting machinery for handling and manoeuvering the dredge is divided into two parts, driven by identical motors, of mill type, 60 h.p. continuous rating, 90 h.p. intermittent, compound wound, with 50 per cent shunt, 50 per cent series fields, the shunt field being suited for continuous full voltage. The forward portion, known as the swinging machinery, consists of gearing and shafting driven through Hill type clutches, three hoist drums, one for the ladder hoist, and a port and starboard swinging rope drum. Behind this is the spud hoisting machinery with drum, clutch and brake for each spud anchor. These motors are operated by manual drum controller and resistance regulation from the pilot house. The spud motor control includes dynamic braking in the off position for lowering the spuds gently in soft material.

The pilot-house arrangement, the dredge interior, showing the main pump room with power plant and switchboard, and a general view of the dredge in operation are given in Figs. 5, 6, and 7. The latter was taken at Three Rivers in November, 1930, at the end of a swing to port while pumping a heavy percentage of sand and silt.

The following list gives some of the general features and dimensions of the dredge:

1. *Hull*—Length—150 feet 0 inches (moulded).
   Width—40 feet 0 inches.
   Depth—12 feet 0 inches.
   Height main deck house—10 feet 0 inches.
   Ladder well—11 feet 0 inches by 16 feet 0 inches.
2. *Ladder*—Built up of 30-inch, 240-pound I beams, with C.S. strong backs and head length from hinge 76 feet, cutter shaft diam. 9 inches under keyways.
3. *Suction Pipe*—26½-inch inside dia. ¾-inch wall machine welded steel, with C.S. fittings and swivel elbow at hinge centre of ladder, furnished with clear water packing under pressure from general service pumps.
4. *Discharge Pipe*—24-inch dia. machine welded steel, with C.S. fittings and C.S. swivel elbow at stern of dredge. Swivel elbow gland supplied with clear water under pressure from general service line.
5. *Spuds*—34½-inch dia. in 36-inch casings, 85 feet long, built up of 16, 6-inch Tee bars with flange moulded to outside cylindrical plate, and tied together on inside edge of web with 1 inch by 4 inch rings at 4 foot 0 inch intervals.
6. *Main Pump*—9 feet 6 inches dia. casing (cylindrical) with 60 inch dia. runner, main shaft 10 inch dia.
7. *General Service Water Pumps in Duplicate*—Cameron centrifugal 40 lb., disch. pressure 1,500 g.p.m., driven by 40 h.p., 1,750 r.p.m. motors.
8. *Machine Shop*—Lathe, drill, press, bolt threader, emery wheels, air compressor and tools. Oxy-acetylene and electric welding sets.
9. *Vacuum Tank.*
10. *Vacuum Pump*—Nash Hytor driven by 10 h.p. motor.
11. *Lighting*—3 k.w. balancer set to furnish 125 v. for lighting distribution, four flood-lights, one searchlight. Vapour proof fixtures in oil storage compartments.
12. *Bilge Pump.*
13. *Booster Pump*—400 g.p.m., 15 h.p., 1,750 r.p.m. to boost general service pressure to 80 lbs. when required, or to paralled general service pumps.

On the Determination of Stringing Tensions for Transmission Lines and Cables

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SUMMARY.—This paper gives a method, illustrated, for finding temperature-tension relations for suspended cables. Three types of problem are considered, viz.: single spans with points of support at the same level, single spans with points of support at different levels, composite spans which have intermediate supporting structures. Hyperbolic methods are used throughout, and in the concluding paragraph the validity of the method for sags of any magnitude is shown.

In his *Numerical Tables of Hyperbolic and Other Functions,** the author has given a handbook of formulae for solving catenary problems of various types, and in particular for finding variations produced by changes in weather conditions. The purpose of this article is to give a method which greatly facilitates the obtaining of a set of tabular values from which a temperature-tension stringing chart can be constructed. The calculations are considerably simplified by the availability of the continuous process of computation for certain parts of the work.

The problem divides itself naturally into two main cases.

Case I. *Points of Support at the Same Horizontal Level*

From the formulae given in *Numerical Tables* we have

$$\frac{s}{x} = \frac{\sinh u}{u},$$

$$\frac{2\,q}{x} = \frac{\cosh u - 1}{u},$$

$$\frac{2\,T}{wx} = \frac{\cosh u}{u},$$

where s = length of cable, x = span, q = sag, T = tension at supports, w = weight of cable per unit length, and u = a parameter (span divided by twice the depth of the directrix below the vertex).

Then if we denote by t the temperature, by α the coefficient of linear expansion of the cable, and by λ its modulus of stiffness (ratio of tension to strain) we have

$$\Delta t = \frac{1}{\alpha}\left(\frac{\Delta s}{s} - \frac{\Delta T}{\lambda}\right).$$

Hence starting from a certain condition, e.g. a maximum allowable sag, or a maximum allowable tension, we may construct a table of values of the following quantities in the order given; $2\,T/wx$, u, $(\sinh u)/u$, $\Delta(\sinh u)/u$, $(\Delta s)/s$, $(\Delta s)/s - (\Delta T)/\lambda$, Δt, $(\cosh u - 1)/u$; T, t, q.

We may illustrate by an example:

A No. 3/0 B & S gauge solid copper wire weighs 0.508 lb./ft., has a diameter of 0.410 in. and a coefficient of linear expansion of 9.6×10^{-6} per degree F. An 800 foot horizontal span is to be erected so that the tension shall not exceed 3,000 lb._w when the temperature falls to $-50°$. Required a temperature tension chart for stringing, assuming the modulus of elasticity to be $18 \times 10^6\ \text{lb.}_w/\text{in.}^2$

Here we start with a tension of 3,000 lb._w and so the initial value of $2\,T/wx$ is 14.77. Then using decrements of 0.50 in $2\,T/wx$ we have

$$\Delta T = -101.6\,n,\ \Delta T/\lambda = -0.0000428\,n,$$

where n is the number of the entry, counting the initial entry as zero. Hence we may form the following table:

*Published by Houghton Mifflin Co., 1929.

TABLE I

$$\Delta\frac{2\,T}{wx} = -\,0.50\,n, \quad \Delta T = -\,101.6\,n, \quad \frac{\Delta T}{\lambda} = -\,0.0000428\,n, \quad \alpha = 9.6 \times 10^{-6}.$$

n	$\frac{2\,T}{wx}$	u	$\frac{\sinh u}{u}$	$\Delta\frac{\sinh u}{u}$	$\frac{\Delta s}{s}$	$\frac{\Delta s}{s} - \frac{\Delta T}{\lambda}$	Δt	$\frac{\cosh u - 1}{u}$	T	t	q
0	14.77	.0679	1.00077	0	0	0	0	.0339	3000	− 50°	13.55
1	14.27	.0703	83	.00006	.00006	.00010	10.4	.0352	2898	− 40	14.08
2	13.77	.0728	88	11	11	20	20.8	.0364	2797	− 29	14.56
3	13.27	.0756	95	18	18	31	32.3	.0378	2695	− 18	15.12
4	12.77	.0786	1.00103	26	26	43	44.9	.0393	2594	− 5	15.72
5	12.27	.0818	111	34	34	56	58.3	.0409	2492	+ 8	16.37
6	11.77	.0853	121	44	44	70	72.9	.0427	2391	23	17.09
7	11.27	.0891	132	55	55	85	88.5	.0446	2289	39	17.83
8	10.77	.0933	145	68	68	102	106.1	.0467	2188	56	18.68
9	10.27	.0978	159	82	82	121	126.0	.0489	2086	76	19.57
10	9.77	.1029	177	100	100	143	148.8	.0515	1985	99	20.60
11	9.27	.1085	197	120	120	167	173.9	.0543	1883	124	21.70
12	8.77	.1148	220	143	143	195	203.0	.0575	1782	153	23.00

The required chart is obtained by plotting T against t as given by this table.

Remarks:—

1. The values of $2\,T/wx$ and of T are best found by repeated subtraction (the continuous process), and the deductions $\Delta T/\lambda$ which are to be made from $\Delta s/s$ can best be set down by repeated addition. The other columns are obtained by using the *Numerical Tables*, and most of the necessary multiplications can be done on a slide rule.

2. A maximum tension at a specified temperature is the simplest critical condition from which to start in the construction of a Table I, but if the limitations are not of this form they can easily be reduced to it by means of the formulae given in *Numerical Tables*. Thus, suppose the tension is not to exceed 3,000 lb._w when there is a half-inch coating of ice at 0° F. and a wind pressure of 10 $\text{lb.}_w/\text{ft.}^2$

The weight of the ice per lineal foot is

$$3.14\left(\frac{.705^2}{144} - \frac{.205^2}{144}\right)\frac{62.5}{1.1} = .564\ \text{lb.}_w$$

The weight of ice and wire per lineal foot is

$$.564 + .508 = 1.072\ \text{lb.}_w$$

The force of the wind per lineal foot is

$$\frac{1.41}{12} \times 10 = 1.175\ \text{lb.}_w$$

Then the effective w is

$$(1.072^2 + 1.175^2)^{\frac{1}{2}} = 1.591.$$

$$\text{Then}\quad \frac{\cosh u}{u} = \frac{2\,T}{wx} = \frac{2 \times 3000}{1.591 \times 800} = 4.713,$$

$$\text{whence}\quad u = .2172,\ \frac{s}{x} = \frac{\sinh u}{u} = 1.00788.$$

The equation for a change in the value of w with a fall in temperature of t is (*Numerical Tables*, p. 69)

$$\frac{\sinh u_1}{u_1} - \frac{w_1 s}{2\,\lambda}\,\frac{\cosh u_1}{u_1} = \frac{s}{x}\,(1 - \alpha t - T/\lambda),$$

where the letters denote conditions before or after the change according as they are without or with the subscript 1.

Hence to get the conditions at 0° F. without wind and ice, take $w_1 = .508$ and $t = 0$.

$$\text{Then}\ \frac{w_1 s}{2\,\lambda} = \frac{.508 \times 1.00788 \times 800}{2 \times 23.7 \times 10^6} = .0000864,$$

$$\frac{s}{x}\,(1 - \alpha t - T/\lambda) = 1.00788\,(1 - .001265) = 1.00661$$

Therefore

$$f(u_1) = \frac{\sinh u_1}{u_1} - .0000864\,\frac{\cosh u_1}{u_1} - 1.00661 = 0.$$

To solve, form a table:

u_1	$\frac{\sinh u_1}{u_1}$	$\frac{\cosh u_1}{u_1}$	$.0000864\,\frac{\cosh u_1}{u_1}$	$f(u_1)$
.200	1.00668	5.100	− .00044	− .00037
.205	1.00702	4.981	− .00043	− .00002
.206	1.00709	4.958	− .00043	+ .00007

Therefore $\quad u_1 = .2053.$

$$\text{Then}\quad T_1 = \frac{w_1 x}{2}\,\frac{\cosh u_1}{u_1} = \frac{.508 \times 800}{2} \times 4.974 = 1011.$$

The procedure now is as before, with 1,011 lb._w as the limiting tension at 0° F. without ice or wind.

CASE II. *Points of Support at Different Levels*

This is the case which usually occurs in practice, but though at different levels the line joining the points of support does not usually make a large angle with the horizontal.* In such cases the tensions will be given to a close approximation by calculating them as for Case I, with the direct line joining the supports taken as the span. The limit of the inclination at which the approximation is satisfactory seems to be about 10°.

On the other hand, there is a method analogous to that used in Case I which will apply regardless of the inclination, and which will give the sag and other characteristics of the span at various temperatures.

By the formulae given in *Numerical Tables*, p. 70, we have:

$$y = c\{\cosh(x/c + k) - \cosh k\},$$
$$s = c\{\sinh(x/c + k) - \sinh k\},$$
$$\sqrt{s^2 - y^2} = 2\,c\sinh x/2\,c,$$
$$y/s = \tanh(x/2\,c + k),$$
$$T = wc\cosh(x/c + k)\ ,$$

where one end of the span is at (0,0) and the other is at (x, y);† s is the length, c is the depth of the directrix below the vertex, T is the tension at (x, y) and $\sinh k$ is the slope of the curve at (0,0).

In this case it is simpler to proceed from a series of values of s as independent variable and calculate the corresponding values of the other elements. The third of the above equations may be written

$$(\sinh x/2\,c)/(x/2\,c) = \sqrt{s^2 - y^2}/x,$$

$$\text{and}\quad \Delta\frac{\sqrt{s^2 - y^2}}{x} = \frac{s^2}{x\sqrt{s^2 - y^2}} - \frac{\Delta s}{s}$$

if we neglect terms of higher than the first order in Δs.

*This angle may conveniently be referred to as the inclination of the span.

†Actually (x, y) can be regarded as an arbitrary point on the catenary, but we are usually interested in the terminal conditions.

We may therefore form a table of values of the following quantities: s, $(\sinh x/2\,c)/(x/2\,c)$, $x/2\,c$, $x/c + k$, k, c, $\cosh\,(x/c + k)$, T/w, T, Δs.

The initial value to be taken for s is determined by some extreme allowable condition, and may be calculated by the method given in *Numerical Tables*, or it may be taken by finding the length for supports at the same level and separated by a distance equal to the direct distance between the given supports. As it is not essential that the initial value taken be exact, the latter method is usually good enough and it is more convenient.

The values of $x/c + k$ and of k are obtained by combining $x/2\,c + k$ with $x/2\,c$. But since the total change in s will not usually affect the fourth decimal place in y/s, the initial value of $x/2\,c + k$ may be used throughout the formation of the table.

We may illustrate again by an example:

Suppose that with the wire used in the example worked above, the horizontal distance between the supports is 800 feet, and that one end is 200 feet above the other. Required a temperature-tension relation so that the tension at the upper support shall not exceed 3,000 $lb._w$ at a temperature of $-50°$.

We have $x = 800$, $y = 200$, and if we denote the direct distance between the supports by $\bar{x}$ ft., then

$$\bar{x} = \sqrt{800^2 + 200^2} = 824.621.^*$$

Then for $T = 3000$, $w = .508$, $\bar{x} = 824.6$ we have

$$\frac{\cosh u}{u} = \frac{2\,T}{w\bar{x}} = 14.32,$$

whence $u = 0.0700,$

and $s = 824.621 \times 1.00082 = 825.397.$

This will serve for an initial value of s.

Then

$$\tanh\left(\frac{x}{2\,c} + k\right) = \frac{y}{s} = \frac{200}{825.4} = 0.2423,$$

and therefore $x/2\,c + k = 0.2472.$

Also

$$\sqrt{s^2 - y^2} = 800.800,$$

$$\frac{\sqrt{s^2 - y^2}}{x} = 1.00100,$$

$$\frac{s^2}{x\sqrt{s^2 - y^2}} = 1.064.$$

*The reason and justification for retaining six significant figures is given in the discussion following Table III.

Then if we take

$$\Delta s/s = 0.0001\,n,$$

we have

$$\Delta s = 0.0825\,n,\ \ \Delta(\sinh x/2\,c)/(x/2\,c) = 0.0001064\,n.$$

Hence we may form Table II.

In forming this table, it is well to leave two or three blank lines at the beginning to allow for additional entries. In this case, for example, the initial s adopted gives a T lower than the required initial T, but a couple of back entries remove this defect, and if now T be plotted against Δs, by the data of the last two columns, a series of values of Δs, starting from zero at an initial tension of 3,000 $lb._w$ and equal decrements of 100 $lb._w$, may be read off. The use of standard size graph paper of about 1 mm. fine mesh makes this possible with ease. Thence we may calculate the corresponding temperatures by constructing the following table:

TABLE III

$s = 825.277$, $\alpha = 9.6 \times 10^{-6}$, $\lambda = 2.37 \times 10^6$,
$\Delta T = -100\,n$, $\Delta T/\lambda = -0.0000422\,n$.

n	T	Δs	$\frac{\Delta s}{s}$	$\frac{\Delta s}{s} - \frac{\Delta T}{\lambda}$	Δt	t
0	3000	.000				− 50°
1	2900	.050	.000061	.000103	10.7	− 39
2	2800	.103	125	209	21.8	− 28
3	2700	.160	194	320	33.3	− 17
4	2600	.223	270	439	45.7	− 4
5	2500	.298	361	572	59.6	+ 10
6	2400	.380	460	713	74.2	24
7	2300	.475	575	870	90.6	41
8	2200	.585	708	1046	108.9	59
9	2100	.710	860	1240	129.0	79
10	2000	.860	1040	1462	152.2	102
11	1900	1.035	1253	1717	178.6	129
12	1800	1.225	1483	1990	207.0	157

There are several points of interest that may be mentioned regarding this solution:

1. In the matter of significant figures, although the horizontal and vertical distances between the supports are known only to the nearest foot say, one is justified in calculating the direct distance to six significant figures, as has been done, when differential changes are sought. The case is analogous to the finding of $\Delta(x^2)$ for $x = 417.3$ and $\Delta x = 0.0127$. The increment we know will contain three significant figures if we use differentials and apply ordinary

TABLE II

$\frac{\Delta s}{s} = 0.0001\,n$, $\Delta s = 0.0825\,n$, $\Delta\frac{\sinh x/2\,c}{x/2\,c} = 0.0001064\,n$, $\frac{x}{2\,c} + k = 0.2472$.

n	s	$\frac{\sinh x/2\,c}{x/2\,c}$	$\frac{x}{2\,c}$	$\frac{x}{c} + k$	k	c	$\cosh\left(\frac{x}{c}+k\right)$	$\frac{T}{w}$	T	Δs
− 2		1.000787	.0689	.3161	.1783	5810	1.0503	6100	3100	0
− 1		894	.0732	.3204	.1740	5465	1.0518	5750	2920	.0825
0	825.397	1.001000	.0775	.3247	.1697	5160	1.0532	5450	2770	.1650
1		1105	.0815	.3287	.1657	4910	1.0545	5180	2630	.2475
2		1212	.0854	.3326	.1618	4685	1.0558	4950	2515	.3300
3		1318	.0889	.3361	.1583	4500	1.0570	4760	2420	.4125
4		1425	.0925	.3397	.1547	4325	1.0583	4580	2330	.4950
5		1531	.0958	.3420	.1514	4175	1.0591	4425	2250	.5775
6		1638	.0992	.3464	.1480	4030	1.0606	4275	2170	.6600
7		1744	.1024	.3496	.1448	3905	1.0617	4150	2110	.7425
8		1851	.1054	.3526	.1418	3790	1.0628	4030	2050	.8250
9		1957	.1082	.3554	.1390	3700	1.0638	3940	2000	.9075
10		2064	.1114	.3586	.1358	3590	1.0650	3825	1943	.9900
11		2170	.1140	.3612	.1332	3510	1.0660	3745	1903	1.0725
12		2277	.1169	.3641	.1303	3420	1.0670	3650	1855	1.1550
13		2383	.1196	.3668	.1276	3345	1.0680	3570	1813	1.2375
14		2490	.1223	.3695	.1249	3270	1.0690	3495	1775	1.3200
15		2596	.1247	.3719	.1225	3210	1.0700	3435	1745	1.4025

rules. But the same increment may be obtained by taking the difference $417.3127^2 - 417.3000^2$.* In the case of the increments in this solution, differentials cannot be used and one is obliged to use extended figures and subtraction. The practice, however, is in no way a violation of the fundamental principles of significant figures.

2. When a value for $\Delta s/s$ is adopted, the increment of $(\sinh x/2c)/(x/2c)$ should be calculated. The tabular values of the latter function are then obtained by the method of repeated addition.

The adoption of a simple increment for $\Delta s/s$, such as $0.0001\,n$ which has been used here, has advantages over the adoption of a simple increment for Δs, especially when dealing with spans of different lengths.

3. The values of $x/2c$ are given from column 2 by interpolation from the *Numerical Tables.* They can be obtained to three significant figures. It is true that when $x/2c$ is less than 0.1, the value of the third figure so obtained is slightly in doubt, but in practice not more than to the extent of 1 or 2. This slight uncertainty can, however, be overcome if desired by noting that at this range $(\sinh u)/u$ is given by $1 + u^2/6$ to the sixth decimal place. Hence if the decimals in the column $(\sinh x/2c)/(x/2c)$ are multiplied by 6 and their square roots taken, the results will be $x/2c$. The square roots are readily read from the table of squares, *Numerical Tables*, pp. 54, 55, or the operation may be performed on a slide rule. As a matter of fact, interpolation from the *Tables* gives accuracy which is as close as is warranted by the data in problems such as these, and the tabulation of an extra decimal place in the *Tables* would not have been worth while.

4. When k is negative, the obtaining of the values of q, the sag below (0, 0), may be useful as a check on stringing conditions. The values may be obtained by a slide-rule since the table already contains both c and k, and since $q = c(\cosh k - 1)$.

The foregoing two cases illustrate the fundamental principles involved in problems of this nature. There is, however, a type of problem which involves the application of these fundamental principles to more complex cases.

Case III. *Composite Spans*

In the erection of transmission lines when several consecutive spans are strung at the same time, we might call the several spans so strung together a composite span. When the wire is run through single fixed sheaves at the intermediate supports the tensions on the two sides of each sheave will be equal until the wire is clamped. Hence when the individual spans are of the same length, and when the inclinations of the separate spans are not too large, the temperature tension relation which would apply to an individual span will also apply for the composite span. But when the individual spans are unequal, or when their inclinations are unequal and not small, then the temperature tension relations for the individual spans are unequal and that for the composite span needs to be worked out.

We shall consider an example.

A copper wire such as that used in the two previous problems is to be strung over a composite span of three sections. With the origin at one end, the co-ordinates of the other three supporting structures are (800, − 60) feet, (1,300, − 68) feet and (2,000, 12) feet. Required a temperature tension stringing relation so that the tension shall not exceed 3,000 lb.$_w$ at − 50°, and so that there shall be no uplift on any of the structures.

*The same result would also be obtained by taking the difference $417.3273^2 - 417.3146^2$, or by using any other set of three figures to extend the number 417.3, before adding 0.0127, provided the rounded off value of the extended number remains 417.3. That is, there is no assumption that 417.3 is exact. But of course, the simplest set of digits to use is three zeros.

A general method of procedure which will work with all problems of this type is as follows:*

1. From a sketch of the composite span it is obvious that the point at which uplift will first occur is at the structure between the second and third spans. Therefore construct a Table II, as in Case II, for each of the second and third spans, designed to give a maximum value of 3000 for T_3.

Now, since $dy/dx = \sinh(x/c + k)$, there will be uplift between spans 2 and 3 if the $x/c + k$ of 2 is less than the k of 3 for corresponding values of T_3 and T_2. In the initial parts of the tables, this will be found to be true. Also the values of T_2 are less by 40 (= 80 × .508) than the corresponding values of T_3.

Hence plot T_3 against the value of k for span 3, and on the same sheet plot T_3 against the value of $x/c + k$ for span 2. The value of T_3 at which the two curves intersect is the maximum allowable value of T_3. This value will be found by this means to be 2390.

2. Form a Table II for span 1, contemplating a maximum tension of 2,390 lb.$_w$ Data for greater tensions are now known to be irrevelant.

3. From the Tables II for the three spans plot T_1 against Δs_1, T_2 against Δs_2, and T_3 against Δs_3. Then from these graphs, remembering that for values of T_3 the corresponding values of T_1 and T_2 are less by 40, form the following table:

Table IV

$\Delta T = -100\,n$, $\Delta T/\lambda = -0.0000422\,n$, $\alpha = 9.6 \times 10^{-6}$,
$s_1 = 803.240$, $s_2 = 500.309$, $s_3 = 705.095$, $s = 2008.844$.

n	$T(=T_3)$	Δs_1	Δs_2	Δs_3	Δs	$\frac{\Delta s}{s}$	$\frac{\Delta s}{s} - \frac{\Delta T}{\lambda}$	Δt	t
0	2390	0	0	0	0			0	− 50°
1	2290	.085	.020	.060	.165	.000082	.000124	12.9	− 37
2	2190	.190	.045	.125	.360	174	258	26.8	− 23
3	2090	.310	.070	.205	.585	291	418	43.6	− 6
4	1990	.450	.105	.290	.845	421	590	61.4	+ 11
5	1890	.620	.140	.410	1.170	583	794	82.7	33
6	1790	.810	.185	.535	1.530	762	1015	105.6	56
7	1690	1.035	.240	.690	1.965	979	1274	132.6	83
8	1590	1.315	.300	.855	2.470	1230	1568	163.2	113

The first and last columns of this table give the desired relation between tension and temperature for the composite span. When the wire is strung at any one temperature and then clamped to string type insulators at the intermediate structures, adjustment of equilibrium for subsequent changes of temperature, which before clamping would have been by a slight slipping of the wire through the pulleys, will now be by a slight motion of the hanging insulators in the plane of suspension. The maximum of such motion will however be slight.

The method here given is perfectly general and will work in all cases, but there is an alternative method which will work with sufficient accuracy when the slopes of the individual spans are not too great. Using the direct distances between the supports as the spans, one may form for each span a table, such as Table I, but for the following five quantities only: $2T/wx$, u, $(\sinh u)/u$, $(\sinh u)/u$, Δs. Then without plotting the T's against the Δs's, a Table IV may be constructed for the composite span directly. There are, however, the following points of disadvantage with this method:

1. The maximum allowable tension to avoid uplift, 2,390 lb.$_w$ in this case, would have to be determined before forming the tables, and this involves considerable work.

*To save space, only the steps which are not illustrated fully by Cases I and II are given in detail.

2. Although the tables formed are somewhat shorter and the drawing of graphs is avoided, the Tables II, on the other hand, give full information of all the characteristics of each span at each tension. Also, the graphs of T against Δs afford useful checks on the accuracy of the numerical work.

It is therefore questionable whether there is any real gain in this method over the former one which is perfectly general.

The foregoing discussion shows how temperature-tension relations, and other mechanical characteristics, can be obtained for spans of any nature. It is believed to be fairly common practice, when the span is not too great and when the inclination is small, to use the parabolic approximation for calculating conditions. However, with the *Numerical Tables* available which have been tabulated, the parabolic solution for the cases in which it gives sufficiently accurate results is no simpler than the hyperbolic solution for the same cases. The advantages are therefore all with the hyperbolic method, which solves the simple cases with at least equal ease and which without essential modification solves cases where the parabolic method will not apply.

There is, in conclusion, a further point worth noting. In developing the fundamental equations of the catenary the cable is assumed to be of uniform density, but if the sag is large, the tension will depart considerably from uniformity and so there will be unequal effects on the density. But for wire cables the variation in tension will not be sufficient to produce an appreciable variation in density, and when there is a large change in tension due to change in weather conditions, the changes at all points will be very nearly equal. Therefore Hooke's law will apply in giving change in length just as if the tension were uniform throughout, provided we consistently deal with the increments of tension at some one chosen point, the error introduced in so applying it being negligible. That is, the methods which have been given will yield sufficiently accurate results for wire cables for sags of any amount, and not for small sags only. Any attempt therefore at refinement by making allowance for variation in tension by calculating an average tension only adds complexity to the calculations and secures no increase of accuracy. There are some, it is true, who appear to prefer to find the unstretched length of a suspended cable as a preliminary step, and then use this length as a basis for subsequent calculations. The theoretically correct value for such a length is of course best obtained from the average tension, but equally serviceable for the use to which it is to be put, would be what might be called a pseudo-unstretched length, viz., the unstretched length based on the tension at the chosen point already referred to. Actually there is no need for using the unstretched length at all, but for those who prefer to do so, this pseudo-unstretched length is equally serviceable. There is therefore no need to introduce average tensions and the methods here given are good for wire cables and sags of any magnitude.

The Development and Operation of Oil-Electric Rail-Cars on the Canadian National Railways

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SUMMARY.—After briefly discussing the various types of rail-car, attention is drawn to the development of the Diesel-electric drive for such cars by the Canadian National Railways. The four, six and eight cylinder cars are described and data given as to the results of experience in their operation. The paper concludes with a description of the Diesel-electric switcher locomotive now in service in Montreal, and its method of operation.

The unit rail-car is not, as many people suppose, a new development in the railroad field. Cars of this type were built and operated twenty-five years ago, but it is only within the last ten years that their use has become general on practically every large railway on this continent and on many railroads in Europe.

A unit rail-car may be described as a car which operates in ordinary railway service by power furnished from a source within the car itself. This source may consist of storage batteries or some form of power plant. In the case of storage batteries, power is delivered to the car wheels through electric motors. When a power plant is used, it consists of a prime mover transmitting power to the wheels through either a mechanical or electrical transmission.

Where the power from the engine is transmitted to the driving wheels through a mechanical transmission, the car is called a gasoline-mechanical. This was the first type of rail-car to be developed, and the McKeen car, many of which were built and operated chiefly in the middle western states, was a pioneer so well designed that it has survived in service to the present time, and has a wonderful record of performance. One car shows a total of 1½ million miles. The mechanically driven rail-car is particularly suitable for light service. It requires very little attention and has a high mileage per gallon of fuel. Although the heavier types of rail-car with a combination mechanical-electrical power plant are gaining in popularity, there is still a wide field for the light weight mechanically driven car.

Since the mechanically driven car of large size and weight has poor starting characteristics and involves a somewhat complicated gear shift, it is natural that the next development in rail-cars should combine a gasoline engine with electrical apparatus—in other words, an electrical transmission. This type of car is called gas-electric. This combination gives good starting and an extremely flexible speed control system. The power plant takes the form of a gasoline engine directly connected to an electric generator which in turn supplies power through suitable control apparatus to electric traction motors geared directly to the car axles. An ample number of speed ratios are available, which are simply and easily controlled by the operator, either by varying the engine speed; by changing the connections to the traction motors; by varying the generator voltage, or by combinations of these methods. Smooth acceleration is assured since the transitions in electrical connections can be made even by an inexperienced man without any effect being perceptible to the passengers. The driver is relieved of all except the simplest operations and can devote all his attention to the track ahead. On account of these advantages, the car of the internal combustion engine-electric type undoubtedly leads the rail-car field today.

During the War, none of the railroads were in a position to pay very much attention to the self-propelled car. After the conclusion of hostilities, however, they found themselves faced with serious competition from the automobile. The internal combustion engine, together with the whole automotive industry, had developed greatly, and trucks, buses and other public carriers began to make serious inroads into railroad revenues. In order to meet this

Fig. 1—400 h.p. Eight-Cylinder Articulated Car.

Fig. 2—200 h.p. Four-Cylinder Car.

competition, it was necessary to find some means of transportation which would provide a rapid and suitable service and at the same time do it economically. The Canadian National Railways, along with others, found that such a service was very desirable, in fact, necessary, if the railroad's position in the transportation field was to be retained.

Among the first efforts to meet this competition was the storage battery car. This consisted of a comparatively small passenger car equipped with electric traction motors which received power from storage batteries carried beneath the car floor. No power plant of any kind was carried on the car itself, but the storage batteries were charged at the ends of the run. This car proved satisfactory for short, frequent runs with a sufficient interval in between for battery charging. For longer runs, the schedule had to be arranged to allow charging time at each end. This in itself was a serious drawback, since the schedule was necessarily governed in many cases by the limitations imposed by battery charging, rather than by the actual requirements of the service. Charging facilities involved heavy costs for the installation of two charging plants, one at each terminal, since a direct current supply was very rarely available. A charging plant meant a skilled attendant, and so a car often had two maintainers. Flexibility of operation was lost since a car could not be changed to another run in emergency or for heavy traffic needs, without moving or providing additional battery charging facilities.

Other limitations also made themselves felt. A storage battery is necessarily limited as to capacity, and while a car might prove entirely satisfactory during the summer months, the first fall of snow would call for an output of power entirely beyond its resources and a failure would result miles from the terminal.

It was obvious that the storage battery car could not fulfil long distance requirements. When the first battery renewals became necessary, two cars were converted to gas-electric by the removal of the storage batteries and the installation of a gasoline engine generator set. These converted cars proved satisfactory and showed conclusively that the rail-car with the self-contained power plant was the solution for light traffic on branch lines.

As the converted cars were small, the seating capacity was found insufficient for many runs. There was no baggage space, since the power plant had been mounted in the space originally provided for that purpose. These cars were therefore suitable only for shorter runs where little, if any, baggage requirements were necessary.

Attention was turned toward cars of a larger type, designed with a special view to average conditions and incorporating suitable baggage, seating and other facilities. Studies of gas-electric car operation, as carried on in the United States, showed that with considerably higher gasoline costs in Canada, expected economies might not be so apparent. About this time, many reports were heard of the radical improvements to the Diesel engine which had been effected in Europe. Further information was obtained and proved so encouraging that several members of the mechanical department of the Canadian National Railways went to England and the continent to investigate thoroughly the progress which had been made.

As is generally known, the Diesel engine operates under quite high pressures and until a few years ago was of massive construction in order to withstand the stresses set up. With such a heavy engine, it would be impossible to design a rail-car within practicable limits. However, with the impetus to research provided by the War, alloys were developed which reduced the weight per horse power to such a point that Diesel engines were available which were no heavier nor larger than gasoline engines of equivalent power. Among the firms which had made notable strides in this direction was Wm. Beardmore and Company Ltd., Glasgow. In co-operation with the British Air Ministry they had developed an engine, using special aluminum alloys and high tensile steels, which weighed about 14 pounds per horse power as compared with 50 or 60 pounds per horse power, using older materials and methods. Here was a Diesel engine eminently suitable for rail-car application.

After investigation and tests, the Canadian National Railways decided to build some unit rail-cars using this engine. These were the first oil-electric cars built for regular railroad operation on this continent. Two sizes of engines were chosen—a four-cylinder and an eight-cylinder. Seven cars were built using the smaller unit, the power plant comprising a Beardmore engine of 200 h.p., direct connected to a 105 kw. 600-volt D.C. generator. Two cars using an eight-cylinder Beardmore engine of 400 h.p. were also constructed. The engine is connected to a 200 kw. 600-volt D.C. generator. These two cars are of the articulated type, that is, they consist of two separate car bodies connected together at one end and supported by a common truck at the joint. This truck contains no traction motors, the motors, four in number, being mounted two on the front truck and two on the rear. The car is shown in Fig. 1 and is 102 feet in length over all, it weighs approximately

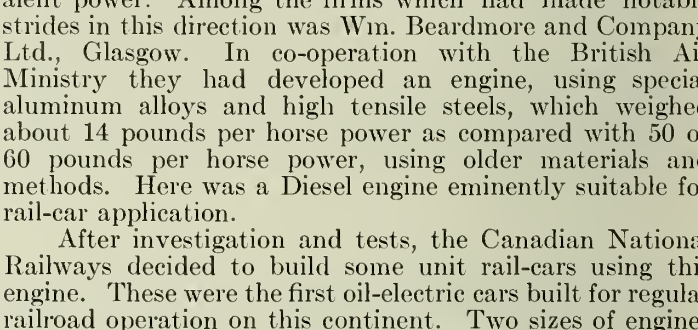

Fig. 3—Plan and Elevation of 300 h.p. Six-Cylinder Car.

Car Data

Builder	*Canadian National Railways*
Length Over End Sills	*73 ft. 9 in.*
Width Over Side Sills	*10 ft. 0 in.*
Overall Length	*13 ft. 11 5/16 in.*
Length of Main Compartment	*22 ft. 8 in.*
Length of Smoker Compartment	*11 ft. 4 in.*
Length of Baggage Room	*15 ft. 11 in.*
Length of Engine Room	*16 ft. 10 in.*
Main Compartment Seating Capacity	*37*
Smoker Compartment Seating Capacity	*20*
Truck Wheel Base (front)	*8 ft. 0 in.*
Truck Centre Distance	*53 ft. 3 in.*
Wheel Diameter	*36 in.*
Car Weight, Complete	*141,000 lb.*

185,000 pounds, and as constructed, seated one hundred and twenty-six passengers and provided a large baggage space, as well as a smoking compartment. Since then, the baggage space has been increased and the seating accommodation consequently reduced.

The four-cylinder cars shown in Fig. 2 are somewhat smaller and consist of the regular type of car body 60 feet over all, seating fifty-seven passengers and with a good sized baggage compartment. These cars have not been changed materially and are in service today practically as built.

With the exception of the steel car frames, which were built by one of the Canadian car companies, all car work, including the finishing, equipping and installing, of every piece of equipment, on both four and eight-cylinder cars, was done at the Railway's Montreal shops. Construction was carried out during 1925 and all cars went into service before the end of the year.

As an initial effort in an entirely new field, these cars have proved very satisfactory, the four-cylinder type particularly. They are capable of hauling light trailers, and are doing so on practically all runs, attaining speeds of from 50 to 60 miles per hour where conditions are favourable. All are equipped for double end operation, this feature being thought necessary, as it was planned to operate the cars on branch lines where turning facilities might not always be available. Actually, however, on nearly every run, some means was found of turning the car at its terminal. It was also found that the drivers much preferred to operate with the engine end leading, as in this way they were always beside the power plant and in constant touch with it.

Auxiliary equipment of both cars comprises a fuel oil tank, a water supply for engine cooling, and a tank for lubricating oil. Storage batteries are provided for car lighting, field excitation and engine starting, using the generator as a motor. Suitable controls and switching apparatus perform all electrical functions. Radiators mounted on the roof provide for cooling the engine circulating water and lubricating oil. In these cars, the engine room is provided with a hatch in the roof for lowering the power plant into place.

The electrical equipment on the four-cylinder cars consists of a single-bearing generator directly connected to the engine and having an exciter mounted on an extension of the armature shaft. Both engine and generator are mounted on a common bed. The exciter operates at 60 to 80 volts and provides field excitation for the main generator and charging for the storage batteries. Current is taken from the main generator through a K-type controller, which provides series, parallel and shunt-parallel connections to the traction motors, both of which are mounted on the front truck. The engine throttle control is mechanical through flexible cables.

An undesirable feature on these cars is that current for the operation of the air compressor is taken from the main generator, which means that the supply of air will only be kept up while the voltage is near 600, that is, when the car is running. On long down grades, the engine must be operated at almost full speed and practically no load so that full air pressure will be available at all times for braking. This feature is probably the greatest drawback to the type of control used on these cars. However, it does not prevent these units giving excellent results in service.

The articulated cars have a main generator only, with two sleeve-type bearings connected to the engine through a flexible coupling. Field excitation is obtained from the storage battery, which, in turn is charged from the generator when its voltage is above a given value. Two air compressors are provided, one of which operates from the storage battery when the engine is at rest and the other from the main generator during car operation. In this way, full air

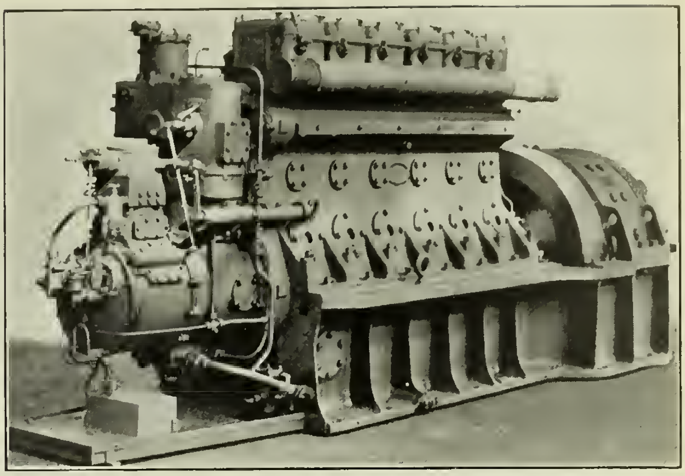

Fig. 4—Beardmore Six-Cylinder Engine.

pressure is always assured. Car speed is controlled by varying the generator field through a master controller. The engine throttle is also controlled electrically through this same controller.

On account of its construction, somewhat more electrical equipment is necessary than would be the case with a single unit car. Also it is more or less difficult and always undesirable to carry conductors for heavy electric current across a gap, such as the articulation makes necessary. The size of the car renders it unsuitable for any but especially selected runs and it is not likely that any more of this type will be built. This car is equipped throughout with S.K.F. roller bearings on the truck axles.

After a year's operation, with the cars under constant observation while records of performance, suitability, etc., were kept, information was obtained which indicated the desirability of some modifications in future oil-electric cars. The four-cylinder engine units were found to be somewhat lacking in power and the eight-cylinder articulated cars too special in their design and scope of service, so that a design in between these two was selected as the next step. Accordingly five six-cylinder cars were built at the Canadian National Railways shops, Montreal, and placed in service in 1927. They are shown in Fig. 3, are 73 feet 9 inches long, and weigh approximately 140,000 pounds. The engine shown in Fig. 4 is a Beardmore, developing 300 h.p. at 750 r.p.m., and, like the first two types of engines used, has an 8¼-inch bore by 12-inch stroke. The generator is 198 kw. 600-volt D.C., with a single sleeve type bearing and is mounted on the same bed plate with, and rigidly connected to, the engine. On the same shaft with the generator is mounted a 5.6 kw. 64-volt exciter. It is usually spoken of as the auxiliary generator, for the reason that it not only provides field excitation, but at full engine speed, battery charging and air compressor operation. Two traction motors permanently connected in parallel are mounted on the front trucks. It may be noted that on all single unit cars, the motors have been mounted on the front truck which carries the weight of the power plant and all auxiliaries, thus obtaining maximum adhesion.

All electrical connections, including engine starting, are established through electro-pneumatic and electromagnetic contactors from a master controller, which is combined with a mechanically connected engine throttle. Based on experience with previous rail-cars, single end control only is provided, all controls being mounted in the engine room.

Engine starting is accomplished by motoring the generator from a 64-volt storage battery. This battery also provides 32-volt lighting through a three wire system. The air compressor is driven by a 64-volt motor which may receive its energy from three sources,—the storage

Fig. 5—300 h.p. Six-Cylinder Car and Trailer.

battery when the power plant is at rest, the auxiliary generator at full engine speed, or the main generator at idling engine speed. It will be noted that the faults in air compressor operation as they existed on the four-cylinder cars are entirely eliminated, as all contingencies met with in normal service are provided for. The storage batteries are charged from the auxiliary generator during car operation and from the main generator during idling periods which means that they are charging practically all the time.

The radiators are mounted vertically at the front of the car, five sections on the roof for water cooling and one section below the front window of the engine room opposite the driver for lubricating oil cooling. Both the water and lubricating oil radiators are fitted with shutters in front which may be opened or closed depending upon weather conditions. On the last cars built, the water radiators are completely enclosed with a metal housing and have shutters both front and rear. This has been found desirable as the cooling effect in very cold weather at high car speeds has been found a great deal more than is necessary to keep the engine at its most efficient operating temperature.

So successful have these cars been and so near to meeting average operating requirements that this type has been practically standardized for further development. (See Fig. 5.)

After three years' operation with the six-cylinder cars, seven more were placed in service in 1930. These cars are practically duplicates of the first five, except that Westinghouse-Beardmore engines are used.

The Westinghouse Company, after spending nearly three years investigating the performance of the oil-electric cars on the Canadian National Railways, secured the American rights for the manufacture of Beardmore engines.

In appearance, the Westinghouse engine is very much the same as the Beardmore and in operating principle, of course, is identical. The chief difference in the two engines is in the governor speed control and in the construction of the fuel pumps which deliver fuel oil to each cylinder. Where Beardmore uses a mechanical type of governor, Westinghouse uses a hydraulic. A shorter engine, consequently a shorter overall length of power plant is attained, which is of particular advantage in rail-car construction where every inch saved in the engine-room means more space for revenue use. (See Fig. 6.)

The mechanical governor used by Beardmore is rather complicated and is made up of many moving parts, requiring very careful fitting. Experience has shown, however, that this governor is readily adjusted and, once in working order, remains that way and requires no further attention.

The Westinghouse hydraulic governor is simpler and consists of a minimum of parts. As with the Beardmore governor, its actuating medium is the engine lubricating oil. Since there is a change in viscosity of this oil, from cold to engine operating temperature, some variation in the speed of the engine occurs when it is first started, but this disappears very quickly as the engine warms up.

The Beardmore fuel pump, for a six-cylinder engine, consists of three main plungers, each plunger delivering fuel oil to either of two cylinders, the cylinder being selected by a switch valve. The amount of fuel oil delivered, depending upon the load conditions of the engine, is regulated by a control valve. For each of the three main plungers, there is, therefore, a control valve and a switch valve, making a total of nine parts. Very high grade materials are required in these fuel pumps and great care is necessary in fitting the parts. The plungers are finally lapped in place using rouge as the abrasive. A fuel pump in good condition will give pressures up to 8,000 pounds per square inch, which will give some idea of the high quality of workmanship required.

The Westinghouse fuel pump, again considering a six-cylinder engine, provides a main plunger and control valve combined in one, for each cylinder, making a total of six plungers. With this arrangement a switch valve is unnecessary, since each cylinder has its own pump unit. This design was adopted since it eliminates three moving parts. It offers certain other advantages also. In the Beardmore engine, failure of one main plunger puts two cylinders out of commission, since both receive fuel from the same pump alternately. Using an individual plunger for each cylinder means that one cylinder only fails in case of a pump failure. The use of separate fuel pumps also provides adjustment for each cylinder individually and the eccentricities of one cylinder are not necessarily reflected in another.

Excepting for some slight modifications and refinements, the electrical circuits and controls on the Westinghouse cars are the same as on the earlier Beardmore cars. The radiator arrangements for both engine cooling water and lubricating oil are identical, except that on the later cars, thermostatic control combined with manual operation is used. The lubricating oil is carried in a separate tank in the newer cars, where in the first units it was carried in the engine sump. With a view to easier maintenance, a general re-arrangement of the engine-room layout has been made to make the electrical contactor panels and connections more accessible. The traction motors on both the first six-cylinder cars and the last, are the same. Although the Westinghouse engine is of higher rating, this additional power is used only during acceleration and the capacity of the motors is ample for this load since it exists for relatively short periods only.

The main generator has been re-designed to use a single ball bearing which shortens it considerably. The capacity is 300 kw. and as before, it is directly connected to the engine shaft.

All the six-cylinder cars have trucks equipped with roller bearings for easy starting and to cut down maintenance.

A feature of the electrical equipments on all the six-cylinder cars is the generator torque control. This device, in the form first developed for oil-car application, consists of a small motor, the armature of which tends to revolve against the tension of a spring and whose shaft carries a contact-making arm. The field of this motor is proportional to that of the main generator and the armature is in series—through a shunt—with the main generator armature. Thus the torque of the small motor is directly proportional to that of the main generator. When the torque exceeds a pre-determined value, a contact is made which inserts resistance into the generator field, reducing the voltage and thereby the generator output. When the load is relieved, the original condition is restored. A manual adjustment is provided on the torque governor to take care of a condition where the engine is incapable of producing its full power and the electrical load thus limited at a lower point than normally.

The torque governor has accomplished good results, but since it is entirely dependent on the generator, that is, the electrical load, for its functioning, it will readily be seen that if the engine is incapable of producing the output for which the torque governor is set, an overload condition will result. In other words, if the torque governor is set for the full electrical load of a six-cylinder engine-generator set and only five cylinders are firing, the engine will be overloaded to the extent of one cylinder's output. To protect against such a contingency, the torque governor is usually set considerably below the normal torque of the engine throughout its speed range. Of course, if the operator realizes engine overloading is taking place, he can immediately reduce the torque governor setting, but a falling off in engine power is not always readily detected.

On future equipments, a more recent development, known as "engine torque control," will be used. This device prevents overloading of the engine by limiting the fuel to each cylinder to the amount corresponding to full load fuel at any one of several working speeds between idling and full speed positions. The engine throttle is mechanically connected to the control for the fuel admission and positively limits the amount of fuel for any given throttle position.

The auxiliary generator is also provided with a special field winding so that its voltage is very closely proportional to the engine speed. In addition, by means of electrical connections, varying resistances are set up for the different throttle positions and the voltage is limited by a control relay. With these conditions, an overload will cause a drop in engine speed as the fuel admitted to each cylinder is positively limited by the throttle.

This drop in engine speed causes a drop in voltage which in turn actuates the control relay, introducing resistance into the generator field circuit, thus reducing the generator load to a point below normal for that speed.

The engine torque control gives an electrical output curve more nearly in agreement with the engine output than has previously been obtained and actually prevents overload.

Large baggage space is provided in all six-cylinder cars and the seating capacity considerably cut down, since it is customary to use a trailer for passenger accommodation. In connection with passenger seating accommodation, it may be noted that there is a tendency to eliminate passenger facilities in the motor car itself, these being transferred to a trailer. Space in the motor-car is then utilized for baggage, express and mail. Although railway post office compartments are seldom seen on Canadian rail-cars, they are widely used in the United States. In a rail-car train with a motor-car of this design, passengers are completely separated from the power plant, there is no noise or vibration, and gas fumes, if there are any, never reach the trailer. The transfer of passenger accommodation from the motor-car to trailers is particularly evident on many railroads where very large, or in many cases, double power plants, are in use.

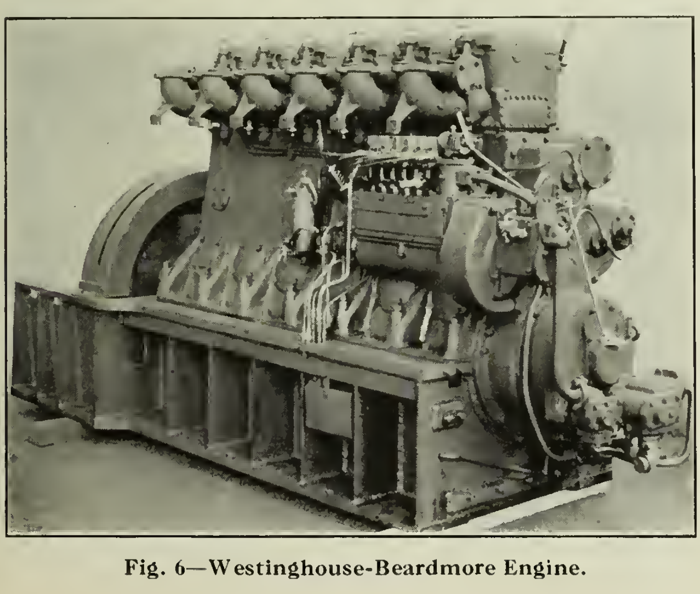

Fig. 6—Westinghouse-Beardmore Engine.

Six more cars will go into service on the Canadian National Railways during this year and two have been designed along these lines, with baggage and express accommodation only. The service in which these two cars will operate is on the main line, for local traffic where a large quantity of express is handled.

A great deal of interest has been evident on the part of many railroads in the oil-electric car development, but there has been considerable timidity in its adoption. There are various reasons for this and the high first cost is undoubtedly one of them. Admittedly, the oil-electric car does cost more than the same type of car using a gasoline engine, but with expanding use, mass production will play its part and costs will sooner or later reach a common level. Even now, the Diesel engine does not cost a great deal more than the gasoline engine and there is nothing inherent in its construction which will prevent the adoption of quantity production methods when the demand justifies.

Another reason which has often been voiced is an idea that the Diesel engine is complicated. That there is no foundation for this is borne out by the experience on the Canadian National Railways where the first nine cars built were widely seattered over the entire system, some of them in remote locations, with no special provision made for them. Remembering that these were the first cars of their kind to be built, all maintenance work must necessarily have been carried out by men who had never seen such equipments before. Yet they operated successfully. It should be borne in mind also that since the oil-electric car is a new development and consequently a novelty, all eyes are focused upon it and so every mishap and failure is apt to become exaggerated and magnified.

Considering these facts and allowing for errors in design, and in the use and application of various mechanical parts, certain to be present in a first attempt, these cars made an excellent record. As an example of what was accomplished with no special arrangements for maintenance, a four-cylinder, 200 h.p. oil-electric car operated for 200,000 miles with a serviceability of 86 per cent. This car operates throughout the year under all sorts of weather conditions and is in a remote location. After making this mileage, the car went in for general overhaul. Only such wear as might be considered normal was found.

Another four-cylinder, 200 h.p. car operated 19 months with 100 per cent serviceability and covered 59,000 miles. (It was one of these four-cylinder units which made the run from Montreal to Vancouver in sixty-seven hours.) A six-cylinder, 300 h.p. car operated 109,000 miles with 92 per cent serviceability.

In service, it has usually been found necessary to have one man specially detailed to look after the maintenance of each car. The reason for this is that in nearly all cases the cars are widely separated. Where several cars operate out of a common terminal, it has been found entirely practicable for a maintainer to care satisfactorily for more than one unit. Each maintainer reports to a supervisor who usually has control of a number of cars operating in a fairly wide territory. His duties are to see that each car under his supervision is properly cared for, to advise and assist the maintainers, and to instruct the men operating the equipment.

General overhaul of the cars has been carried out at Moncton, Toronto and Winnipeg and also, to some extent, at Montreal, at all of which points railroad shops are located. No particular effort has been made to gather

Fig. 7—450 h.p. Six-Cylinder Switching Locomotive.

together a personnel made up of mechanics with former experience on Diesel engines. The best men, however, have been drafted from the regular shop staff to perform such work.

No attempt has been made, as yet, to set up an organization purely for oil-electric car work. With a comparatively small number of units in operation, twenty-four in all to date, and realizing that these are widely scattered, it will be appreciated that special equipment could not economically be provided at a number of points. Neither would it be feasible to concentrate a special staff on oil-electric car work only, as it is evident that there would not be enough work to keep them occupied full time. The most elaborate attempt to take care of this new equipment has been made at the Toronto shops, where a special machine for testing fuel pumps has been set up and various machine tools installed. The work is in charge of one man who, when not engaged in the overhauling of cars, supervises the making of various engine replacement parts.

All work in connection with gas-electric and gas-mechanical cars is handled at this point also, as the machine tools used in oil-electric car work are equally suited to gasoline engines.

As the use of unit rail-cars increases, as it undoubtedly will, and more cars are placed in service, the time will come when facilities devoted entirely to engine re-conditioning and general overhauling will be essential. Several American railroads which have gone in for rail-cars on a large scale have already taken this step. The advantages of such facilities are immediately apparent. Special tools and machines can be provided with building space set aside for them, to care for nothing except internal combustion engine work. A staff of specially trained men who will always be fully occupied with rail-car maintenance can be retained permanently. Under these conditions, repair work will gain in efficiency, since it will be possible to properly organize it and experience gained can be utilized to better advantage.

As mentioned before, the oil engine used by the Canadian National Railways is very similar to the gasoline engine in general appearance. In construction, the oil engine is built to withstand much heavier stresses and special alloys and materials are used to attain this end, without undue increase in size and weight. The engine cylinder block is of cast steel. The cylinders are formed of steel liners pressed into the cylinder block and sealed around all water passages with rubber gaskets of special composition. Pistons are aluminum alloy with compression rings at the top and one or two oil scraper rings at the bottom. Connecting rods are forgings with a floating bearing, steel in bronze and aluminum at the piston end and bronze babbitt-lined on the crank pin. The crank shafts are nickel-chrome steel forgings supported by a main bearing between each cylinder, bronze babbitt-lined, and with an additional bearing at the generator end to provide for thrust. With the exception of the connecting rod bearing in the piston which is dependent on splash lubrication, every bearing in the engine receives lubricating oil under pressure. On all engines the cylinder heads are aluminum alloy with cast iron valve seats imbedded in the aluminum. Two valves are provided on both inlet and exhaust ports. These are of the overhead type. All valves are actuated by one camshaft through push rods and rocker arms.

The fuel pump, lubricating oil pump, water circulating pump, camshaft, etc., are driven through a train of gears from a main gear on the crank shaft at the front of the engine.

In the four-cycle Diesel engine of the solid injection type, such as is used on the Canadian National Railways rail-cars, the sequence of operations is practically the same as in a four-cycle gasoline engine, but with these exceptions. On the induction stroke, air only is drawn into the cylinder. At the end of the compression stroke, fuel is sprayed into the cylinder by an atomizer in the cylinder head. The compression in the Diesel engine is extremely high so that the temperature of the air when compressed is sufficient to ignite the spray of fuel oil without any auxiliary device, such as a spark plug. The remaining two strokes in the cycle, the explosion and exhaust, are the same as that of the gasoline engine.

The temperatures reached in the cylinder of a Diesel engine are so high that incomplete combustion is practically impossible. Analysis of exhaust gases shows a negligible quantity of carbon monoxide. Compare this with the gasoline engine, where carbon monoxide is always present in large quantities, and you will appreciate that the Diesel has very efficient combustion.

Tests made by the American Railway Association last year on unit rail-cars, using gasoline, distillate and fuel oil (Diesel), showed an over-all efficiency of the power plants that is, from the fuel tank to the generator terminals, as follows:

Gasoline and distillate, approximately 12 to 15 per cent.
Fuel Oil or Diesel, 23 to 26 per cent.

These tests were made on different railroads and the cars were tested exactly as found, without adjustment or change to any part of the equipment. The operators were told to carry on as usual and endeavour to forget that any tests were in progress. Expressing these results in another way, the kilowatt hour output per gallon for gasoline and distillate averaged about 5, while for Diesel fuel oil it averaged over 10, just double.

Besides the application of the oil engine to rail-cars, there is another field in railroad service where the Diesel has already proved its economy and aptitude. This is in switching service.

In theory, the greatest fuel saving possible in any service is by eliminating stand-by losses. As switching service represents a form of operation with wide fluctuations of load and much idle time, it would seem to offer an excellent field for the internal combustion engine. A number of tests made in representative switching service were analyzed and certain fundamentals established. In the first place, it was shown that the maximum power actually developed by the locomotive did not average more than 40 per cent of its rating and this for not more than a one minute period. Further, for only fifteen minutes of a sixteen hour test was power developed beyond 36 per cent of the locomotive's rated horse power. For the entire sixteen hours, the average horse power developed was slightly under seven per cent of normal rating.

A study of these operations indicated that an engine of 450 h.p. could handle the service successfully. While there would be certain periods during which time would be lost, due to inability to meet peak loads, there would be many other times where this could easily be made up by a greater utilization of the oil engine in movements not requiring its maximum power. The tests mentioned covered only certain classes of switching service and it must not be assumed that a 450 h.p. locomotive will satisfactorily meet all conditions of railroad switching work. There are certain services, such as heavy transfer work, where a more powerful locomotive will be required.

A switcher locomotive, equipped with a 450 h.p. engine, maximum rating, was built and placed in coach yard service at Montreal, making up passenger trains, at the end of May, 1930. It is shown in Fig. 7, and its operation to date indicates that the assumptions based on steam switcher operation, as previously outlined, have been well justified. The locomotive operates three shifts a day—twenty-four hours—every day in the week except for one eight-hour shift every fifth day when it has to be brought in for fuel, lubricating oil, water, sand, etc. An inspection of all parts of the engine, electrical equipment, brakes, etc., is made at the same time. The first cost of the oil-electric locomotive is, of course, higher than for an equivalent steam locomotive. It can hardly be otherwise where only one unit is considered. For one thing, development costs can not be distributed, as would be the case where a number are built at one time.

Considering all features which we are able to develop, the 450 h.p. oil-electric switcher now in operation saves in twenty-four hours approximately $40, an amount ample to meet any extra costs over and above the cost of a standard steam locomotive of the same capabilities. As compared with a steam unit, there is no time lost in cleaning fires or taking coal and water and idle time is dependent only upon what lost motion there is in the actual switching operations.

The Westinghouse Beardmore six-cylinder engine used in the switcher locomotive is the same as used in the rail-cars. It normally develops 350 h.p. at 800 r.p.m. Since the power output of the engine is proportional to the speed, it will be seen that if the speed is stepped up, the horse power output will step up also. An auxiliary foot throttle is provided which increases the engine r.p.m. to one thousand and this speed gives approximately the 450 h.p. rating. Considering the power requirements of average switching services as indicated by the tests made on steam switchers, the increased rating of the engine is seldom called upon.

The power plant in the switcher is very much the same as that of the rail-cars, but naturally the service requirements call for higher ratings and more ruggedness in design, particularly in the electrical equipment. Various changes in design are also necessary for some of the auxiliary devices.

Comparing the operation of a switching locomotive with that of a rail-car, several differences are immediately obvious. The rail-car, except for short periods during acceleration, operates at high speed and always in one direction. Since the locomotive may be called upon to operate in either direction and at slow speeds, mounting the radiators on the roof at one end and depending on the natural current of air for cooling is out of the question. These are therefore mounted in the roof itself and ventilated by motor-driven fans.

The average power developed in a rail-car throughout a run is usually not over 175 or 200 h.p., a figure established by actual tests on a number of cars. The switcher, on the other hand, may make many movements which, while possibly of short duration, may call for a heavy power output for practically the whole of the movement. It has, therefore, been necessary to make the traction motors much heavier. These are four in number, one on each axle, and of such capacity that forced ventilation is unnecessary. Advantage is taken of the fact also that most switching movements are short, with usually an interval between during which a great deal of heat can be radiated.

Since switching service calls for the continuous use of the air brakes, large air storage and compressor capacity is necessary. Two air compressors are installed with a total of 150 cubic feet of air per minute. Large air capacity is also an essential in some passenger car switching movements where the number of cars makes necessary the connection of the train line. The air requirements to bring the brake pressure in a string of passenger coaches up to the point for proper operation, without undue delay, are considerable.

Both air compressors operate from the main generator during idling and from the auxiliary generator during running. This is similar to the air compressor operation on the six-cylinder rail-cars.

Operation of the switcher is from one end only. The control is practically the same as for the six-cylinder cars, except that the traction motors operate through the first positions two and two in series, after which they are connected in parallel. No shunt field connection is provided. The throttle consists of a single lever which actuates the engine throttle mechanically and makes connections to the electrical equipment through a contact drum. The number of controls which the engineman has to operate is exactly the same as for a steam locomotive and consists of the throttle, reverser and air brake.

If the oil engine is to play an extensive part in railway service, it will have to be further simplified, and those parts which require frequent examination must be made more readily accessible than has been yet accomplished. Not only can improvements be made in simplifying the oil engine itself, but also the number of auxiliaries and accessories used in the electrical and mechanical apparatus can be greatly reduced, and possibly many eliminated entirely. Simplicity of all parts should be the key-note in rail-car construction. It must be remembered that the organization which now takes care of all railroad rolling stock is the result of years of operation, and any new development in the railroad field, to be successful, must meet with their approval and co-operation.

Type Testing of Aircraft

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SUMMARY.—Type testing of aircraft is carried out to determine the airworthiness and flying qualities of a machine before approval for general service, and these tests also determine the capabilities of the type and aid in the selection of proper machines for special work. The paper describes the qualitative and quantitative tests regularly carried out for this purpose, explains briefly the theory of stability and discusses the methods of determining the performance of the aircraft as regards rate of climb, power consumption, service ceiling and maximum range at different heights. The method of reduction of performance trials to a uniform standard of comparison is also described.

"Type Testing" is the term commonly used to describe the trials or tests which an aircraft undergoes to establish its characteristics and normal performance for the purpose of comparison with contemporary aircraft of similar type.

The necessity of establishing the general flying qualities of an aircraft before it is put into general service, where it is flown by less experienced pilots, will be readily appreciated. On the other hand, knowledge of the capabilities of an aircraft is very essential when it comes to the selection of aircraft for operational work. Then again, of course, the choice between two types of aircraft hinges principally on performance, while a secondary, and also very important, consideration is general suitability from the point of view of constructional robustness, maintenance, and disposition of crew and equipment.

Thus, Type Testing may be divided into two classes, viz.:

1. Qualitative Tests,

and 2. Quantitative Tests.

Qualitative Tests

The qualitative tests are done first and are for the purpose of determining the balance, manoeuvrability, controllability and stability of the craft both on land, or water, and in the air. The ground tests consist of taxying the aircraft across smooth surface, rough ground, soft and hard surfaces (or glassy water, rough water, and in water currents, as the case may be) under all the various wind conditions, such as, no wind, medium, severe wind, and gustiness. The aircraft is then taxied, in the case of a landplane, along on its wheels with tail up, or in the case of a water craft, along on its step, at a speed just under flying speed, in order to establish lateral and longitudinal stability and controllability under such conditions. The aircraft is next taken off and landed again in what is termed "straight hops," that is to say, the aircraft is simply taken into the air to a height of a few feet, and then landed again. This is done three or four times in order to ascertain any peculiarities of the type in taking off, and landing before any further tests are attempted.

In all such tests, besides the obvious behaviour of the aircraft, a great deal of the aircraft's characteristics are determined by "feel." That is why a test pilot must have a good deal of experience on various types of aircraft. It is usual to have the tests carried out by two or more pilots, especially if any unusual behaviour is reported.

The aircraft is now taken into the air for its general flying tests to establish balance, manoeuvrability, controllability and stability. All trials commence with gentle manoeuvres and progress by easy stages up to the limit of the evolutions as established for the particular type.

Balance, manoeuvrability and controllability are closely related to stability and co-ordinated with it. An aircraft is said to be properly balanced when it maintains level flight with no persistent tendency to dive or to stall. Manoeuvrability, as the name suggests, is the power of executing manoeuvres, or of rotating about any axis with a high angular velocity and acceleration. All aircraft do not have the same degree of manoeuvrability, which as one would expect, varies considerably from small high speed single engined aircraft to the slow, large freight-carrying multi-engined type. One need only think of the analogy of small motor-cars versus commercial trucks to appreciate this.

Controllability implies easy movement of controls with the application of only moderate forces and prompt and positive response of the aircraft to the control movement. In addition it is essential that the forces required to operate the three systems of control, viz.: aileron, elevator, and rudder, give equivalent relative reactions on the pilot's hands and feet. To quote from a recent article on controls, "the three controls should be in harmony with each other. The angles and forces required from each for general manoeuvring should be of the same order." For instance, an aircraft which is described as "heavy on rudder" is one in which the force required to operate the rudder is excessive as compared with that necessary to operate aileron or elevator control. It may happen also that the control reactions alter considerably, relative to each other, on acceleration from slow speed to high speed or in certain manoeuvres.

As may be seen in all flying tests for controllability and manoeuvrability, the characteristics are determined entirely by "feel" and indicate the necessity for an experienced pilot.

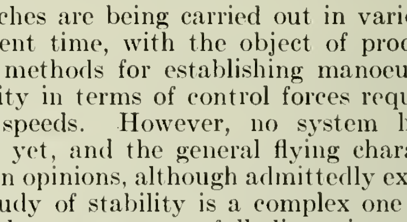
Researches are being carried out in various countries, at the present time, with the object of producing instruments and methods for establishing manoeuvrability and controllability in terms of control forces required, rates of turn, and speeds. However, no system has been put forward, as yet, and the general flying characteristics are still based on opinions, although admittedly expert opinions.

The study of stability is a complex one and it would be impossible to attempt a full discussion of it here. It is intended merely to explain the various types of stability and show how flight tests indicate the degree of stability exhibited by an aircraft.

Since the motions to be analyzed are so complex, a rather elaborate system of symbols for the forces, moments, velocities and accelerations existing is required, and the first step in the creation of such a system is the choice of a reference frame of three mutually perpendicular axes. Fig. 1 shows these, together with the symbols employed for the various quantities involved in considering stability.

The theory of stability deals with the study of the motions of an aircraft about a steady state of flight, when left to its own devices.

A stable aircraft is one which, from any position in the air into which it may have got, either as the result of gusts or the pilot's use of the controls, will recover its correct



Axes	Symbol Designation Positive Direction	x Longitudinal Forward	y Lateral Starboard	z Normal Downward
Force	Symbol	X	Y	Z
Moment	Symbol Designation	L rolling	M pitching	N yawing
Angle of Rotation	Symbol	ϕ	θ	ψ
Velocity	Linear	u	v	w
"	Angular	p	q	r
Moment of Inertia		A	B	C

Fig. 1

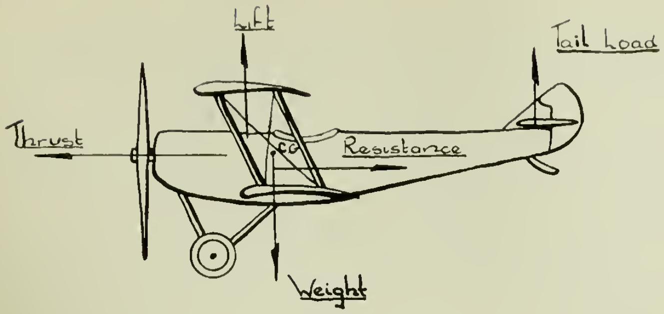


Fig. 2

flying position and speed, when the pilot leaves the machine to choose its own course.

The study of stability comes under two headings, viz.:

(*a*) Longitudinal.

(*b*) Lateral.

Longitudinal Stability

An aircraft is said to be longitudinally stable when it returns to its original attitude and speed of flight after a disturbance in pitch, i.e., rotation about the lateral axis.

Longitudinal stability must not be confused with balance, i. e., the tendency to dive or to stall. Let us consider a perfectly balanced aircraft in horizontal flight, the forces acting on which are as shown in Fig. 2.

The resultant pitching moment about the centre of gravity (the point about which all rotation takes place) is zero. Let it be supposed that the aircraft is disturbed in flight and changes its attitude, the speed of flight remaining the same or changing, depending on the magnitude or continuance of the disturbance. The moments due to the main planes and tail plane alter considerably with change of incidence, attitude, and speed of airflow. The effect of change of inclination of thrust and drag, relatively speaking, is not of much importance unless the balance between main plane and tail plane moments is very fine.

For a stable aircraft, the resultant pitching moment, in disturbed flight, should be such as to cause the machine to return to its original attitude. That is to say, if from normal flight the nose of the aircraft is suddenly pushed upwards, the resultant pitching moment must be a nose-diving moment and vice versa. For example take a general diagrammatic representation of pitching moments of an aircraft, as shown in Fig. 3.

The relative value of moments, due to the main planes, tail plane, and other causes, is readily appreciated. It will be seen also that the resulting moment satisfies the condition of proper correcting moment for disturbed flight.

Obviously the position of the centre of gravity is the controlling factor in longitudinal stability. The cure for longitudinal instability is to move the C.G. forward. The increase of control surface is, but rarely, the solution for instability, because the increased weight gives a moment which aids the unstable condition, and the greater surface means greater control loads and poorer manoeuvrability. This will be discussed again later.

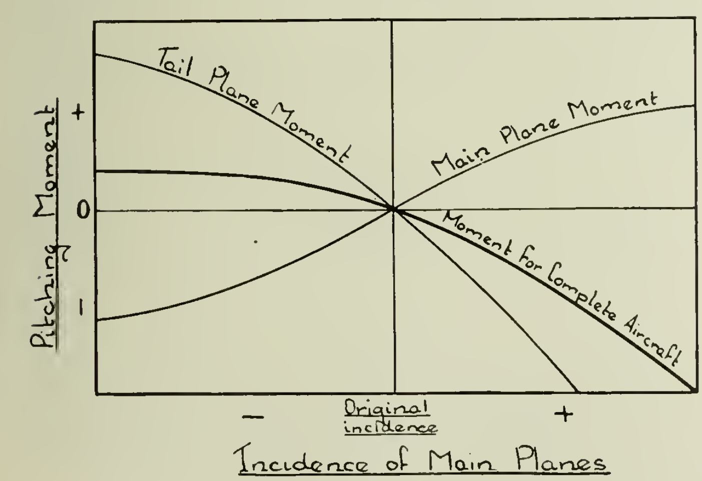


Fig. 3

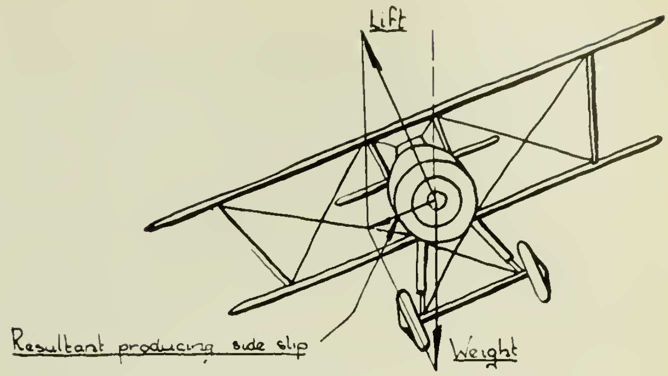


Fig. 4

In general the tail plane of an aircraft is in the slip-stream of the airscrew wherein the velocity of the air is greater than that on the wings. Stability in gliding flight, where the velocity of the airflow is approximately the same over both main planes and tail plane, may be quite different and consequently gliding flight also requires investigation. This is particularly important on aircraft with a fixed tail plane where balance in gliding flight is obtained by constant use of the elevators.

Lateral Stability

Let us now consider a normal and well balanced aircraft in straight flight suddenly banked by the pilot's action or by a gust of wind.

The condition produced is shown by Fig. 4. The weight acts in the direction of gravity, the lift is always at right angles to the span and hence the resultant force produces side slipping.

In Fig. 5 are shown the forces and moments caused by the side-slipping which affect lateral stability.

The velocity of side-slip "v" added geometrically to the forward velocity "u" produces the angle of yaw ψ. The aircraft is side-slipping to the right, consequently the air acting on the vertical fin and rudder causes a yawing moment N_v tending to turn the aircraft into the relative wind with the angular velocity "r". This tendency to lead the aircraft into the relative wind is known as "*Directional Stability*."

As the aircraft yaws to the right under the action of the moment N_v generated by the fin and rudder, the left wing moves forward and the right wing backward. The motion combined with forward velocity "u" results in the left wing moving faster than the right wing. This results in increased lift on the left wing and a reduction of lift on the right wing, and the difference in lift generates the rolling moment L_r, tending to roll the aircraft in the direction of

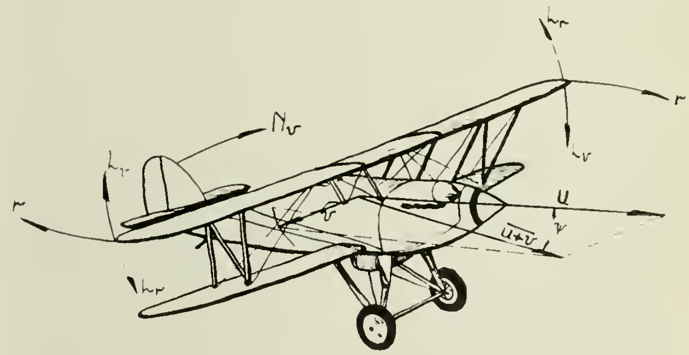


Fig. 5

the original bank. The presence of the vertical fin makes the machine stable in yaw by generating the moment N_r but it has a secondary effect, generating the moment L_r, which is detrimental to lateral stability. It tends to roll the aircraft in the wrong direction and to increase the bank.

The side-slip, however, acts directly on the wings as well as on fin and rudder. Dihedral angle on the wings sets up a moment L_v which is a stabilizing moment. This moment tends to raise the wing on the side of the side-slip and hence reduce bank. Thus if the stabilizing moment L_v is greater than the destabilizing moment L_r, the machine will oscillate in roll slightly and then resume straight flight, i.e., it is *laterally stable*.

If, on the other hand, the moment L_v is smaller than the moment L_r due to yaw, the latter will roll the machine to the right, increasing the bank. Increased bank will cause increased side-slip, which will in turn increase the rate of yaw and the destabilizing moment L_r.

Thus we have a small initial side-slip generating yaw and yaw aggravating side-slip. The aircraft deviates from the straight path and travels along a spiral path gradually tightening the turns. This form of lateral stability is known as "*Spiral Instability*."

If, now, the stabilizing moment L_v is very much greater than L_r the aircraft would level out too quickly. The forces due to angular as well as translational velocity of roll and of side-slip would carry the machine past the normal attitude. The machine would bank to the opposite side, side-slip, and the cycle would be repeated on that side. Instead of straight flight, here we would have a series of oscillations alternating from one side to the other, known as "*Unstable Oscillations*."

The nature of this flight varies from a slight persistent roll up to severe oscillations (as the fin area is decreased or the dihedral increased). In the latter instance, the aircraft is unstable in yaw and the severe rolling oscillations are accompanied by large degrees of yaw. Finally the tendency is for the machine to swing severely dropping a wing. This wing immediately stalls due to the sudden loss of speed caused by the severe yaw; the upper wing follows suit as the aircraft loses forward speed. The nose of the aircraft drops and autorotation about the longitudinal axis is set up. This is known as "*Spin Instability*" and is caused by improper ratio of fin area to dihedral, i.e., either too little fin area or too much dihedral on the wings.

In the above discussion, only one forward velocity of the aircraft was considered. It will be appreciated that the forces and moments will not all alter directly as the forward speed, nor all to the same ratio. Consequently stability may alter with change of speed.

During type trials, the behaviour of the aircraft is observed for all possible disturbances in straight flight at three different speeds with engine on, and with engine off. The pilot trims the aircraft for level flight, causes a disturbance by depressing the nose, dipping the wing, etc., releases all controls and notes the behaviour of the aircraft. The aircraft is also put into various degrees of turning, both in power flight and in a glide, the controls are then released completely and behaviour noted. For instance, the pilot depresses the nose of the aircraft and then leaves the machine to its own devices. In a stable aircraft, the nose of the aircraft rises to a point above the normal attitude, then depresses again below the normal, and after a few such oscillations, resumes the original attitude of level flight. If slightly unstable, the oscillations continue for a considerable period and small oscillations may even persist. The latter is usually termed "hunting." If very unstable, the oscillations become increasingly greater until the aircraft either stalls or goes into a nose dive. Similarly, the behaviour of the aircraft is studied and recorded for disturbances about the other axes.

It may possibly appear as though a perfectly stable aircraft is the ideal, but this is not so. A very stable machine requires large forces or control movements to break its will, and responds to every gust and can be kept steady only with difficulty in bumpy weather. In addition, it probably has a large change of trim engine on and off. Thus it is seen how closely balance, stability, controllability and manoeuvrability are related, and how important it is to carry out experimentation in order to discover which of the various qualities may be sacrificed and to what extent.

After having completed the qualitative tests and having been proved to have the normal and requisite characteristics of a good flying machine, the aircraft is ready for the quantitative tests to establish its measurable performance. Should the craft have been discovered to be unstable in a spin or to have any vicious characteristic, it is immediately qualified as "not airworthy."

Quantitative Tests

These tests consist of the determination of the performance of the aircraft at all altitudes from ground level to the maximum height at which it can fly.

In order that direct comparison may be made of any two things, no matter what, it is essential that the results be compared on the same basis. In aircraft work, we are dealing with the performance of machines operating in a gas which is neither uniform in density, pressure or temperature throughout, nor do such changes take place in a regular nor constant manner. This has led to the adoption of a "standard atmosphere" which specifies the normal or average conditions from the ground up to very great heights. As is well known, the "standard atmosphere" is never found, that is to say, at no time or place do "standard" or average conditions of all meteorological elements at all altitudes occur simultaneously. Nevertheless, it is necessary to adopt so-called "standard" values, and it is desirable to have these represent as closely as possible the true mean values in order that corrections due to departures from these means may be comparatively small in most cases. The adoption of an "isothermal atmosphere," although a desirable simplification in some respects, is inadvisable because of the large corrections that would have to be applied at practically all altitudes. What is required, in defining the "standard atmosphere," is a series of values of pressure, temperature, and density, at different altitudes, these values to represent as closely as possible actual average conditions. It has been shown from observations over a long period that up to 11,000 metres, the mean variation of the temperature with altitude at latitude 45 degrees or so is expressed very closely by Toussaint's formula:

$$\theta = 15 - 0.0065\ Z$$

where θ is the temperature in degrees Centigrade and Z the altitude in metres.

An International Standard Atmosphere was formulated from this, and has been universally adopted.

The International Standard Atmosphere is defined as follows:

1. It will be assumed that the air is dry and that its chemical composition is the same at all altitudes; the composition in volume is approximately as follows: 78.03 per cent. nitrogen, 20.99 per cent. oxygen, 0.94 per cent. argon and 0.04 per cent. carbon dioxide. The value of "g" will be taken uniformly as 980.62 in c.g.s. units.
2. It will be assumed that at mean sea level the temperature is 15 degrees C. and the barometric height, reduced to 0 degree C., 760 m/m of mercury.
3. Under these conditions the atmospheric pressure is 10,332 kg. per square metre (1013.2 millibars) and the weight of a cubic metre of air is 1.226 kg.*

*More exactly 1.2257 kg.

4. It will be assumed that, for any altitude Z, measured above mean sea level and between 0 and 11,000 metres, the variation of the temperature θ of the air is as follows:

$$\theta = 15 - 0.0065\, Z.$$

5. It will also be assumed that, for all altitudes above 11,000 metres, the temperature of the air is constant and equal to − 56.5 degrees C.

6. It follows that, for any altitude Z measured above mean sea level and between 0 and 11,000 metres, the barometric pressure p_z, the specific weight a_z, and the specific mass ρ_z of the air will vary according to the following equations:

$$\frac{p_z}{p_o} = \left(\frac{288 - 0.0065\, Z}{288}\right)^{5.256}$$

and

$$\frac{\rho_z}{\rho_o} = \frac{a_z}{a_o} = \left(\frac{288 - 0.0065\, Z}{288}\right)^{4.256}$$

7. Similarly, for all altitudes above 11,000 metres, the foregoing equations will be replaced by the following:

$$\log_{10}\frac{\rho_{11000}}{\rho_z} = \log_{10}\frac{p_{11000}}{p_z} = \log_{10}\frac{a_{11000}}{a_z} = \frac{Z - 11000}{14600}$$

8. The following table shows the values of temperature, pressure and density at heights from 0 to 11,000 metres. These values are derived from the equations given in paragraph 6 above.

Temperature, Pressure and Density at Heights Up to 11,000 Metres

Height in kilometres	Temperature			Pressure in Millibars	Density in grammes per cubic metre
	Degrees Absolute	Degrees Centigrade	Degrees Fahrenheit		
0	288	15	59	1,013.2	1,226
1	281.5	8.5	47.3	898.6	1,112
2	275.0	2.0	35.6	794.8	1,007
3	268.5	− 4.5	23.9	700.9	909
4	262.0	− 11.0	12.2	616.2	819
5	255.5	− 17.5	0.5	540.0	736
6	249.0	− 24.0	− 11.2	471.6	660
7	242.5	− 30.5	− 22.9	410.4	590
8	236.0	− 37.0	− 34.6	355.8	525
9	229.5	− 43.5	− 46.3	307.2	466
10	223.0	− 50.0	− 58.0	264.1	413
11	216.5	− 56.5	− 69.7	226.1	364

Performance Trials

The actual flying tests consist of a series of short or partial climb trials covering a range of speeds from 5 m.p.h. above stalling speed to 10 m.p.h. above maximum level speed at the given height (the last, of course, is a descent). These "partial climbs" are done at four heights chosen as 4/5, 3/5, 2/5 and 1/5 of the estimated or specified service ceiling of the aircraft. The height range covered at each speed is adjusted so that not more than 3 minutes is occupied in covering it, and must be at least 500 feet. Full throttle is used unless maximum r.p.m. are reached, when the throttle is adjusted to give these r.p.m. From these figures, rate of climb at each point is plotted against indicated airspeed, and the maximum rate of climb, best climbing speed, and maximum level speed at each height may then be determined with reasonable accuracy.

Two straight climbs are also performed. Besides establishing the rate of climb at all heights up to absolute ceiling, these climbs prove the adequacy, or otherwise, of cooling systems, lubrication, etc. Maximum level speeds at heights are determined on descent from one of the climbs.

Information on the power required to fly level at speeds intermediate between the best climbing speed and the maximum level speed at the service ceiling is also required for such purposes as determining the maximum range of the aircraft at different heights. This is obtained by finding the r.p.m. to fly level at all speeds throughout the range, and the test is combined with that for finding the position error of the Pitot head. The aircraft is flown over a surveyed speed course at four or five speeds between stalling speed and maximum horizontal speed.

To avoid waste of flying time, the tests are performed in the following sequence:

(1) Partial climbs at 3/5 and 1/5 of service ceiling. These give the correct climbing speeds to be used for subsequent climbs.

(2) Climb to service ceiling, partials at 4/5 service ceiling.

(3) Climb to service ceiling and level speeds at intervals of two thousand feet on the descent.

(4) Position error and r.p.m. to fly level, partials at 2/5 service ceiling.

The flying time required to complete all the tests is approximately seven hours. This does not include, of course, repetition of tests which may often occur due to bad atmospheric conditions.

Method of Reduction

Until a few years ago, the reduction of performance trials was based on the assumption that the brake horsepower was a function of density only, i. e.,

$$F(H) = \text{a power factor} = f(\sigma) = f\left(\frac{p}{\theta}\right)$$

As a result of considerable experimentation, it was then shown that the power developed by normally-aspirated engines should be considered a function of pressure only, rather than of density only, i. e.,

$$F(H) = f(p)$$

A complete review of all experimentation was made quite recently, the results of which show that, whereas,

(*a*) The simple pressure law is undoubtedly better than the simple density law.

(*b*) The law defined as $F(H) = f(p^{\frac{3}{4}}\sigma^{\frac{1}{4}})$ is a more accurate representation of the power law.

For the supercharged engine, the position is not entirely satisfactory, but from limited evidence available it appears that above full throttle height, the brake horsepower should be regarded as a function of density rather than of pressure. Thus the density method is used for such reductions.

The power factor can be expressed as $(p^{1-\alpha}\sigma^{\alpha})^m$. Hence the reduction to standard conditions of the performance of an aircraft carried out on a day when the density associated with a particular pressure is not standard, will depend on the relative importance of p and σ in the expression. That is, the reduction depends on the index α but is independent of the index m.

The principle underlying the method of reduction is as follows. Suppose that for any aircraft the power curve is of the form $HP \propto F(H)N^r$, where "r" is a constant, and "$F(H)$" is the power factor of the particular engine and constant at any given height. Let $V_c\sqrt{\sigma}$, $V\sqrt{\sigma}$ $(= V_i)$ and $N\sqrt{\sigma}$ be called the "indicated" values of the rate of climb, airspeed, and r.p.m. respectively. Then if these "indicated" quantities are obtained from the test observations and plotted against $F(H)\sigma^{\frac{1-r}{2}}$, the results should lie on the same curve irrespective of the atmospheric conditions under which the tests were made. To give the proof of this:

The power curve for an aircraft engine may be represented to a good order of accuracy at ground level by $HP = An^r$ where "n" = r.p.s. and "A" and "r" are constants. Then if Q_o and Q_h represent the torque at the ground and the height "h" respectively,

$$Q_o = An^{r-1}$$

and

$$Q_h = Q_o F(H) = An^{r-1}F(H)$$

$$= \text{airscrew torque} = k_Q \rho n^2 D^5$$

i.e.,

$$AF(H) = k_Q \rho n^{3-r} D^5$$

Now, if we write $J = \dfrac{V}{nD}$,

then

$$n^{3-r} = \frac{V^{3-r}}{J^{3-r} D^{3-r}}$$

so that

$$AF(H) = k_Q \rho \frac{V^{3-r} D^{2+r}}{J^{3-r}}$$

and

$$AF(H)\, J^{3-r} = k_Q D^{2+r} \rho_o \sigma V^{3-r}$$

Now $V_i = V\sqrt{\sigma}$ so that $\sigma V^{3-r} = \dfrac{V_i^{3-r}}{\sigma^{\frac{1-r}{2}}}$

therefore

$$AF(H)\, J^{3-r} \sigma^{\frac{1-r}{2}} = f(J) \rho_o D^{2+r} V_i^{3-r}$$

(assuming $k_Q = f(J)$ and neglecting secondary effects of compressibility and centrifugal twist).

For a given aircraft

$$F(H)\, \sigma^{\frac{1-r}{2}} f(J) = B V_i^{3-r},$$

where B is a constant.

Therefore at a given value of $F(H)\, \sigma^{\frac{1-r}{2}}$,

$$J = f(V_i) \qquad \ldots\ldots\ldots\ldots\ldots (1)$$

From the above

$$\frac{V}{N} = f(V_i)$$

so that

$$\frac{V_i}{N\sqrt{\sigma}} = f(V_i)$$

Therefore

$$N\sqrt{\sigma} = f(V_i) \qquad \ldots\ldots\ldots\ldots\ldots (2)$$

The thrust equation gives

$$k_T \rho n^2 D^4 = k_D \rho\, S V^2 + \left(a + b\frac{R}{R_o}\right) \rho V^2 + W \frac{V_c}{V}$$

Dividing by ρV^2,

$$k_T \frac{D^2}{J^2} = k_D S + a + b\frac{R}{R_o} + W \frac{V_c}{\rho V^3}$$

Now k_T and $\dfrac{R}{R_o}$ are functions of J, neglecting secondary effects, and $\rho V^2 = \rho_o V_i^2$ (since $V = \dfrac{V_i}{\sqrt{\sigma}}$ and $\rho = \rho_o \sigma$) therefore for a given aircraft,

$$Cf(J) = k_D S + a + E + W\frac{V_c\sqrt{\sigma}}{V_i^3}$$

where "C" and "E" are constants.

Now k_D is a function of V_i, therefore at a given value of $F(H)\, \sigma^{\frac{1-r}{2}}$ when $J = f(V^i)$

$$V_c\sqrt{\sigma} = f(V_i) \qquad \ldots\ldots\ldots\ldots\ldots (3)$$

Hence for a given aircraft at a given value of $F(H)\sigma^{\frac{1-r}{2}}$, at full throttle, $\dfrac{V}{N}$, $V_c\sqrt{\sigma}$ and $N\sqrt{\sigma}$ are functions of V_i.

Consequently for level speeds, where $V_c\sqrt{\sigma} = 0$, $\dfrac{V}{N}$, $N\sqrt{\sigma}$ and V_i may be plotted directly against $F(H)\sigma^{\frac{1-r}{2}}$.

In the case of climbs, a definite relationship between V_i and $F(H)\, \sigma^{\frac{1-r}{2}}$ should be maintained, and $V_c\sqrt{\sigma}$, $N\sqrt{\sigma}$ and $\dfrac{V}{N}$ are then also functions of $F(H)\, \sigma^{\frac{1-r}{2}}$ and may be plotted as above. As climbing speeds are specified to the pilot in terms of altimeter height (i.e., pressure), this condition is satisfied when $F(H)\, \sigma^{\frac{1-r}{2}}$ is of the form p^m, i.e., on the pressure basis of reduction. On any other basis when $F(H)\, \sigma^{\frac{1-r}{2}}$ contains a power of σ, the climbing speeds specified to a pilot should be modified in terms of actual temperatures prevailing. As, however, the climbing speed is normally an optimum value, a small change would make no appreciable difference in rate of climb.

There is a definite relationship between the values of $F(H)\, \sigma^{\frac{1-r}{2}}$ for any aircraft and the standard height and, therefore, standard height may be specified in terms of this function. Hence the indicated quantities for an aircraft may be plotted against standard height and the results are still independent of the atmospheric conditions at the time

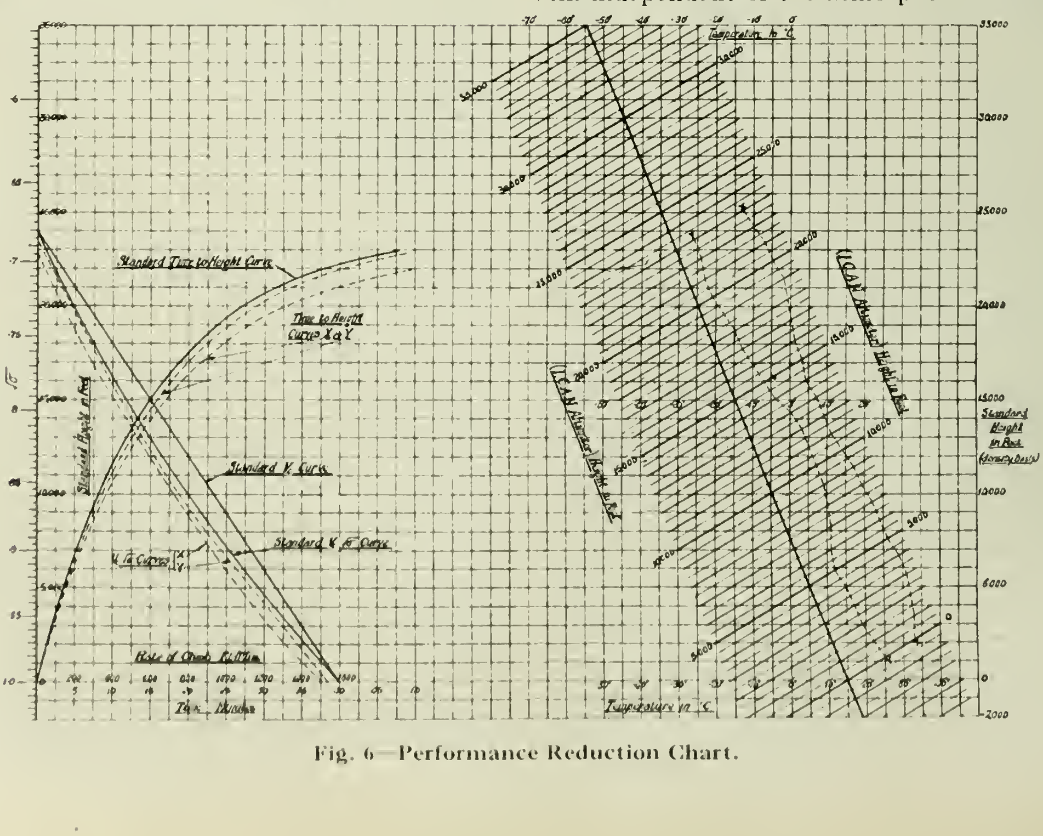


Fig. 6—Performance Reduction Chart.

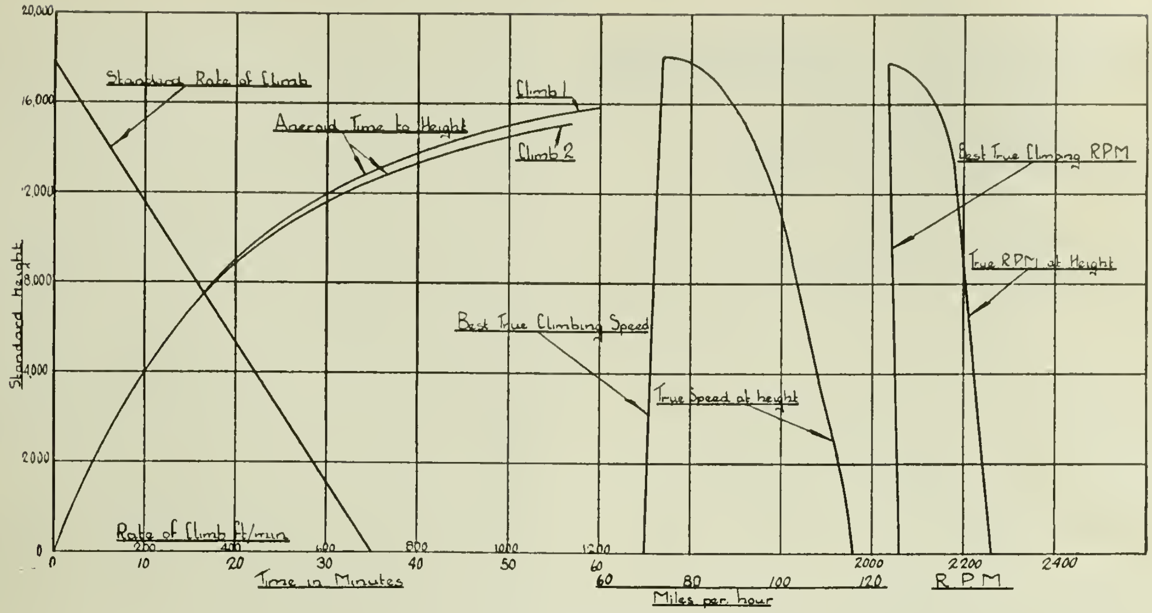


Fig. 7—Typical Performance Curves.

of the tests. The quantities which must be obtained from the test observations are therefore $V_c\sqrt{\sigma}$, V_i, $N\sqrt{\sigma}$ and the corresponding standard heights.

As explained previously, the best agreement between the results of observations taken under different atmospheric conditions is obtained when the observations are reduced on neither the pressure nor the density basis, but on some intermediate basis $(p^{1-\alpha}\sigma^{\alpha})^m$. Thus the procedure is to reduce two sets of observations by both methods, and from the ratio of the displacements of the two curves on the pressure and density reductions, the evaluation of the index α may be made. In a recent report (R. & M. 1316) Messrs. H. L. Stevens and A. E. Woodward Nutt publish a set of charts which they divised to simplify the reductions and eliminate a lot of tedious arithmetic. It is not intended to explain the use of the charts in the reduction, since it is covered most completely in their report. However, the chart shown in Fig. 6 is taken from their report for the purpose of indicating the evaluation of the index α.

The two $V_c\sqrt{\sigma}$ curves X and Y shown, were reduced on the pressure basis. The observed temperatures taken during the climbs, are plotted on the right hand side of the chart. The mean relative movement between the two $V_c\sqrt{\sigma}$ curves corresponding to the observed temperature difference for a change from the pressure to the density basis may be seen, and from the $V_c\sqrt{\sigma}$ curves themselves may be seen the mean relative vertical movement which will give the best agreement between them. The ratio of the second of these two relative movements to the first will give the best basis for reduction, i.e., the value of α in the expression $F(H) = (p^{1-\alpha}\sigma^{\alpha})^m$. The proportionate correction from the chart may then be applied and the mean standard $V_c\sqrt{\sigma}$ curve found. The standard rate of climb curve is found by dividing a series of points on the curve by the appropriate values of $\sqrt{\sigma}$ on the chart and, if required, the time to height curve may then be found by integration.

Level speed at heights, climbing speeds, r.p.m. at heights and r.p.m. climbing, are reduced to true speeds and true r.p.m. by both methods and the best basis obtained in a similar manner to that previously described for true rates of climb.

The results are then plotted in the form of the curves shown in Fig. 7, which give a complete representation of the performance of the aircraft.

Symbols Used in Reduction Theory

ρ	Density
σ	Relative density
p	Pressure
θ	Temperature
N	Engine Speed
V_c	Rate of Climb
V	Airspeed, true
V_i	Airspeed, indicated
n	Airscrew speed
Q	Airscrew torque, with coefficient $k_Q = \dfrac{Q}{\rho n^2 D^5}$
T	Airscrew thrust, with coefficient $k_T = \dfrac{T}{\rho n^2 D^4}$
D	Airscrew Diameter
J	$\dfrac{V}{nD}$
W	Weight of Aircraft
L	Lift, with coefficient $k_L = \dfrac{L}{\rho S V^2}$
D	Drag, with coefficient $k_D = \dfrac{D}{\rho S V^2}$
S	Area
$\dfrac{R}{R_o}$	Slipstream effect on resistance or drag

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The Fifth Plenary Meeting of Council

Plenary Meetings of Council have been held annually since 1927, and have had an important influence on The Institute's work and policy. In an organization like The Institute, whose branches are scattered over a vast extent of country between Cape Breton and Vancouver Island, co-ordination of the activities of these units can only be insured if there are periodical opportunities of this kind for the personal exchange of views between branch representatives. Such meetings, which all councillors have the opportunity of attending, enable council to shape its policies so as to express the aims of the membership as a whole. They also afford occasions on which councillors can form and renew personal acquaintanceships, and can obtain first hand knowledge of the way in which the business of The Institute is conducted. This year the Plenary Meeting will be held on Monday, Tuesday and Wednesday, September 21st, 22nd, and 23rd. A full attendance is likely, and the agenda include many subjects of importance as regards The Institute's policy and development.

Highway Traffic and Its Problems

In Canada the development of our highway system was comparatively slow until the end of the nineties, when the growth of motor traffic created a demand for improved means of road communication. Naturally in the older provinces it has been necessary to improve existing roads and make them suitable for the new conditions, while in the west, the mountain and prairie trails have had to be replaced by roads fitted for modern traffic. The magnitude of the task which has been accomplished will be realized from the statement that in 1904 only 535 motor vehicles were registered in Ontario, while there are now licensed in Canada nearly a million and a quarter automobiles. Some 400,000 miles of road now exist in Canada, so that with our present population there are only about twenty-five persons per mile of road. Our people are scattered over an enormous area and this makes our road transportation problem particularly difficult of solution. It is further complicated by the trend of population towards urban centres, so that while large stretches of country are still inadequately provided with road transportation and there is, as yet, no trans-Canada highway, we have in and near our larger centres of population, areas where traffic congestion already presents problems of administration and control comparable with those which are so pressing in the United States.

Our provincial and municipal authorities are also confronted with the question of finance. The annual expenditure on Canadian highways is now some $90,000,000, of which maintenance alone requires about $50,000,000. A substantial proportion of the whole is covered by registration fees and taxes, including that on gasoline, leaving a considerable balance to be taken care of from other Federal or provincial funds. The apportionment of the funds between maintenance and new construction; the decision as to the best way of expending the amount available for new roads, whether main highways or local feeders; the type of construction to be adopted, must not be based on guesswork but on the best judgment available.

In addition to our local and purely Canadian traffic, we have to provide for an ever-increasing number of visitors, and it is estimated that in 1930 about two and a half million cars crossed the border for a longer or shorter tour in the Dominion of Canada. The total number of cars entering Canada from the United States was of course much greater than this.

At first sight the effective control of traffic on our main highways would appear to be an administrative rather than a technical matter. On closer examination, however, many engineering questions arise which call for immediate decision. Many of the highway problems confronting us in Canada have already presented themselves in the United States, where there are twenty times as many cars and highway construction has taken place on a much more extended scale, but where the funds available have been correspondingly more abundant. Experience there and in Europe, as well as in Canada, has shown that in employing public funds for highway construction adequate results can only be obtained when the expenditure is based on close study, the results of experimental investigation and the advice of qualified engineers. Unwise design or methods of construction lead not only to the waste of public money but also to a needless increase in the hazards which face the road user. In a recent article, the Engineering News-Record pointed out that the highway engineer

> "is involved in design and construction, so that the highway roadbed may be inherently safe; in the provision of those accessories which are essential to safe operation, as signals, information signs, lane marks and shoulders; in the treatment of special problems that arise at branches, intersections and other danger points; and finally in safe maintenance of the road."

His engineering activity is, of course, not limited to the roadway itself. Modern traffic conditions call for many items of operating equipment undreamt of in the easy-going days of the past, and in particular much remains to be done before a reasonable degree of efficiency is reached as regards safety measures. There is, indeed, at the present time no agreement on such vital points as speed limit legislation; methods of signalling from motor vehicles; the question of red light turns; the effect of safety islands on congested traffic; and the proper adjustment and use of the automobile head-lamp. All of these affect the engineer's work.

When it is realized that an important highway may cost from $40,000 to $70,000 per mile and may carry an average traffic of more than 3,000 cars per day, it will be understood that on our main roads the closest consideration must be given to such questions as safety at grade crossings and intersections; the delay due to traffic congestion at these points; the visibility required for travelling at high speeds; the surface in relation to its durability, freedom from skidding and correct width and banking at curves; the formation of adequate shoulders and the proper provision of warning signals for approaching traffic. The best highway practice to-day looks upon maintenance as of equal importance with construction in its bearing on transportation efficiency and aims at steady improvement to take care of the inevitable increase in volume and speed of traffic.

While the highway engineer's work has led to a striking development of the art of road-building, the mechanical and electrical engineer has accomplished an equally remarkable task in the development of the automobile itself. Automobile engineers have now placed at the disposal of the motoring public comparatively cheap cars capable of comfortable driving at sustained high speeds which a few years ago could only be reached by cars in the luxury class, and a corresponding change has taken place in the performance of commercial vehicles. The result has been that the average highway speed is steadily increasing and highways are being improved and reconstructed to provide for this. Automobile design has already done so: brakes, steering gear, tires, motors and the chassis itself, on any good make of modern car, are adequate and reliable if the machine is intelligently maintained and used. The increased risk of present day driving is not so much due to the roadbed or the motor car as to the ignorance and lack of judgment of a few motorists, whose irresponsible actions cannot be controlled by any legal restrictions and who can only be eliminated by education or death.

All these points and many others have long been the subject of discussion by public bodies and technical associations in Canada and the United States, and it is a pleasure to draw attention to the excellent work which has been done in this country by the provincial governments, the automobile clubs and the various good roads associations. Their efforts have not only aided in determining the methods of construction and operation most suited to our arduous Canadian conditions, but have also done much towards educating the motorist. The Canadian Good Roads Association and the Inter-provincial Conferences of Highway and Transportation Officials have also been active in promoting that uniformity in practice which is necessary in order that in passing from one province or locality to another the road-user may not be confronted with unfamiliar signals, road-conditions calling for speeds to which he is not accustomed, or local regulations with which he finds it difficult to comply.

Much still remains to be done, but the publicity which is now being given to highway and automobile questions cannot fail to have its due effect in educating the motor-vehicle operator. It is hoped to make him realize that accidents result not so much from unsuitable road conditions as from unfitness of vehicle or driver or from his negligence, lack of experience or inattention.

There is no question as to the effective work done by those who design and construct our roads and automobiles; but there is a real difficulty in providing for their proper use by people who have no technical knowledge, little experience and not enough imagination to picture the possible results of carelessness or ill-judged action.

Engineers as a body realize far more clearly than does the general public the great diversity of factors on which the safe use of our highways depends and are thus specially qualified to help in educating the motoring public to a proper sense of its responsibilities. As individuals, and collectively, should we not take a more prominent part in this work?

Students' and Juniors' Prizes

Papers presented to any branch by Students or Juniors of The Institute during the prize year July 1st, 1931 to June 30th, 1932, are eligible for one of the five Institute prizes (each of the value of $25.00), which will be awarded in 1932. These prizes are assigned 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, 1932. Further information as to the requirements and rules may be obtained from the General Secretary.

OBITUARIES

George Cleghorn Mackenzie, M.E.I.C.

Members of The Institute will learn with regret of the sudden death of George Cleghorn Mackenzie, M.E.I.C., which occurred at Bark Lake, Que., on August 22nd, 1931.

Mr. Mackenzie was born at Kincardine, Ont., on July 26th, 1877, and received his early education at public and high school in Brantford, Ont., and graduated in Arts from Trinity College, Toronto. In 1903 he graduated from Queen's University with the degree of B.Sc.

Following graduation he was, until 1905, assistant blast furnace superintendent with the Londonderry Iron and Mining Company at Londonderry, N.S., and from 1908 to 1910 Mr. Mackenzie was engaged on special mining reports and claim inspection for the Ontario Bureau of Mines, Toronto. In 1910 he was appointed chief of the ore-dressing and metallurgical division of the Mines Branch, Department of Mines, Ottawa, and in 1915 he also became secretary and commissioner, Canadian Munitions Resources Commission, holding both appointments until 1918, at which time he joined the Electric Steel and Engineering Company, Welland, Ont., as general manager. In 1921 Mr. Mackenzie became general secretary of the Canadian Institute of Mining and Metallurgy, at Montreal, and for ten years he filled that position with outstanding efficiency and success. Within the same period he acted as secretary to the Canadian meetings of the Empire Mining and Metallurgical Congress, in 1927, and was active in promoting the success of those meetings.

Mr. Mackenzie joined The Institute as a Member on March 27th, 1923.

George William Volckman, M.E.I.C.

Regret is expressed in recording the death in London, England, on July 15th of George William Volckman, M.E.I.C.

Mr. Volckman was born at London, England, on March 27th, 1873, and was educated at Dulwich College and King's College, London, graduating from the engineering department of the latter institution in 1890. From 1890 to 1899 he acted as assistant to Mr. G. W. Manton, Mr. W. J. S. Binnis and Sir J. Wolfe Barry and Partners. Under the first he was connected with excavation and training works on the Mersey locks giving access to the Bridgewater and Runcorn docks and docks at the Royal Dockyard, Portsmouth. Subsequently he was engaged on the staff of Messrs. Price and Reeves on the Notting Hill Gate-Marble Arch section of the Central London Railway, and next was in charge of the construction of a four and a half mile main line section of the South Eastern Railway. Later he was connected with the widening of the London and North Western and Great Western joint line from Chester to Birkenhead.

In 1902 Mr. Volckmann was in charge of the sinking of caissons at the site of the then proposed Avonmouth docks, and later of the sinking of the Sloane street station shaft of the Piccadilly Tube railway. Between 1902 and 1907 he acted as engineer and manager in charge of the Bermuda Dockyard extension for the Admiralty, and in the latter year he visited Canada to report on lake ports. In 1908 he took up the position of engineer for the Montreal Ottawa and Georgian Bay Canal Company, and in 1910 was engineer to the Dominion Dry Dock Company for which he designed docks at Quebec and Saint John, N.B. From 1910 to 1912 Mr. Volckmann was chief engineer for MacArthur, Perks & Company, Ottawa, and in this capacity was responsible for the design and construction of concrete piers at Havana, and also for section dredging and reclamation for Messrs. Barclay Parsons and Klapp of New York. He was later engaged on railway work on the Pacific coast for the same firm. In 1928 he accepted the appointment of chief engineer and representative in India and the East for Sir Alexander Gibb and Partners.

Mr. Volckmann was a member of the Institution of Civil Engineers and of the American Society of Civil Engineers. He became a Member of The Engineering Institute of Canada (then the Canadian Society of Civil Engineers) on October 9th, 1909.

PERSONALS

George M. Bell, S.E.I.C., is now engaged on the two year course for student engineers of the Canadian Westinghouse Company at Hamilton, Ont.

J. C. Neufelt, S.E.I.C., a graduate of the University of Manitoba of the current year, is now on the staff of the Department of Mines and Natural Resources of the province of Manitoba, and is a draughtsman on the survey of the Dauphin river water power scheme.

D. B. Leightner, S.E.I.C., who graduated from the University of Manitoba in the spring of the current year, is at present with the Canadian Westinghouse Company at Hamilton, Ont., being engaged on the student apprenticeship course.

Frank C. Askwith, A.M.E.I.C., formerly deputy city engineer of Ottawa, has been appointed by that city as Commissioner of Works, to succeed A. F. Macallum, M.E.I.C., who retired early in 1931. Mr. Askwith entered the service of the municipality in 1907, and has since that time been chief draughtsman, sidewalk engineer, roadway engineer and deputy city engineer.

PROFESSOR ERNEST BROWN, M.E.I.C.

Professor Ernest Brown, M.E.I.C., Becomes Dean of the Faculty of Engineering at McGill University

Professor Ernest Brown, M.Sc., M.Eng., M.E.I.C., formerly professor of mechanics and hydraulics at McGill University, has been appointed Dean of the Faculty of Engineering of that institution.

Professor Brown graduated from University College, Liverpool, in 1897, with the degree of M.Eng., having already secured the degree of M.Sc. from Victoria.

In 1898-1900 he conducted a research at the Central Technical College, London, on "Temperature Rise in Field Coils of Dynamos," and from 1900 to 1903 was a lecturer in engineering at the same university, while continuing his research work with Professor Hele-Shaw. In 1903-1905 he was lecturer in applied mechanics at the University of Liverpool. Coming to Canada in 1905, Professor Brown was, until 1911, assistant and then associate professor in applied mechanics at McGill University, at which time he became professor of applied mechanics and hydraulics. Professor Brown has engaged on special laboratory investigations in reinforced concrete, and has contributed important papers on this subject to the Transactions of The Institute. He has also carried on investigations and made reports and designs in connection with special problems for the Quebec Bridge Commission, the St. Lawrence Bridge Company, the Laurentide Company, the Atlas Construction Company, etc. Professor Brown has been for some time connected with the Shawinigan Water and Power Company on hydraulic work. He is greatly interested in the affairs of The Institute, and represented the Montreal Branch on the Council during the years 1918-1919 and 1920.

H. P. Lingley, S.E.I.C., formerly with the engineering department of the Canadian National Railways, Moncton, N.B., is now connected with the Saint John Harbour Commission, Saint John, N.B. Mr. Lingley graduated from the University of New Brunswick in 1930, with the degree of B.Sc.

John Stephenson, A.M.E.I.C., is at present on the staff of the engineering department of the Saint John Harbour Reconstruction, at Saint John, N.B. Mr. Stephenson, who was formerly with the Canadian Steel Corporation at Ojibway, Ont., was for a time with the Riverside Iron Works at Calgary, Alta., and also with the Inland Steel Company of Indiana Harbour, Indiana, U.S.A.

Professor C. V. Christie, M.A., B.Sc., M.E.I.C., Macdonald professor of electrical engineering and head of the department of electrical engineering of McGill University, has been appointed a member of the main committee of the Canadian Engineering Standards Association.

Fred. A. Robertson, A.M.E.I.C., secretary to the chief engineer and engineer in charge of the library, Hydro-Electric Power Commission of Ontario, Toronto, was appointed a director of the Special Libraries Association at the annual convention of the society recently held in Cleveland, Ohio. The appointment is for a term of three years. This is the first time a Canadian has been invited to sit on the board of the Special Libraries Association, which is the business branch of the American Libraries Association.

F. S. Small, M.E.I.C., has been appointed assistant chief engineer on the Saint John Harbour Reconstruction, West Saint John, N.B. Mr. Small was assistant engineer with the Federal Department of Public Works on the Saint John River, N.B., in 1914, and in 1916 he was appointed acting district engineer, which position he held until 1917. In April, 1917, he became connected with the Fraser-Brace Engineering Company, and has been with that company with the exception of one year until the present time, holding the following positions: office engineer on the extension of the power plant at Cedars, Que., designing engineer, field engineer, manager of the Hydrolithic Waterproofing Company, one of the company's subsidiaries, superintendent of construction, and resident engineer on hydro-electric plant construction on the Gatineau and Churchill rivers.

Fred Newell, M.E.I.C., has recently been appointed by the Dominion Bridge Company, Ltd., Montreal, to the position of assistant chief engineer. Mr. Newell was educated at the London and Woolwich Polytechnic School, London, England. After several years engineering experience in England, he came to Canada in 1907, and shortly afterwards joined the engineering staff of the Dominion Bridge Company. In 1921 he was appointed mechanical engineer, and has since been intimately associated with the construction throughout Canada of a wide variety of important structures, including hydraulic regulating gates, cranes, car unloaders and moveable bridges of various types. Mr. Newell is recognized as an outstanding authority on the design of hydraulic equipment and has been closely associated with practically all construction of this nature in this country during recent years.

FRED NEWELL, M.E.I.C.

R. A. Bainbridge, M.E.I.C., has retired from the service of the Canadian Pacific Railway Company after forty-five years' service. Entering the company's service in 1886, he was engaged as rodman and leveller on construction of a line from Montreal to Saint John, N.B., until 1888, and from 1888 to 1890 he fulfilled the same duties on surveys for diversions of line or elimination of various trestle crossings of lakes between Fort William and Winnipeg, and on surveys from Regina to Prince Albert. During the year 1890-1891, Mr. Bainbridge was on the construction of the first railway built in the Kootenay district of British Columbia, from Robson to Nelson, and on improvements being made on the portion of the Canadian Pacific Railway between Yale and Savona, B.C. From 1901 to 1905 he was resident engineer at Nelson, B.C., and from 1905 to 1908 was assistant engineer, Pacific district, at Vancouver, B.C. From 1908 to the present time, Mr. Bainbridge has been engineer of the Esquimalt and Nanaimo Railway, located at Victoria, B.C. Mr. Bainbridge joined The Engineering Institute of Canada (then the Canadian Society of Civil Engineers) on April 23rd, 1903.

Correction

We regret that through an error in the August, 1931, issue of The Journal it was stated that A. Lariviere, A.M.E.I.C., had been appointed engineer of the Quebec Public Service Commission. Mr. Lariviere has, in fact, held that important position since 1922 and now relinquishes it on appointment as a member of the Commission. Mr. Laberge, the late Commissioner, was justly esteemed and it is a matter for great satisfaction to the profession that the government has named as his successor an engineer of such high standing and professional qualifications as Mr. Lariviere.

CORRESPONDENCE

Montreal, Que., July 8th, 1931.

The Secretary,
The Engineering Institute of Canada,
Montreal.

Sir:—

At a recent meeting of the Montreal Branch, Mr. Tennant of the Dominion Bridge Company expressed the opinion that the qualifications for admission should be relaxed in favour of individuals who had specialized along certain narrow lines.

In addition to those particular men with whom Mr. Tennant is acquainted, there are many others who are employed on engineering work, specialists in their line, yet because they have a very narrow range of experience and a limited education, they cannot be termed engineers. If I remember aright, the feeling of the meeting was against Mr. Tennant, but it has occurred to me that these men should be admitted as Affiliates.

Numbers may not mean strength in the discussion of "The Quantum Theory" or on "Stresses in Rigid Frames," but they most certainly do in the matter of finances, and if a thousand Affiliates could be added to The Institute, its prestige and usefulness would be much increased.

C.I.E.M.A.

Acknowledgment

With reference to the article on the *Empress of Britain* appearing in the July number of The Journal, it should have been stated that Fig. 4 was reproduced from *Engineering*.

We have received from the Structural Clay Tile Association of Canada a folder entitled: "Structural Clay Tile Data," containing information on construction details, technical data and research work relating to the uses of this material. Additional data sheets for the folder will be printed and distributed from time to time and will contain further reports on the uses of structural clay tile. Inquiries of a technical nature regarding this product should be addressed to the Structural Clay Tile Association of Canada, at Montreal, Toronto and Vancouver.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Presented by the Societies:
World Engineering Congress, Tokyo, 1929. Proceedings, Vol. 1: General Reports; Vol. 2: General Problems Concerning Engineering and Miscellaneous.
International Federation for Housing and Town Planning: Proceedings, Thirteenth International Housing and Town Planning Congress, Part 2: Programme and General Reports.
The Institution of Mechanical Engineers: Proceedings, Vol. 2, 1930.
American Institute of Electrical Engineers: Quarterly Transactions, Vol. 50, No. 2, June, 1931.
Second World Power Conference, Berlin, 1930: Transactions, Vol. 20: Index.
The Institution of Civil Engineers: List of Members, July, 1931.
The Cleveland Engineering Society: Membership Directory and Constitution, July, 1931.
The Royal Aeronautical Society: List of Members, March, 1931.
The Association of Professional Engineers of the Prov. of British Columbia: List of Members, 1931.
National Research Council. Division of Engineering and Industrial Research: Proceedings of the Tenth Annual Meeting of the Highway Research Board, Dec. 11-12, 1930.

Reports, etc.

Dept. of National Defence, Canada:
Report on Civil Aviation and Civil Government Air Operations for the Year 1930.
Bureau of Statistics, Canada:
Condensed Preliminary Report on the Trade of Canada, 1930.
Dominion Water Power and Hydrometric Bureau, Canada:
Water Resources Paper No. 65: Surface Water Supply of Canada: Pacific Drainage,—British Columbia, and Yukon Territory, Climatic Year 1928-29.
Dept. of Mines, Mines Branch, Canada:
Les Abrasifs, Part 2: Corindon et Diamant.
Dept. of the Interior, Topographical Survey, Canada:
[Perth to Kingston Map], 1931.
Hydro-Electric Power Commission, Ontario:
Twenty-Third Annual Report for the year ended October 31st, 1930.
Dept. of Lands, British Columbia:
Water Power, British Columbia, Canada. 1931.
Harbour Commissioners, Vancouver:
Annual Report, Port of Vancouver, 1930.
Corporation of the City of Hamilton:
Annual Report of the City Engineer, Hamilton, for the Year 1930.
Geological Survey, United States:
Professional Paper 165-E: The Kaolin Minerals.
Bulletin 819: The Wasatch Plateau Coal Field, Utah.
Bulletin 825: Microscopic Determination of the Ore Minerals.
Bureau of Standards, United States:
Handbook Series No. 15: X-Ray Protection.
Ohio State University:
Eng'g Experiment Station Bulletin No. 58: Voltage Relations and Losses in Small Universal Motors.
Eng'g Experiment Station Bulletin No. 61: Effect of Calcium Chloride as an Admixture in Portland Cement Concrete.
Eng'g Experiment Station Circular No. 22: Expansion of Ceramic Bodies Caused by Liquid and Vapour Penetration.
National Electric Light Association:
Industrial Heating Committee, Commercial National Section: Electrical Furnaces with Artificial Atmospheres.
Meter Committee, Eng'g National Section: Derivation and Application of Billing Constants.
Foreign Systems Co-ordination Committee, Eng'g National Section: Some Features of the Telephone and Telegraph Systems.
Foreign Systems Co-ordination Committee, Eng'g National Section: Telephone Cable Circuit Noise and Power Distribution Systems.
Electrical Apparatus Committee, Eng'g National Section: Guide for Specification Covering Metal-Clad Switchgear.
Purdue University:
Engineering Bulletin, March, 1931: Proceedings of the Seventeenth Annual Road School Held at Purdue University, January 19-23, 1931.

Technical Books, etc.

Presented by E. & F. N. Spon, Ltd.:
The Engineers' Technical Dictionary, English-French, [1931], by Mark Lvoff.
Presented by D. Van Nostrand Co. Inc.:
Analytical Mechanics, 3rd ed., revised, by H. M. Dadourian. 1931.
Presented by American Railway Association, Signal Section:
American Railway Signalling Principles and Practices, Chapter 16: Interlocking.
Presented by American Locomotive Company:
The Locomotive on the Railroads' Battlefield: An Address before Princeton University in the Cyrus Fogg Bracket Lectureship in Applied Engineering and Technology, delivered on April 14, 1931, by W. C. Dickerman.
Presented by Universal Oil Products Co.:
A Standard Knock-Testing Apparatus with Method for Rating Motor Fuels, [21 pp.]—Reprinted from Oil and Gas Journal, April 30, 1931.
Presented By Structural Clay Tile Association of Canada:
Structural Clay Tile Data [Folder, containing data sheets].
Presented by the Institution of Engineers (India):
Journal of the Institution of Engineers (India), Vol. 10, May, 1931.
Purchased:
A.S.M.E. Power Test Codes: Code on Definitions and Values, May, 1931.
Electrical Insulating Materials, by H. Warren. Published by Ernest Benn, Limited, 1931.

Catalogues

Stephens-Adamson Manufacturing Co.:
Catalogue No. 30: Material Handling Equipment.
Canadian Johns-Manville Co. Limited:
Manual No. 103: Johns-Manville Service to the Oil Industry. [219 pp.].

BOOK REVIEWS

Underground Systems Reference Book

Published by the National Electric Light Association, New York, 1931, cloth, 8½ x 11½ in., 377 pp., illus., figs., tables. Members, $4.00; Non-members, $6.00.

L. A. Kenyon, a.m.e.i.c.*

The publication of this Reference Book fills a gap in the list of books usually found on the desk of men connected with the transmission and distribution of electrical energy. It is alike interesting to office and field men, and, being well and profusely illustrated, it should be appreciated by cablemen who ordinarily read but little. It has been compiled and edited by practical men directly connected with the industry through the medium of the various committees of the N.E.L.A. Underground System Section.

The compilation has covered a period of years and has been carried out by men who are acknowledged specialists in their line, and under circumstances tending to free the book from pedagogic inaccuracies and the oft-times biased assertions of individual authors.

The practice of conduit construction, cable manufacture, installing, splicing, training and fireproofing varies considerably with the training received by the workmen and the local facilities available. Methods and practices which are commercial for one system may not be so for another where experience has evolved somewhat different arrangements to obtain the same general result, i.e., safe and satisfactory installation along with economic operation.

The above precludes laying down hard and fast rules and practices, but, where the same end is obtainable by several methods, these are discussed and illustrated so that a choice can be made best suited to local conditions.

The book has a good index, as well as two appendices—one giving general information and the other a bibliography. The body of the work is divided into eight chapters, the first of which is introductory, giving an historical sketch of the underground transmission of electricity and the use of cables as a solution of this problem.

The remaining seven chapters deal with cables, conduits, cable installation, cable splices, maintenance and operation, equipment and safety practices. The book is well bound and the illustrations clear and legible.

The Engineers' Technical Dictionary

English-French

By Mark Lvoff. E. and F. N. Spon, London, [1931], cloth, 4 x 6½ in., 296 pp., 6/- net.

Most existing technical dictionaries besides being out of date contain a great deal of unnecessary matter which increases their size and price without increasing their efficiency. The present dictionary obviates these faults and at the same time is of handy size.

It is chiefly intended for the use of mechanical and electrical engineers and contains a large number of new words used in general

*Assistant Engineer, Electrical Department, Montreal Light, Heat & Power Cons.

engineering, in wireless and the motor and aeroplane industries, technical expressions from other branches of industry which cannot be found in any other dictionary, and current commercial and legal expressions of use to engineers. Care has been taken to include not only new technical expressions, but also new meanings attached to ordinary words in special branches of engineering. In accomplishing this object and in the selection of words and expressions, and the elimination of others, the author has drawn upon his long experience extending over a quarter of a century in translating technical literature, including engineering, legal and commercial matter.

Transactions of the Second World Power Conference Berlin, 1930

Volume 20: Index-Volume

Published by VDI-Verlag, GmbH, Berlin, 1930, cloth, 6 x 9½ in., 315 pp. Agents: Percy Lund, Humphries & Co. Ltd., London, E.C. 4. £2.10.0.

The publication of the Index Volume completes the Transactions of the Second World Power Conference, held in Berlin in June, 1930. The Transactions are a complete record of the work of the conference, which owes its success to the collaboration of forty-nine National committees and over one thousand engineering experts from all over the world.

Over three hundred and fifty papers were presented by the National committees for discussion. These reports were grouped under the heads of 34 Sections (technical meetings). A number of the sections were devoted to special branches of engineering, whilst others gave a general review of the present status of engineering in different countries. Others, again, discussed particular questions relating to power-economy in which a number of related fields of engineering are concerned.

This method of organizing the proceedings has also made it possible to publish the Transactions of the Second World Power Conference—departing from previous practice in this respect—in twenty volumes, instead of the two to four volumes that have been usual hitherto. As a result, the individual volumes, which can be purchased singly, are cheaper and of a handier size. The work of the conference is thus made accessible to much wider circles than would be the case if only the comparatively expensive complete publication were available.

The study of the papers published in the Transactions is greatly facilitated by the alphabetical index of subjects and of authors which is contained in the Index Volume just published. The list of authors contains the names of the contributors of the individual papers and of the general addresses, together with the titles of the papers in the particular conference language (English, German, French) in which they were written. Furthermore, the authors and the titles of the general reports are given in the three official languages of the conference, and all those who spoke at the various discussions are mentioned by name.

The alphabetical index of the subject matter is drawn up in the three languages of the conference, each language being separated and rendered readily distinguishable from the others by coloured insert leaves. The individual reports, general reports, contributions to the discussions, and the general addresses are arranged here according to the matters treated. In order to facilitate the use of the trilingual index, each of its three sections is preceded by a terminological index of subjects in the three languages, arranged in alphabetical order.

Even those who possess none, or only a few, of the volumes of the Transactions will find the Index Volume a valuable source of information.

The American Bureau of Standards has been studying the penetration of water into brickwork. The results show that when the interior walls of brick buildings become wet during a rain it is likely that water has entered through open spaces between brick and mortar rather than directly through these solid materials. Such openings may be produced either by poor workmanship or by shrinkage of mortar. If there are no openings of this sort, the probability of penetration by water through solid 8-inch brick walls is exceedingly remote under normal climatic conditions and if proper precautions in design have been taken. One necessary precaution is to avoid plastering directly on the brick in an 8-inch wall, and that may be accomplished either by furring the wall or by the use of metal ties in place of header bricks. The time required for water to travel through a brick, thence through a mortar joint, thence through another brick is far greater than the time taken for water to penetrate the two bricks and the mortar joint when those materials are tested separately and out of contact with one another. Probably one reason for this is the fact that the pores in one material do not communicate directly with those in the other. It is also known that a brick must become highly saturated before it transmits water to another material. This degree of saturation is not attained when the brick is merely wetted through.—*The Engineer.*

BRANCH NEWS

Hamilton Branch

J. R. Dunbar, A.M.E.I.C., Secretary-Treasurer.
J. A. M. Galilee, Affil.E.I.C., Branch News Editor.

First Meeting of the New Executive Committee

The first meeting of the newly elected Executive committee of the Hamilton Branch was held recently at a joint luncheon meeting with the outgoing Executive committee, with a total attendance of eight.

W. F. McLaren, M.E.I.C., outgoing chairman, called the meeting to order.

Minutes of the previous Executive committee meeting were read and approved and the revised financial statement was presented. Messrs. D. W. Callander, A.M.E.I.C., and W. L. Miller, A.M.E.I.C., were appointed auditors.

Mr. McLaren then called upon E. P. Muntz, M.E.I.C., to take charge of the meeting.

Mr. Muntz expressed his appreciation of the honour the branch had done him by electing him chairman, and asking the Executive committee for their full co-operation to make the coming year one of the most successful the branch has had.

It was decided that the standing committees for 1931-32 would be as follows, with the duties as given below:

Meetings and Papers Committee.

Duties: 1. To arrange for speakers for at least one meeting per month.
2. To ascertain from the speaker if a lantern, blackboard, etc., would be needed, and to arrange to have them available.
3. To arrange for a suitable hall for each meeting.

Membership Committee.

Duties: 1. To obtain applications for admission from qualified engineers.
2. To pursuade present members to apply for transfer to a higher grade, when eligible.
3. To investigate and to report on applications for admission or transfer, when the applicant is not personally known to a member of the Executive committee.
4. To handle cases of members in arrears, members resigning or over age, etc.

Entertainment Committee.

Duties: 1. To arrange for entertainment and refreshments at all Branch meetings, as required.
2. To arrange for Branch luncheons and dinners.
3. To arrange for transportation when required.
4. To arrange for visits to industrial plants.

Publicity Committee.

Duties: 1. To prepare a report of all meetings for Branch News.
2. To insert advertising in the local papers when instructed to do so.
3. To co-operate with the representatives of the press in giving general publicity to Branch activities.

Reception Committee.

Duties: 1. To assist the chairman to look after the speaker while he is in Hamilton, except during the meeting.
2. To arrange informal dinners before the Branch meeting, to enable the speaker to meet members of the executive, and others.
3. To welcome new members and visitors at the Branch meetings.

The following members were appointed to the various committees for the coming year:

Meetings and Papers Committee.

Chairman........................E. M. Coles, A.M.E.I.C.
Members........................J. Stodart, M.E.I.C.
T. S. Glover, A.M.E.I.C.
G. Moes, A.M.E.I.C.
J. R. Hutton, S.E.I.C.

Membership Committee.

Chairman........................H. B. Stuart, A.M.E.I.C.
Members........................J. Stodart, M.E.I.C.
W. A. T. Gilmour, Jr.E.I.C.
H. W. Blackett, Jr.E.I.C.

Entertainment Committee.

Chairman........................G. A. Colhoun, A.M.E.I.C.
Members........................W. A. T. Gilmour, Jr.E.I.C.
C. Anderson, A.M.E.I.C.
A. R. Hannaford, A.M.E.I.C.

Publicity Committee.

Chairman........................J. A. M. Galilee, Affil.E.I.C.
Members........................V. S. Thompson, A.M.E.I.C.
P. R. Adams, S.E.I.C.

Reception Committee.

Chairman........................W. F. McLaren, M.E.I.C.
Members........................H. A. Lumsden, M.E.I.C.
W. L. McFaul, M.E.I.C.
L. W. Gill, M.E.I.C.
J. J. MacKay, M.E.I.C.
J. W. Tyrrell, M.E.I.C.
F. W. Paulin, M.E.I.C.
E. H. Darling, M.E.I.C.
H. U. Hart, M.E.I.C.
R. K. Palmer, M.E.I.C.

Some discussion took place regarding revision of the branch by-laws, and Messrs. Darling and Dunbar were appointed a committee to consider the revision to the by-laws and bring their recommendations before the Executive committee.

After some further discussion regarding address stencils and members in arrears of fees the meeting adjourned.

Ottawa Branch

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

Notes on the Mineral Industry of South Africa

The following notes are based on an address delivered at a meeting of the Ottawa Branch of The Institute on January 15th, 1931, by Dr. Charles Camsell, M.E.I.C., Deputy Minister of Mines, who was one of the Canadian representatives at the Empire Mining and Metallurgical Congress in South Africa last spring.

Dr. Camsell remarked that some two hundred and forty delegates gathered in Capetown at the congress from all parts of the world, of whom twenty-four were Canadians.

After the congress meetings at Capetown, which were presided over by the Governor-General of South Africa, the Earl of Athlone, the members were enabled to travel by special train all over the Union of South Africa and Rhodesia, and had the opportunity of seeing a good deal of the important mineral industries of the country.

Four principal points were of particular interest to Canadians, these being, the mineral resources of South Africa and how they compete with or supplement those of Canada; the relationship of the government to the mineral industry; the fuel problem of the Union and Rhodesia and how it is handled, and the system of concessions for prospecting.

The Union's mineral industry is similar to that of Canada in many ways, but a point of dissimilarity is that ninety five per cent of this value is attributable to three minerals—gold, diamonds, and coal. The small remainder is, however, derived from a great variety of minerals, including asbestos, tin, platinum, copper and manganese. Dr. Camsell gave it as his opinion that these other minerals which occur in such variety are not being developed to the fullest extent.

In the matter of asbestos, Canada is beginning to feel the competition from the Transvaal and Southern Rhodesia. Canadian asbestos production, which a few years ago amounted to eighty per cent of the world production, is now beginning to fall off on account of South African and Russian competition. There are great asbestos resources in southern Africa, particularly of the long fibre type, and undoubtedly South Africa will in future contribute a greater and greater percentage of the world's supply.

As regards copper production, although there is no large output at the present time, the mines of northern Rhodesia are likely to become an important factor in the world's market. Figures were quoted by the speaker comparing the amount of resources known in the United States, Chile, Cuba and Mexico, together with the recoverable copper contained as compared with northern Rhodesia. An interesting point in this connection was that in the prospecting of concessions and the making of geological surveys the work in northern Rhodesia was being done by Dr. Bancroft of McGill University with his staff of Canadian and Canadian-trained geologists.

With regard to gold production, although on account of its fixed price South African gold does not affect Canada, it has a very important bearing on the world's supply. About fifty-three per cent of the total recovery of this metal in the world comes from South Africa and at the present time the future outlook is not very optimistic. It is estimated by engineers that production is now at its peak and that in a period of three or four more years it will suffer a sharp decline owing to the fact that lower grade ores will have to be utilized for the recovery of this metal. Thus, the future supply of gold is a little uncertain and is a cause of concern to economists.

At Village Deep mine on the Rand a vertical depth of 7,640 feet has now been reached, with an increase of 300 feet per year. It is expected that mining can be carried on to a total depth of 9,000 feet. In this operation difficult problems have to be faced, in a rising temperature that becomes almost unbearable to the white man and an atmosphere that is saturated with moisture in order to keep down dust. Dr. Camsell related it as his personal experience that a descent to the lowest depth—wherein the first 4,000 feet drop was made in a matter of two minutes—was very trying.

In touching upon the water supply situation, Dr. Camsell stated that while at dinner with General Smuts the latter made the statement that Canada's greatest national asset was her winter's snow. By this the General meant that, as the snow was one of the greatest sources of supply for the waters of our rivers and lakes, it was a most important consideration. The water supply of South Africa is a serious problem. There are no natural lakes in the Union and, of course, there is no snow. There are also no extensive forests to retard the run-off. The precipitation varies from ten to forty inches per year but there are great difficulties connected with the matter of conservation in that the rate of evaporation is very high due to the almost continuous sunshine. In Johannesburg this rate is about 60 inches per year and in Buluwayo about 100 inches per year.

South Africa is, for the most part, a high plateau with a steep gradient along its edges toward the sea, and as a result the streams are not navigable for more than a few miles up from the coast. When the rains come the water runs off rapidly in the streams so that for the various periods of the year there is a great variation in the rate of flow. During the dry season many of the streams become absolutely dry. These conditions are so serious as to affect the growth of the population. Facilities, however, are provided by the government in the matter of drilling wells for water.

Another difficult matter is the racial problem. So far as the relationship between the English and the Dutch is concerned, any difficulties resulting as an aftermath of the Boer War are gradually being straightened out and in this regard conditions are constantly improving. The really serious question, however, is that of the coloured races. In southern Africa there is a total population of about 9,000,000, the proportion of whites and blacks varying from 1:4 in the Union to 1:150 in northern Rhodesia. Further, the growth of the black population is more rapid than that of the white. This results from the curtailment by the government of their one-time warlike activities and the introduction of hygienic services together with the very small amount of immigration of the whites. The government is fully cognizant of these conditions and the changes that are taking place in the coloured races.

Largely on account of the preponderance of natives, opportunities in South Africa for the white man are not as great as one might be inclined to believe. In spite of the fact that they have one of the finest climates of the world, development and settlement are not going on rapidly enough to furnish full opportunities for white immigrants. The labourers are coloured and this race is also encroaching upon the skilled trades. There are four universities in the Union with a student attendance of between six and seven thousand, of which, under government auspices, a sufficient number of technical and professional men are turned out to meet their own requirements.

Dr. Camsell stated in concluding his talk that the congress afforded a remarkable opportunity to meet representatives from all parts of the British Empire.

New National Safety Code for Elevators

The elimination of all speed limits for passenger elevators is one of the features of the new national safety code for elevators announced recently by the American Standards Association. Approval of the code by the association followed nearly four years of research on elevator safety devices at the United States Bureau of Standards and extensive investigation by a technical committee composed of thirty-eight representatives of architectural, engineering, governmental, and other organizations.

For the first time, the national elevator code permits the operation of more than one elevator in a single shaft, thus removing one of the obstacles to the erection of skyscrapers—the excessive space required for elevators. The code provides rigid safeguards to eliminate any possibility of collision between two elevators in the same shaft. The code also provides for two-storey cars which consist of two separate cages, one above the other, to serve two floors simultaneously from the same shaft. These will not be "one man cars," however, an operator for each of the two cages being required by the code. Safety devices will prevent the two-storey car from moving until the safety gates of both cages are closed.

Further provision is made for a new type of express-local system in which the master express elevator will stop at only three or four express or plaza floors, ten, fifteen, or even more stops apart, at which points passengers will transfer to local elevators starting from the plaza floors rather than all from the first floor, the present practice in skyscrapers.

The code insists upon fireproof elevator shaft enclosures and fireproof housing for the elevator machinery so that elevator evacuation of a fire-swept skyscraper will be possible.

Although the framers of the code found that present safety devices would permit safe elevator operation at any speed it is believed that the limit of speed will not go much beyond 1,200 feet per minute because of the discomfort to passengers resulting from rapid change in air pressures in ascent or descent.

Any speed above 700 feet per minute requires automatic operation with automatic floor leveling devices because of the difficulty of stopping more rapidly moving cars at floor levels. It was also found that at speeds of over 800 feet per minute an operator could not read floor numbers four feet high.

The code also includes provisions for the safe operation of freight and other types of elevators, the passenger-operated lifts, escalators, and dumb-waiters.

Pneumatic Tires

As pneumatic tires for both cars and commercial vehicles give such great reliability to-day, with life mileages which even a year or two ago would have seemed incredible, their trustworthiness and durability are now taken as a matter of course. It is true that the big advance made in road surfaces throughout this country and the general improvement of the highways are distinct contributory factors to the longer wear of tires. Speeds, together with more rapid acceleration and deceleration, have, however, also progressed, and, therefore, it may be said that tire design and manufacture together with improved systems of testing, have been largely responsible for the beneficial results accruing to motor vehicle users. An account of the process adopted by the Dunlop Rubber Company in the manufacture of pneumatic tires will illustrate how scientific this branch of the motor industry has become and what care is taken to maintain a high standard.

Rubber Preparation

Raw rubber is prepared on the plantations in the form of thin sheets of crepe or smoked sheet. After compression for packing purposes, these sheets form practically a solid block of rubber. On receipt at the works the packing is removed, and each block of rubber is immediately divided into eight parts by one cut of a heavy star-shaped knife against which the rubber is forced by hydraulic pressure. An important purpose of this cutting operation is to permit the rubber from many different cases to be mixed together in a methodical manner. This blending is one of the many precautions taken to ensure uniformity in the finished tire.

The raw rubber is next submitted to a process of working or mastication between large steel rollers, reducing it to a comparatively soft and plastic condition and in this state it is possible to mingle with it all the ingredients required to give the various mixed or compound rubbers the physical properties required in the various parts of the complete tire. The ingredients are of many kinds—for example reinforcing and toughening agents, dispersing agents, activators of vulcanization, vulcanizing agents, softeners, and colouring matter if required. The compounding of rubber for tire purposes is a science in itself, not only in the selection of the ingredients and the prescription for the compound but in the scientific control which has been found necessary in this important basic process. A large and up-to-date closed type mill, capable of dealing with a batch of rubber weighing 800 pounds, will produce over 150,000 pounds of compounded rubber in twenty-four hours. The total mixing capacity at Fort Dunlop exceeds 2,000,000 pounds weekly. Batches of mixed rubber are fully tested before issue to the manufacturing departments. Samples from each batch are sent by vacuum tube to the central control-room, where the tests occupy an hour. Pass-out warrants are then issued if the batch has proved satisfactory, and the compounded rubber is released for use in the different processes required. The standards of physical qualities and uniformity are high, and every precaution is taken to avoid anything which would produce variations in the capacity for service of the finished tires. The compounded rubber, having been distributed to the various departments of the factory, has now to be formed in such a way that it can be used in the particular portion of the tire for which it is intended. The hard-wearing rubber composing the visible tread and side walls of the tire is run out in the form of strips specially shaped for the purpose, thick in the centre, tapering to the edges. This is done by a profiling calender consisting of four steel rollers, one being provided with grooves of the requisite shape, through which the rubber compound is passed. The strips as they emerge from the calender are carefully gauged for accuracy, cooled by running through a water tank, and eventually cut to the lengths required for the particular sizes of tire. In this unvulcanized state the rubber is comparatively soft and has little elasticity.

Making Cotton Cord

Preparation of the cotton cord made to exacting specifications involves special processes. The finished fabric is not woven into warp and weft, but, as it ultimately consists of only warp threads, it is known as weftless cord. The threads are laid side by side in parallel lines almost touching each other, and while in this state they are fed through a four-roll calender, which is kept supplied with suitably compounded rubber. As a result they are completely embedded in a sheet of soft elastic material, which not only insulates every separate cord from its neighbour but forms a substantial layer of rubber which will, in due course, insulate and cushion each ply of material when built into the finished tire. Each cord, from a series unwinding from bobbins or cheeses, is led through its individual hole in a specially pierced plate and eventually guided out into the form of a flat sheet which is moving forward into the calender. Special control devices are used to provide uniformity of tension and to ensure the attainment of exact dimensions.

A machine is used to measure the strength and elasticity of cotton cords. It records automatically the character of the cords tested and is another of the precautions taken to ensure the maintenance of a high standard of suitability and uniformity. The actual operation on the prepared and rubbered cord fabric is to cut it into strips at an angle across the sheet or on the bias. These strips will ultimately form the plies of fabric which are built up into a tire casing. The width depends on the type and size of the finished tire; both it and the bias angle must be very accurately determined, and thereafter carefully produced in the cut strip. Once set to the dimensions required, the automatic machine will cut strips of the correct angle and width without variation. The long diagonal knife clamp is automatically fed forward to the requisite amount for cutting and the cut-off strip is rolled in a liner. The rubber surface of the strip is tacky and the liner prevents the fabric sticking to itself. The rolls of strip are passed forward for the tire-building process. Strips received from the cutting machine are assembled or buit up one on the other to form the casing of the tire. They can be built on a cylindrical former, the periphery of which is practically flat, or upon a former, or core, shaped almost exactly like the interior of a finished tire. Each ply on the core is so arranged that the cords run the opposite way across—that is, the bias of one strip opposes the bias of the other. As each pair of plies is laid down, the former is revolved and an ingenious mechanism of rotating discs gradually rolls the fabric down into shape, smoothly and without pucker. The wires forming the inextensible cover edges are added and the building up of the raw outer cover is practically completed. As the core is arranged so that it can be collapsed, the outer cover can easily be lifted from it.

The built-up cover is next moulded. First, a thick type of inner tube, known as an air-bag, is inserted in the cover. The cover and its air-bag are placed in the bottom half of the mould. A connection from a compressed air supply is made to the air bag, and the mould is then shut and fastened by special clamping arrangements. The mould consists of a hollow chamber through which steam is continually circulated. The mere act of closing the mould sets in movement a series of automatic controls. First the air is admitted to the air-bag to a predetermined pressure and continuously kept at that pressure. Electrical contacts operate the mechanism in the control room. This mechanism signals by lighting a red lamp above the mould when the allotted time of vulcanization has expired. The operator then immediately opens the mould, but it should be noted that this cannot be done until the pressure in the air-bag has been exhausted. The tire, after removal from the mould, has the air-bag extracted and is passed forward for the finishing processes.

As an example of the detailed care necessary in modern tire production the operation of balancing covers in certain sizes may be mentioned. The covers are mounted upon special wheels which are balanced with micrometer accuracy, and this enables any slight "out of balance" in the tire to be detected. The portion of the cover which is lighter in weight is marked with an indicating label, and when mounted on the wheel of a car, the valve of the inner tube is fitted at this portion so that the most accurate running balance is obtained.

Inner Tubes

In the manufacture of inner tubes compounded rubber which will give a soft and elastic vulcanized product is used. The tube compound is of a special type adapted for its purpose and formulated with reference to its resistance to oxidation and the effects of ageing. The thickness of the tube wall being relatively small, it is very important that there should be no particles of grit or foreign matter embedded in it. The rubber is therefore subjected to a process of refining. There are several ways of doing this, but one of the most effective is by screening or forcing the rubber through a fine metal mesh. This is done by means of a very powerful forcing machine.

Dunlop inner tubes are manufactured in circular form, not only as to section, but in circumference. This enables them to fit properly into the outer cover without puckering, renders the operation of fitting the complete tire to the rim comparatively easy, and removes the danger of trapping the inner tube. For this purpose the soft, unvulcanized tube, which has been cut off into a length from the forcing machine is blown on to a circular mandrel by means of compressed air and skilled manipulation. The tube is vulcanized on this mandrel and eventually removed; at the same time it is turned inside out so that both the interior and the exterior surfaces come under the closest scrutiny. The joining up of the inner tube to make a complete air-tight chamber is a special feature of the operations. The joint is not merely overlapped, solutioned and stuck down, but the tube ends are carefully bevelled by patented methods matched up together with a suitable vulcanizing compound between them, and then placed in an appropriate collar apparatus where the joint is steam-vulcanized throughout, so that in substance it practically does not differ from the remainder of the tube.

After the operations of fitting the valve patch, valve, printing the size, trade mark, etc., the tube may be regarded as a finished article, subject, however, to an exacting test for air-tightness in every part. The test involves the use of very efficient and ingenious machinery which is the subject of Dunlop patents. There is a circular water tank in which revolves a series of arms like the spokes of a wheel. These arms each carry two large bobbins over which the inflated tube is placed. As the arms revolve they carry the tubes through the water tank. The air pressure which can be carried by an inner tube when unsupported by an outer cover is comparatively small, so that to give the effect of the actual pressure used in the tires, the bobbins move apart and thus considerably stretch the tube in the process. Observers are stationed alongside the tank. Their special duty is to watch for any bubbles arising, which would indicate a slight leak.—*The Times Trade and Engineering Supplement* (abridged).

Preliminary Notice

of Applications for Admission and for Transfer

August 22nd, 1931

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, 1931.

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

BOWEN—JOHN ALFRED CLARKE, of Long Branch, Ont., Born at Haverfordwest, South Wales, Apr. 5th, 1905; Educ., Cambridge Local, 1918. O.L.S. Prelim., 1925. Honour and Pass Matric., Long Branch High School, 1931. 2 years, evening classes, Toronto Technical School; 1923-25, chaining and some instrument work, W. J. Baird, O.L.S.; 1925-26, on survey of Lake Nipigon for late W. R. B. Rubidge, Surveyor; 1927 (Apr.-Nov.), transitman, and 1928 (Jan.-June), chief of party, flooded areas, etc., Kerry & Chace; 1928 (Aug. Oct.), chief of party, topog'l. work, mining claims, E. M. MacQuarrie, A.M.E.I.C.; 1927 (Jan.-Mar.), and from Oct. 1928 to May 1930, with Messrs. Lang & Ross, as transitman on flooded areas, chief of party, power line location, junior engr., placing footings for steel towers, chief of party, damsite cross sections and power line location, instr'man. on machy. footings, chief of party, locating towers, and foreman on switch tower footings; 1930 (July-Dec.), senior layout man, concrete dam, rock shaft, tunnel, etc., Algoma District Power Co.

References: J. L. Lang, K. G. Ross, J. G. G. Kerry, A. E. Pickering, E. M. MacQuarrie, H. R. McClymont.

LANG—EUGENE C., of Chicago, Ill., Born at Chicago, July 31st, 1894; Educ., B.Sc. (Elec. Engrg.), Armour Institute of Technology, 1914; 1914-15, dftsman., City of Chicago; 1915-24, with the Arnold Company as follows: 1915-17, dftsman., and supt. of electr'l. constrn. additions to rly. shops; 1917-24, asst. supt. of gen. constrn. during rebldg. rly. shops; asst. engr. preparing engrg. reports, appraisals, etc. on industrial plants, utility, electric and steam rly. properties; engr. preparing designs and making studies and layouts of various rly. shops and terminal improvements; elect'l. engr. in charge of preparation of plans and installns. of elect'l. equipment in engine terminals and shops; gen. supt. of constrn., Plymouth, Michigan Engine Terminal, Pere Marquette Rly.; 1924 to date, with the Utilities Power & Light Corporation, Chicago, Ill., as follows: valuation engr. in charge of valuation dept., gas engr. with direct supervision over constrn. and reconstrn. of all gas plants of subsidiary companies (this position relinquished approx. four years ago). For the past four years, asst. to executive vice-president, duties of an executive nature, requiring knowledge and decision for and in the absence of the executive vice-president. Also direct charge and supervision of valuation dept.

References: G. G. Routledge, F. Chappell, R. L. Dobbin, F. A. Dallyn, G. G. Robinson.

MITCHESON—SEPTIMUS, of 2056 Belgrave Ave., Montreal, Que., Born at Tynemouth, North'd., England, Jan. 14th, 1891; Educ., 1908-11, Marine School of Engineering, South Shields, England; 1907-11, apprentice, Wallsend Slipway and Engrg. Co., Wallsend-on-Tyne, England; 1911-12, junior dftsman., with above company; 1912-13, dftsman., C. A. Parsons & Co., Heaton Works, England, on turbine driven generators and condensing plants; 1913-14, dftsman., R. and W. Hawthorne Leslie & Co., England, on turbine details and pipe arrangements for naval vessels, and 1917-19, with same company on geared turbines; 1914-17, corporal in Royal Engrs ; 1919-27, senior dftsman., Wallsend Slipway & Engrg. Co., on pipe arrangements, oil fuel installns., oil engine arrangements and details, etc.; 1927-28, designing dftsman., on special elevators and conveyors, transmission mach'y., The Dodge Mfg. Co., Toronto; 1928, designing dftsman., on power plant layout for paper mill, Kerry & Chace, Toronto; 1928-30, group-leader with Babcock-Wilcox & Goldie-McCulloch Ltd., Galt, Ont., in charge of group detailing Stirling boilers, air heaters, superheaters, and pulverized coal plants; 1930 (Feb.-Nov.), group-leader with Ontario Refining Co. Ltd., Copper Cliff, Ont., in charge of group designing, and supervising erection of steam piping and other pipe lines, also gen. plant layout work; March to May 1931, designing dftsman., United Engineers and Constructors, Montreal, on mech'l. side of foundry extension.

References: M. Balls, H. E. McLellan, R. E. MacAfee, H. R. McClymont, G. H. Kingan.

McQUEEN—HOWARD RENTON, of 4876 Cote des Neiges Rd., Montreal, Que., Born at New Glasgow, N.S., June 11th, 1885; Educ., Grad. with Honours, R.M.C., Kingston, 1907; Three years service in office of chief acct., N.S. Steel & Coal Co.; 1907-08, topog'r., rly. survey; 1908, survey, prov. of Quebec, for Dept. Militia and Defence; 1908-09, mining engr., Keokee Coal & Coke Co., Keokee, Va.; 1909, transit traverse, Militia and Defence; 1909-15, mining engr., U.S. Steel Corpn. and Oliver Iron Mining Co., Chisholm and Hibbing, Minn.; 1915-19, overseas, Capt., 1st Can. Rly. Troops; 1919-27, gen. contractor, roads and bridges; 1927 to date, President and gen. mgr., Iron Fireman Ltd., Montreal. Equipped approx. 200 small and medium sized boiler plants with Iron Fireman Automatic coal stokers, including Hotel Dieu, Montreal, Notre Dame Hospital, Seminary of Quebec, Seminary of Three Rivers, etc.

References: A. R. Ketterson, B. Ripley, H. T. Doran, F. A. Combe, C. K. McLeod, A. W. McMaster, H. L. Trotter.

THORNE—EDWARD CHARLES, of Drummondville, Que., Born at London, England, June 27th, 1903; Educ., Polytechnic Institute, London, England, 1921-22; Technical Institute, Chelmsford, 1922-24; Student, Inst.E.E., 1925; 1919-24, first class apprenticeship, and 1924-26, asst. engr., with Messrs. Crompton & Company, Chelmsford, England, outside erection and constrn. dept., installn. of rotary converter plant, switchgear motors and generators; 1926-29, not engaged in engrg. work; 1929-30, London Manager, and 1930, Secretary. to Robert Bright, Limited, Agents and Engrs., London and Coventry; at present, mtce. engr., operating dept., Southern Canada Power Company, Ltd., Drummondville, Que.

References: J. B. Woodyatt, P. T. Davies, J. S. H. Wurtele, D. Anderson, H. E. Pawson.

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

MACDONALD—CHARLES BEVERLEY ROBINSON, of Sao Paulo, Brazil, Born at Halifax, N.S., Dec. 8th, 1893; Educ., Grad. with Honours, R.M.C., Kingston, 1914; 1910-11 (summers), chainman and rodman, C.P.R. irrigation dept. surveys; 1914 (July-Nov.), asst. hydrographer, Hudson Bay Hydrographic Survey; 1914-19, overseas. Capt., Royal Engrs.; 1919-20, visiting various engrg. works in Canada, and gaining practical experience on Welland and H.E.P.C. canals; 1920 (May-Sept.), instr'man. and asst. engr., Capreol divn., C.N.R.; 1920-22, asst. chief engr., constrn. of two locks for Belgium Govt. by the firm of Constructions Civiles et Travaux; 1922-23, asst. office engr., Macdonald, Gibbs & Co., London, England; 1923-25, sectional engr., Argentine Transandine Railway Co.; 1925 to date, as employee and later director of the firm of Macdonald, Gibbs & Co. (Engrs.), Ltd., engrs. and contractors, London, England, as follows: 1925-26, engr. i/c surveys and constrn., Lobetas Development Rly., Northern Peru; 1926 (July-Dec.), engr. i/c surveys, Pellonis-Salinas Project, Southern Peru, for the Borax Consolidated Ltd.; 1927 (Jan.-Sept.), chief asst. engr. and later i/c survey parties, for the Sao Paulo Rly. Co., Brazil; 1927-28, engr. i/c surveys, Orinoco Rly. Project, Venezuela; Sept. 1928 to date, engr. i/c surveys and constrn., Sao Paulo-Parana Railway Co., Parana, Brazil. (*S. 1914, A.M. 1919.*)

References: A. S. Dawson, F. Anderson, H. L. Bucke, S. McIlwain, A. C. Macdonald, A. W. K. Billings, F. S. Keith, J. M. Campbell, H. J. Lamb, G. E. W. Cruttwell.

WELDON—RICHARD LAURENCE, of Larchmont, N.Y., Born at Winnipeg, Man., Nov. 27th, 1894; Educ., B.Sc., 1917, M.Sc., 1920, McGill Univ.; 1918-19, asst., metallurgical dept., Peter Lyall & Co., Montreal; 1919-20, engr., Laurentide Co., Grand Mere, Que.; 1920-23, mech. engr., St. Lawrence Paper Mills Ltd., Three Rivers; 1923-25, designing engr., i/c design of Corner Brook mill of Nfld. Power & Paper Co. Ltd., and 1925-28, chief engr. and asst. mill mgr. for above company; 1928 to date, mgr., International Power & Paper Co. Ltd. of Nfld., and 1930 to date, chief engr., International Paper Company of New York. (*S. 1915, Jr. 1918, A'M. 1921.*)

References: G. G. Gale, J. Stadler, R. E. Chadwick, W. I. Bishop, F. W. Taylor-Bailey, E. B. Wardle, D. C. Tennant, F. Newell, F. P. Shearwood.

FOR TRANSFER FROM THE CLASS OF JUNIOR TO A HIGHER CLASS

BARNETT—HAROLD EVANS, of Fraserdale, Ont., Born at Moncton, N.B., May 24th, 1897; Educ., B.Sc. (Civil), Univ. of N.B., 1918; 1915 (summer), surveys, Can. Govt. Rlys.; 1917 (summer), Can. Govt. Geol. survey; 1918-19, overseas. C.E.F.; 1919-20, rodman on survey and constrn. work, 1920-22, instr'man. on mtce and location surveys, Can. Govt. Rlys.; 1922-23, dftsman., right of way dept., C.N.R.; 1923-26, chief dftsman., N.B. Electric Power Commission, on rehabilitation of Musquash Div. and prelim. work on Grand Falls Div. in N.B.; 1926-30, designing engr., H. G. Acres & Co., Niagara Falls, Ont., on power developments, filtration plants, industrial bldgs., reports, estimates, etc.; 1930 to date, designing engr., Dominion Construction Corporation, on Abitibi Canyon power development, Ontario. (*Jr. 1921.*)

References: H. G. Acres, R. L. Hearn, G. Mitchell, S. R. Weston, P. C. Kirkpatrick.

BARRETT—ANDREW GRANT, of Asbestos, Que., Born at Summerstown, Ont., Oct. 26th, 1896; Educ., B.Sc., Queen's Univ., 1921; Summers 1917, 1920, 1921, instr'man., topog'l. divn., Geol. Survey of Canada; 1921-22, instr'man. on municipal engrg., 1922-23, instr'man., Dept. Public Highways, Ontario; 1924 (Jan.-June), instr'man., Quebec Development Co.; 1924 (June-Nov.), municipal engrg.; 1924 to date, with the Canadian Johns-Manville Co., as follows: 1924-26, instr'man. and office work; 1926-29, asst. chief engr., and 1929 to date, chief engr. (*S. 1921, Jr. 1925.*)

References: H. R. Lynn, S. R. Newton, W. L. R. Stewart, R. C. Smith, D. D. MacCrimmon.

RICKARDS—CHARLES SELBY, of Toronto, Ont., Born at Banff, Alta., Nov. 20th, 1896; Educ., Senior Matric., also advanced maths. (one year) at Hamilton Technical School. 1921-22, 2 years maths. under private tutor; 1912-13 (summers), mech'l. ap'tice (student), Ogden Shops, C.P.R., Calgary; 1915 (8 mos.), hydrographic survey, Dom. Govt.; 1916-19, electr'l. ap'tice, Canadian Westinghouse Company, Hamilton, Ont.; Also with same Company as follows: 1919-20, trouble engr., 1920-21, asst. dist. engr., Calgary district; 1921 (6 mos), engr.'s asst. on constrn.; 1921-22, meter engr., Abitibi Power & Paper Co. Instructor of electr'l. classes in technical school at Iroquois Falls. (Industrial Technical and Art School Cert. No.365); 1923-26, elect'l. mtce. dept., Toronto Hydro-Electric System, work particularly in connection with automatic stations and supervisory control; 1926 to date, erecting engr., Can. Gen. Elec. Co. Ltd., Toronto, Ont., specializing in industrial and automatic control equipment, supervisory control and telemetering, having full responsibility of the installn. of equipment for various projects throughout Canada. (*Jr. 1922.*)

References: C. H. L. Jones, W. E. Ross, A. B. Gates, G. N Thomas, J. H. Coruish, W. A. Bucke.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

BALLENY—JAMES LISTER, of Montreal, Que., Born at Colinsburgh, Fife, Scotland, May 19th, 1904; Educ., B.Sc. (E.E.), McGill Univ., 1925; 1919-24 (3 years in all), gen. elect'l. work in paper mill; 1925-26 (15 mos). test course with Can. Gen. Elec. Co.; 1926-27 (4 mos), indust. control work, and 1927-29, industrial heating engr., on design, manufacture and installn. of electric heating equipment for Can. Gen. Elec. Co., Davenport Works; Feb. 1929 to date, asst. elect'l. engr., Dominion Bridge Company, Montreal. (*S. 1922.*)

References: W. E. Ross, C. E. Sisson, F. Newell, R. H. Findlay, D. C. Tennant, K. O. Whyte, G. Kearney.

BULLER—FRANCIS H., of 1095 Brierwood Blvd., Schenectady, N.Y., Born at Montreal, Que., Nov. 23rd, 1900; Educ., B.Sc., McGill Univ., 1923. M.S. in E.E., Union College, Schenectady, 1931; 1923 to date, with General Electric Company as follows; 1923-24, test course; 1924-25, transformer engrg. dept.; 1925-26, A.C. engrg. dept.; 1926 to date, asst. engr., cable section, central station engrg. dept. (*S. 1920.*)

References: C. V. Christie, E. G. Burr, G. A. Wallace, C. M. McKergow, R. M. Wilson.

DES BRISAY—ARETAS WILLIAM YOUNG, of Camp Borden, Ont., Born at Petit Rocher, N.B., June 21st, 1904; Educ., Grad., R.M.C. 1925. B.Sc. (E.E.), McGill Univ., 1927; Summers: 1925, operation, hydro-electric plant of Bathurst Co. Ltd. at Grand Falls, N.B., also mtce gang in pulp mill for same co.; 1926, instr'man. on hydro-electric investigation survey on Nepisiguit River for same co.; 1927-28, instr'man., prelim. rly. survey, and dftsman. in pulp mill, summer 1928, for same company; 1928-31, engrg. staff, transmission engrg. dept., Northern Electric Company, Ltd., Montreal; at present, Lieut., Royal Canadian Signals, Camp Borden, Ont. (*S. 1926.*)

References: H. J. Vennes, W. B. Cartmel, A. G. L. McNaughton, E. Forde, W. A. Steel, P. Earnshaw.

ENNIS—LEO E., of 5154 Mountain Sight Ave., Montreal, Que., Born at Perth Road, Ont., Dec. 1st, 1902; Educ., B.Sc. (Civil), Queen's Univ., 1923; 1923-24, asst. field engr., Ford Motor Co. of Canada, Ford City, Ont.; 1924 to date, with the Bell Telephone Company of Canada, as follows: 1924-26, student engr. on inventory, central office, installn. and constrn. studies; 1926-27, divn. constrn. engr., eastern divn., on special organization and constrn. problems; 1928-29, divn. constrn. supervisor, eastern divn., technical adviser to the constrn. supt. and in charge of organization programming of all major outside plant constrn.; 1929 (June-Sept.), special studies engr., in charge of special problems and budget work connected with the plant engr. dept.; Oct. 1929 to date, toll pole and wire engr., Quebec Divn. (*S. 1922.*)

References: J. E. Porter, W. P. Wilgar, V. C. Jones, F. M. Corneil, A. M. Mackenzie, W. H. Slinu.

FAIRBAIRN—JOHN MACFARLANE, of Montreal, Que., Born at Ottawa, Ont., Apr. 17th, 1903; Educ., B.Sc., McGill Univ., 1924; 1922, office work, Grand Trunk Arbitration; 1923, lightkeeper, Can. Govt. Geod. Survey; 1924-25, ap'tice, Steel Company of Canada; 1926-27, inspr. of malleable castings and steel forgings in mfg. plants, The P. & M. Co., Chicago, (Railway Supplies), and 1927-28, selling rail anchors, rail oilers, ballasters, etc. to American rld. engrs. and inspecting performance in service, with same company; 1928, sales engr., Maintenance Equipment Company, Chicago; 1928-29, with Chas. Warnock & Co., Toronto, district mgr. i/c of soliciting, arranging plans and specifications, and handling of all inspection work in that district; 1929 to date, with Chas. Warnock & Co., Montreal, gen. mgr. i/c of all functions of company. (*S. 1921.*)

References: J. A. McCrory, C. Warnock, P. B. Motley, R. L. Latham, F. J. Blair, J. H. Larmonth.

LOVETT—PERCY ARTHUR, of 107 Morris St., Halifax, N.S., Born at Liverpool, N.S., Apr. 17th, 1903; Educ., B.Sc. (E.E.), N.S. Tech. Coll., 1928; Summers, 1927, C.G.E. factory at Peterborough, Ont.; 1928, asst. with Nova Scotia Fuel Board; 1928-30, student ap'tice course, Canadian Westinghouse Co., Hamilton, Ont.; Nov. 1920 to date, asst. equipment engr., Maritime Telephone and Telegraph Co., Halifax, N.S. (*S. 1928.*)

References: W. A. Winfield, F. A. Bowman, F. R. Faulkner, W. P. Copp, W. F. McLaren.

The Constitution of Portland Cement and the Deterioration of Concrete in Alkali Soils

Co-operating Organization: University of Saskatchewan

Silicates and aluminates of widely varying composition constitute a large part of the material used in the ceramic, glass building and insulating industries. Due to the wide variation in the chemical and physical properties of the compounds, as evidenced by the appearance of the rocks and their slow deterioration, the behaviour of the substances when exposed to external agencies is not always so well known as to ensure the best use of the substance. This is particularly true of newly developed materials or materials used in new surroundings. In this respect, the resistance of silicates and aluminates in concrete against the attack of sulphates is a very pressing problem for western Canada where the losses due to the deterioration of concrete are serious.

It is now generally accepted that tricalcium aluminate is one of the important components of Portland cement; the action of sulphate on the hydrates of this substance is considered to be the main cause of the failure of concrete in solutions of sodium and calcium sulphate, that is, in alkali water containing these two salts in solution. One crystalline hydrate of tricalcium aluminate has been known previously; it forms hexagonal plates, needles and spherulites. By treating pure tricalcium aluminate with steam under a pressure of approximately 70 pounds per square inch and drying the product over quicklime, a new form of hydrated tricalcium aluminate was prepared, belonging to the isometric system and crystallizing as cubes and trapezohedrons. It is stable at 100 degrees C. but at 275 to 300 degrees C. it gives up three-quarters of its water and forms a stable hydrate of composition $3CaO\ Al_2O_3\ 6H_2O$. This is decomposed, on heating at 500 to 600 degrees C., to $5CaO\ 3Al_2O_3$ and free lime. When the resulting mixture is placed in saturated steam at 150 degrees C. recombination takes place, and the hexahydrate of tricalcium aluminate is again formed. It was found that it could also be obtained directly by exposing a mixture of lime and alumina of appropriate composition to steam at 150 degrees C. The crystals produced are cubes and more rarely dodecahedrons. When pure tricalcium aluminate is exposed to steam at 150 degrees C. the crystals of the hexahydrate appear as trapezohedrons. In each case the refractive index is the same. A hydrate composed entirely of hexagonal plates is obtained when the temperature at which the tricalcium aluminate takes up water is kept low. At about 25 degrees C. and at atmospheric pressure, the hexagonal form goes over into the cubic form, the change apparently taking place the faster the larger the initial percentage of water in the material.

Parallel experiments were made on a number of commercial Portland cements obtained from four different mills. Previous work had shown that prolonged curing in saturated steam at 175 degrees C. renders the mortar almost completely resistant to the action of solutions of sodium sulphate and increases very materially the resistance of the mortar to the action of solutions of magnesium sulphate. A microscopic study of the changes taking place was made and it was found that free lime gradually disappears and that crystals of calcium hydroxide take their place. These disappear in turn when steaming is continued, while a new crystalline substance is formed which is very stable in solutions of sodium and calcium sulphate, but is decomposed slowly by solutions of magnesium sulphate. The crystals are orthorhombic. They are decomposed by very dilute acids, but are stable in solutions of sodium hydroxide and are not affected by temperatures as high as 400 degrees C. The great increase in the resistance of Portland cement mortar to alkali action produced by steam curing for twenty-four hours or more is evidently connected with the production of this crystalline material. Curing in water vapour at temperatures below 100 degrees C. was found to lessen the strength of the material and at a temperature of 50 degrees C. the resistance to the action of sulphates decreased.

Another way of producing high resistance to sulphate action was found to be the addition of siliceous substances; this has been practised for a long time for the purpose of obtaining a mass of greater workability and greater impermeability to water. The capacity of such substances for binding free lime suggested that they might be effective in preventing sulphate action. This was found to be the case when a pure silica gel was added to ordinary Portland cement. Further studies with silica gel and with many natural and artificial products rich in silica are in progress.

As a preparation for a study of the heats of formation of the constituents of Portland cement, new determinations on the heats of solution of calcium oxide and calcium hydroxide in hydrochloric acid were made. The heat of solution of the calcium hydroxide at room temperature was found to be three calories higher than that obtained with material hydrated in steam at 150 degrees C., but after subtracting the heat of wetting the average values were 550.7 and 550 degrees C. The heat of hydration of calcium oxide did not agree with calculated results; a microscopic examination indicated that physical changes in the hydrated material continue for a long time after the temperature of the calorimeter comes to apparent constancy. The heat of solution of calcium oxide was 46.50 calories per mole, and was not materially affected by the temperature of ignition between 800 and 1,200 degrees C.

—*Thirteenth Annual Report of the National Research Council.*

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CIVIL ENGINEER, A.M.E.I.C., R.P.E. (Ont.), 15 years experience, available on short notice. Experienced surveys, draughting, reinforced concrete design, municipal engineering, construction work, inspection, estimating. Apply to Box No. 107-W.

CIVIL ENGINEER, university graduate 1926, desires employment as junior engineer or instrumentman on construction work. Experience, resident engineer on railway construction, miscellaneous surveys. References. Available any time. Apply to Box No. 149-W.

CIVIL ENGINEER, B.Sc., age 34, is open for a position as construction engineer in charge of construction of hydro-electric plants or paper mills; designing engineer of hydro-electric developments or paper mills. Willing to make small investment. Apply to Box No. 157-W.

ELECTRICAL ENGINEER, B.Sc., McGill 1926. Five years experience in the design of switchboards, layouts and wiring diagrams. Considerable experience in high and low tension switchgear design. Fifteen months experience in switchboard estimating. Available at once. Apply to Box No. 247-W.

ELECTRICAL ENGINEER. Graduate '25, wide experience in hydro-electric power stations, desires position on power plant design or related work. Apply to Box No. 278-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. Also some experience in ventilating and heating work and calculators. Accustomed to structural design and details. Good references. Present location Montreal. For interview apply to Box No. 329-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., R.P.E. Ont., with twenty-four years experience embracing dams, wharves, grain elevators, foundations, pile driving, highways, municipal engineering, water power surveys, road locations, inspections and estimating, is open for engagement as engineer or superintendent in construction, operation or maintenance. Location immaterial. Apply to Box No. 358-W.

STRUCTURAL AND CIVIL ENGINEER, Jr.E.I.C., age 31, married. Was instrumentman and structural engineer on erection of Royal York hotel, and asst. resident engineer on James Bay Extension, T. & N.O. Rly. Experience includes structural, civil and mechanical draughting and all kinds of instrument work and special work. Qualified as captain in military engineering, R.M.C., Kingston. Available anywhere in Canada, preferably Toronto, for any kind of work. Apply to Box No. 377-W.

STRUCTURAL AND CIVIL ENGINEER, B.Sc., age 35, married. Thoroughly experienced in design, shop work and erection of steel bridges, buildings and movable structures. Seeks position as designing engineer or engineer on construction. Available on short notice. Will go anywhere. Apply to Box No. 399-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

DESIGNING ENGINEER, A.M.E.I.C., P.E.Q., with extensive experience in design and construction of power plants, industrial buildings and hydraulic structures, desires position as designing engineer or resident engineer on construction. Apply to Box No. 492-W.

MECHANICAL ENGINEER, Jr.E.I.C., B.Sc., '26. Ten months experience in pulp and paper steam control. Four years experience in detail and design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

CIVIL ENGINEER, B.A.Sc., '29, with experience in supervision of construction and general office engineering, desires permanent position with contractor or engineer. Available at once. Apply to Box No. 524-W.

CIVIL ENGINEER, A.M.E.I.C., with twelve years experience embracing survey and construction, railway, hydro-electric and highways, foundations, pile driving, municipal engineering, water power surveys, road location, inspection and estimating, is open for engagement as resident engineer on construction or other responsible position. Experience comprises both office and outside work. Available immediately. Apply to Box No. 527-W.

MECHANICAL, CONSTRUCTION, AND DESIGNING ENGINEER, with special training in hydro-electric power development, underground steam distribution systems, and the operation of large electrical machinery. Active work desired. Apply to Box No. 528-W.

ELECTRICAL ENGINEER, married, graduate of McGill University, desires position in Ottawa, Montreal or Toronto. Experience includes four summers with a building concern as instrumentman and assistant engineer, two and one-half years with the Canadian Westinghouse Co., this time being distributed between tests, design and sales. At present employed but available on short notice. Apply to Box No. 533-W.

UNDERGRADUATE ENGINEER, S.E.I.C., junior year standing (Sask.), desires work to complete course. Electrical or mechanical work preferred. Apply to Box No. 553-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, S.E.I.C., 1931 graduate, experienced instrument man and surveyor. Wishes to join reliable engineering firm on survey party, or draughting, steel and concrete design, estimating, building, construction, etc. Good references. Residing in Montreal. Available immediately. Apply to Box No. 567-W.

CIVIL ENGINEER, B.Sc. McGill Univ., Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

MECHANICAL ENGINEER, A.M.E.I.C., experience in the design and maintenance of steel mills, zinc and sulphuric acid plants, cement plants; power house layouts; familiar with shop practices and costs, desires connection. Apply to Box No. 571-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., (Univ. of B.C., '30), Undergraduate experience in pulp mill. One year's experience, Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

TEMPORARY EMPLOYMENT wanted by an engineer with wide experience in the design and operation of steam power plants and heating system. Apply to Box No. 584-W.

ELECTRICAL ENGINEER, graduate Univ. of Alberta, '31, with excellent record, desires connection with electrical manufacturing firm, power or communication company. Good general experience includes one summer railway construction, two summers geological surveys in oil fields of Alberta, planetable topographer and asst. geologist. Available immediately. Apply to Box No. 596-W.

MECHANICAL ENGINEER, age 22, graduate '31, Univ. of Alberta, experience as draughtsman and instrumentman-inspector, is open for a position. Location immaterial. Apply to Box No. 598-W.

MECHANICAL ENGINEER, S.E.I.C., age 21, four years mechanical engineering, Queen's University, desires permanent employment. Experience in wood work, machine shop work, draughting and surveying. Location immaterial. Available at once. Apply to Box No. 600-W.

Situations Wanted

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building, desires change. Location immaterial. Available on one month's notice. Apply to Box No. 601-W.

ELECTRICAL OR MECHANICAL ENGINEER, B.Sc., '31, S.E.I.C., desires employment which will give experience and lead to advancement. Two summers in a large communication company, including draughting, switchboard and surveying. Available on short notice. Will go anywhere. Apply to Box No. 606-W.

CHEMICAL ENGINEER, S.E.I.C., University of Alberta '30, desires a position in any industry with chemical control. Experience includes three summer vacation periods of five months each as assistant chemist, and ten months as chief chemist with a cement company. Age 29. Single. Available at short notice. Apply to Box No. 609-W.

CIVIL ENGINEER, S.E.I.C., B.Sc. (C.E.), Univ. of Man. '31, desires temporary or permanent employment on engineering work. Twenty months experience in summers as chainman, rodman and instrumentman on railway grade and bridge construction; also as inspector on reinforced concrete highway bridges. Salary and location immaterial. Available at once. Apply to Box No. 614-W.

DESIGNING ENGINEER, industrial building designer, Jr.E.I.C., age 31, married, capable of taking responsible charge of the structural design and architectural details of steel or concrete manufacturing plants or power houses, also has had considerable experience in the design of office buildings, etc., desires reasonably permanent position. Very highest references from present employers. Location immaterial. Apply to Box No. 615-W.

MECHANICAL ENGINEER, Jr.E.I.C., 5 years apprenticeship on general mechanical engineering; 10 years experience on heating and ventilating and mechanical equipment of buildings. Design, draughting and production. Desires change. Capable of taking charge of engineering department. Further particulars if required. Apply to Box No. 616-W.

POWER ENGINEER, M.E.I.C., age 42. Married. Thoroughly conversant with electrical, steam, mechanical and industrial engineering, desires executive position with large industrial, power or financial corporation. Best of references as to ability and positions held. Apply to Box No. 617-W.

CIVIL ENGINEER, Jr.E.I.C., B.A.Sc. '24, age 35, married. Five years designer and estimator with well-known firm of industrial builders; two years detailing, designing and estimating structural steel for bridges and buildings, also survey and municipal experience. Open for position immediately, will go anywhere. Apply to Box No. 618-W.

CIVIL ENGINEER, A.M.E.I.C., graduate '23, married, eight years municipal engineering experience. Sewerage and sewage disposal, water works, street pavement, etc. Also some experience highway construction. For the past three years engaged by firm of consulting municipal engineers. Desires permanent position. Location immaterial. Available immediately. References. Apply to Box No. 624-W.

ELECTRICAL ENGINEER, B.Sc., N.S. Tech. Coll. '31. Experience in design and construction of rural distribution lines, trouble shooting, inventories and general office work, desires position with public utility or industrial plant. Location immaterial. Available at once. Apply to Box No. 628-W.

ELECTRICAL ENGINEER, B.Sc., N.S. Tech. Coll., '31. Experience includes geological survey work in Rouyn mining area and hydro-electric power plant construction both civil and electrical work. Available at once. Apply to Box No. 639-W.

SALES ENGINEER, A.M.E.I.C., McGill '23. Past four years sales representative electrical power apparatus in Northern Ontario mining district, western Canada and with some sales experience in Montreal, Toronto, Ottawa, and eastern Ontario. Two years electrical estimating and engineering on steel mill applications, mine hoists, elevators, pulp and paper drives, crushing and cement and other special applications. Two years design, engineering, test and some erection on steam turbines. Available short notice; location immaterial. Apply to Box No. 641-W.

ELECTRICAL GRADUATE, McGill '30, S.E.I.C., with thirteen months experience on General Electric test course, twelve months draughting and five months as instrumentman on power plant construction. Available September first. Location immaterial. Apply to Box No. 644-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E. (Ont.). Extensive experience as executive and in charge of construction of complete water power developments, including transmission lines, harbour developments, including hydraulic dredging and land reclamation, industrial plants and municipal works. Apply to Box No. 647-W.

OPERATING ENGINEER. Position wanted as operating superintendent or assistant. Age 43. Married. No children. Nineteen years experience operating hydro-electric plants, sub-stations, transmission lines. Available immediately at any reasonable salary and for any location. Apply to Box No. 654-W.

ELECTRICAL ENGINEER, Jr.E.I.C., 1926 grad. of English Tech. Coll. Past two years inspector of communication apparatus; three years varied power and sub-station experience, including automatic sub-stations, on comprehensive training scheme. Age 24, single. Location immaterial. Available at once. References. Apply to Box No. 658-W.

ELECTRICAL ENGINEER, B.Sc.E.E., 1931, N.S. Tech. Coll. Experienced in armature winding and apparatus repairs, in conduit and cable work. Students' course in elevator manufacture, ship's electrician on tropical run. Good cultural education. Available at once, for Canada or tropics. Apply to Box No. 659-W.

ELECTRICAL ENGINEER, university graduate '28. Experience includes one year with operating department of a large public utility and two years with manufacturer of electrical equipment, work including design, test and correspondence. Available on short notice. Apply to Box No. 660-W.

ELECTRICAL ENGINEER, B.Sc., S.E.I.C. Experience: Installation staff Can. Gen. Elect.; students test course with the same company, concrete inspection, transmission line surveying and inspection, also some railway construction experience. References. Desires position with electrical concern. Location immaterial. Available at once. Apply to Box No. 665-W.

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The Pterodactyl Aeroplane

Departures from the conventional form in aircraft-design are so uncommon that considerable interest will be felt in the Westland Hill Pterodactyl Mark IV aeroplane. The machine is a tailless monoplane provided with a three-seater cabin, and the power plant consists of a De Havilland Gipsy III engine, driving a pusher airscrew. The object of the design is to obtain a higher degree of safety, comfort and performance than is possible with aircraft of the normal form, and the features relied upon to secure the first desideratum are the shape of the wings, the arrangement of the control surfaces and the clear view forward, rendered possible by the employment of a pusher airscrew.

With regard to the shape of the wings it may be pointed out that they are swept back in plan, somewhat in the form of a broad arrow, are washed out in incidence towards the tips, and are set at a small negative dihedral angle. It should be mentioned, however, that the extent to which the wings are swept back can be adjusted on the ground or in flight, for the purpose of trimming the machine for different loads and speeds. Both fore and aft and lateral control is obtained by surfaces mounted on the wings tips, and capable of being moved to large negative angles, while steering is effected by means of single-acting vertical wing-tip rudders used separately; both rudders can, however, be used simultaneously in landing, to act as an air brake. It is claimed that stalling and spinning are avoided by the high degree of lateral stability at low speeds inherent in the shape of the wings, together with effective controls in all three directions, and that the possibility of collision is rendered negligible by providing the pilot with a clear view over a wide angle. Another advantage claimed for the pusher airscrew is that the noise in the cabin is reduced. The engine, it may be mentioned, is completely cowled in, the necessary cooling air being drawn in through a duct by the airscrew working close to the outlet end.

The undercarriage is of the tandem-wheel type, the two wheels being mounted on a rocking frame to give easy running over rough ground, but a check is fitted to limit the rocking motion, and thus prevent the machine from overturning in the event of the wheels sinking into soft ground. Steering on the ground is effected by turning the front wheel after the manner of a bicycle, and a brake is fitted on the rear wheel only, also to obviate any danger of overturning. The whole undercarriage is faired with a streamline casing, and should therefore have a low air resistance. It is claimed that the arrangement is but little inferior to a retractable undercarriage from the point of view of performance, while avoiding the mechanical complications of the latter.—*Engineering.*

Wind Tunnel Design

A great deal of interest, by no means restricted to visitors to the National Physical Laboratory, centres just now round the compressed air tunnel. Whilst not yet in commission, the tunnel is complete as regards all major items and only the aerodynamic balances remain to be installed.

The tunnel shell, 50 feet long overall, is in the form of a circular cylinder 17 feet internal diameter, with hemispherical ends. Apart from cusp-shaped fairings at the ends, it constitutes the outer boundary of the annular return flow duct. The working section of the tunnel is an open jet 6 feet in diameter, and 7 feet 8 inches long, co-axial with the shell. Circulation of the air is produced by a two-bladed Duralumin fan of airscrew type mounted on a shaft which passes through labyrinth packing at one of the hemispherical ends of the shell. The screw is driven by a 400-h.p. (overload 500-h.p. for one hour) direct current motor mounted on a pedestal just outside the tunnel. The maximum power is expected to give an airspeed of 90 feet per second at full pressure. Access to the working section for the manipulation of models, is provided by a hinged circular door at the end of the shell remote from the fan.

The air-compressor equipment, which is designed to raise the pressure in the tunnel to 25 atmospheres in 80 minutes, is housed in an adjacent room. It comprises three identical three-stage units with inter-stage cooling. Each set is driven at 300 r.p.m. by a 400-h.p. autosynchronous motor operating on 3,000 volts. The electrical arrangements are such that the nine cranks of the complete plant can be synchronized 40 degrees out of phase so as to minimize, during the operation of the compressors, vibrations, which disturb delicate apparatus in other parts of the laboratory. The auxiliary electrical plant includes a motor generator to provide direct current for the tunnel fan, a storage battery to supply steady current to the solenoids of the aerodynamic balances, and a small step-down transformer for lighting and various general purposes.

A somewhat notable feature of the wind tunnel is the exclusion from the interior of all combustible material. The importance of this precaution becomes at once apparent when the concentration of oxygen, due to the compressed air in the tunnel, is realized. In this aspect of the design advantage has been taken of unfortunate experiences with the American variable density tunnel, at the Langley Memorial Aeronautical Laboratory, which in its original form was damaged by fire.

The aerodynamic design of the compressed air tunnel has been based, to a great extent, on the results obtained with a small-scale wooden model operating at atmospheric pressure. Experimental modifications of shape, intended to improve the characteristics of the working section, can, in this way, be tried out with a rapidity and economy impossible with the metal prototype. The same procedure is now being followed in the case of the first of two 8-foot open-jet atmospheric pressure tunnels which are projected to replace the present 7-foot No. 1 enclosed tunnel. Sanction has now been obtained for the first of these 8-foot jets which is at present in the drawing office stage, experiments with the small-scale model having been brought to a successful conclusion. From the indications of the latter, it appears that the maximum speed obtainable with the consumption of 300 h.p. will be about 190 feet per second. A novel feature of the design, so far as British practice goes, is a double return flow, with one duct above and one below the open jet—a type of construction admirably suited to the accommodation available in the existing 7-foot No. 1 tunnel room. For the second 8-foot open jet, which will be housed in the same building, a less powerful fan to absorb 100 h.p., and a maximum wind speed of 125 feet per second, are contemplated.—*Engineering.*

Hollow-Forged Steel Drums

Hollow forging might be taken to cover the production of small articles such as cartridge cases by deep drawing; tube drawing; tire rolling; and deep dishing, such as is employed in the manufacture of boiler ends. In this article, however, it is proposed only to deal with hollow forgings produced hot, either under hydraulic presses of the vertical type or in hollow rolling mills.

Some remarks may not be out of place concerning the origin and development of hollow forging. So far as I have been able to ascertain, the demand was felt some forty years ago for hollow shafting for naval vessels, and as it was not possible at that time to produce these by boring from the solid, attempts were made to hollow forge them, with considerable success. The diameters were very small, which added to the difficulty, and special precautions had always to be taken against overheating and jamming of the mandrels. Hollow forged gun barrels have also been in demand for many years, and the skill of the forgeman has been greatly developed by the manufacture of these.

Three branches of engineering are responsible for the present-day demand for large hollow vessels.

(1) *Boiler Making.*—The introduction of the Diesel engine caused turbine manufacturers to make an effort to produce a turbine power unit of an increased overall efficiency, such as would compare favourably with the Diesel engine. Speeds were already developed to a very high degree, and, as a result, the only direction in which improvement could be hoped for was an increase in pressure. The boiler maker was accordingly called upon to supply high-pressure boilers operating at pressures which, twenty years ago, were undreamed of. These pressures have now risen to, at any rate, 1,700 pounds per square inch, that is, excluding Benson boilers, and it was quite obvious that riveted construction could never prove satisfactory for such pressures. Accordingly, the demand arose, first, for seamless drums, open-ended, and arranged for riveting—in single piece dished ends—these being used for moderate pressures up to about 400 pounds per square inch—and later for single-piece seamless forged high-pressure drums.

(2) *Oil Cracking.*—The phenomenal increase in motor transport has multiplied the demand for volatile petroleum spirits to an extraordinary degree. Researches have resulted in the introduction of two methods of oil cracking, the first being known as the Dubb's process, which employs a low or moderate pressure, the second being the Cross process, which employs high pressures up to about 1,000 pounds per square inch and high temperatures up to about 900 degrees F. Information on this subject is very sparse, but it may be stated that forgings of very large size are required for the Cross process.

(3) *The Chemical Industry.*—The preparation of synthetic ammonia and dyestuffs and other chemical processes call for the manipulation of gases and liquids at high pressures and high temperatures, and this industry has made very special demands on the metallurgist and the forgeman in the production of hollow forgings in difficult alloys and often of very intricate shape.

Researches are also being conducted in various quarters on the synthesis of oils from coal. It seems probable that this process will follow the lines of the oil-cracking process, the method being to admit coal dust, or a mixture of crude oil and coal, into a chamber containing hydrogen at a very high temperature and pressure. As forgemen we must look forward to a rapid development in this class of work, as it seems that, once established, a great and increasing demand would exist for high-pressure vessels for the process—Mr. E. V. T. Ellis in *Engineering.*

Busfield, McLeod, Limited, Montreal and Toronto, are exhibiting Diesel engines, both marine and stationary types, Lux system of fire extinguishing, Permutit water treating plant, diving equipment and excavating equipment at the Canadian National Exhibition this year. Engineers should make a point of visiting the Engineering and Electrical building at the Exhibition, where they will have the opportunity of seeing the very latest developments in the way of engineering equipment.

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By order,

J. W. PUGSLEY,
Secretary.

Department of Railways and Canals,
Ottawa, August 27, 1931.

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New Fire Alarm Headquarters of the City of Montreal

C. J. Desbaillets, M.E.I.C.,

Chief Engineer, Montreal Water Board, Montreal, Que.

Presented before the Montreal Branch of The Engineering Institute of Canada, April 23rd, 1931.

SUMMARY.—The fire alarm system of the city of Montreal has developed with the growth of the city, and its present form, equipment and operation are discussed in this paper. The system now installed is of the most modern type, in which the alarm from one box is effective even though an alarm from another box is being sounded simultaneously, and includes complete arrangements for recording and repeating to the fire engine houses all signals received from the street boxes, for locating trouble, and for duplicate service in emergency.

This paper describes the new fire alarm headquarters which the city of Montreal is now building on Fletchers' Field.

The present fire alarm headquarters are located on Ontario street in the upper storey of the fire alarm station. It contains apparatus of an older design and can only accommodate a maximum of sixty circuits.

This was quite sufficient for Montreal when the city had a population of from three to four hundred thousand people, but due to the rapid growth of the city and in order to make provision for future extension and requirements, the present station was found to be absolutely inadequate. Therefore, in November, 1929, it was decided to build a new fire alarm headquarters along modern lines, both building and equipment to be of the latest design.

It will be realized that with such an important service as the fire protection of city property it is necessary that the new construction as well as the change over in operation will have to be carried out without an interruption in service.

Extensive studies have been made in order to use as much of the existing conduit and cable system as possible. With this in view, the most economical location for the new central station was found to be on Bleury-Park avenue between Craig street and Mount-Royal avenue, as all the present cables enter or cross this north-south line at some point between Craig and Mount-Royal. Some of the cables now feeding the northern half of the city will only need to come to Fletchers' Field and the existing runs of cables from Fletchers' Field to the present old central station will be used to extend some of the existing cables now feeding the southern half of the city. This re-grouping and re-connection work naturally involved the re-designing of certain parts of the underground conduit system as well as additions to the same system, but this distribution circuit will not be gone in detail into as the object of this paper is mainly to describe what a fire alarm system consists of and how the alarms are conveyed from the box to the operators and in turn transmitted to the various fire stations, some forty-six in number.

As these circuits have to be maintained in good condition throughout the year under any climatic conditions, and as trouble in any point of the distribution system has to be determined and remedied in the shortest possible time, it will be seen from the following description of the equipment that a good deal of thought has been given to methods of quickly detecting trouble, and that these have influenced and actually become part of the equipment.

The paper is in two parts:—

(*a*) A description of the fire alarm equipment.

(*b*) A brief description of the building in which it is installed.

Description of Fire Alarm Equipment

General

A fire alarm system consists of a number of street boxes arranged in a series closed circuit, fed by a source of direct current, into which are connected bells and lamps, located at the central station, these for the purpose of receiving, audibly and visually, signals transmitted from the boxes. In a completely manual system, equipment is provided at the central station for repeating manually on the circuits through the fire engine houses, all fire alarm signals received from the street boxes. Equipment for the recording and dating of signals, received or transmitted, and for the protection of the apparatus, is also provided.

Storage Battery Switchboard

On entering the operating room on the ground floor of the new fire alarm headquarters, a row of switchboards is seen facing the walls. These are for controlling the charge and discharge of the storage batteries necessary for the operation of the system. There are twenty-four of these boards, each with a capacity of ten duplicate sets of batteries, and each provides means for the charging of one set of batteries in series, or in series-multiple combinations,

In a demonstration of the equipment used for the reception and transmission of alarms, the author was assisted by Mr. Charest, Superintendent of the Department of Signals and Alarms, and Mr. Chaussee, Assistant Engineer in the same department.

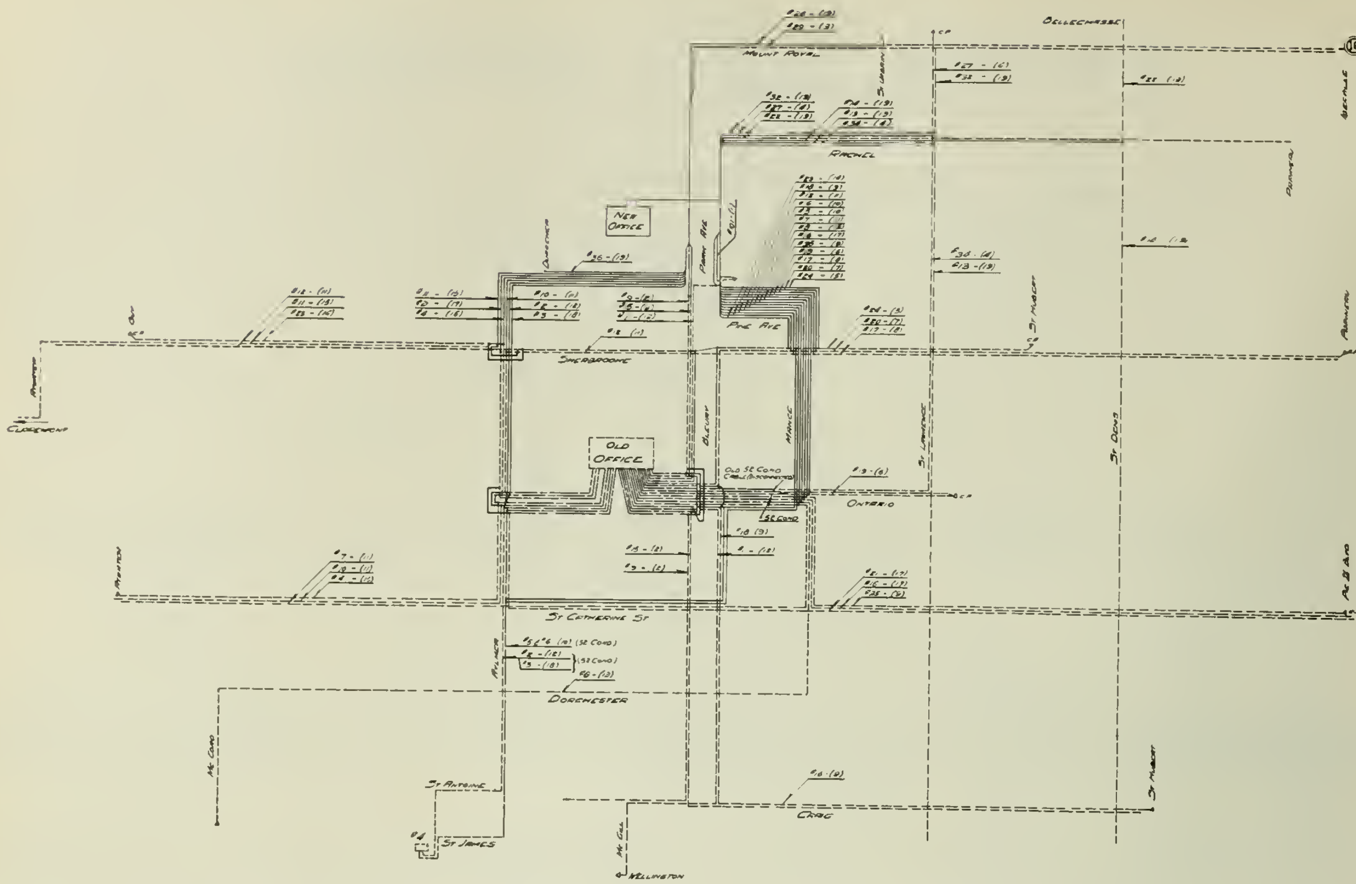

Fig. 1—Cable Layout—Connections from Old Stations to New Central Station.

while the other set is discharging on the line. Each circuit is provided with its own separate battery called "A," and with a duplicate set called "B," so as to provide for maximum safety in operation. Should a circuit develop trouble due to grounds, or short-circuited cells, only this circuit is affected, thus causing not more than twenty boxes to be temporarily out of commission. In the case of short-circuited or broken cells in a battery, the switching over of the circuit on to the duplicate set would allow for the immediate resumption of the service while the first set was being put back into shape. On each of these switchboards meters are provided to take readings on each battery, its condition of charge and discharge. Facilities are also provided to adjust at their normal values the electrical characteristics of either the charge or the discharge of each battery. The total capacity of these boards, that is two hundred and forty circuits, provides for one hundred and thirty box circuits, twenty primary alarm circuits, twenty secondary alarm circuits, forty locals and thirty spare circuits. Behind these boards and inside the metal cabinets enclosing them are seven small panels at which all the leads from the storage battery switchboards and from the storage battery racks terminate to provide for cross-connections. This is advantageous in that when new batteries for a circuit are to be set up or when replacing old ones, the transfer of the circuit connections is done at these panels instead of on the main boards.

Main Line Relay Boards

At the back of these boards, six feet away from them and facing the centre of the room on the south side, are the main line relay boards, each of five circuits capacity, and are for the box circuits, the primary alarm circuits, and the secondary alarm circuits. Each of these circuits consists principally of a main line relay, a tap bell, and a lamp mounted behind a bull's-eye, wired into a closed circuit with the street boxes. When a fire alarm box is pulled for "fire," the circuit is opened a number of times, this corresponding to the number of the box. Every time the circuit is opened, the armature of the main line relay is released thus closing a pair of contacts which control the lamp and cause it to flash, and also a second pair of contacts which control the registers. At the same time, the armature of the tap bell is released thus causing the hammer to strike a gong. For each opening of the circuit there is a flash on the lamp and a blow on the gong, thus providing visual and audible means of receiving signals. Both means are provided in case two or more alarms on different circuits are received at the central office at the same time. When such occasions arise the bells are usually cut out of circuit by means of a suitable switch to prevent confusion in counting the blows, and the flashes on the lamp are counted by the attendants. A check on the signals received is made on the registers which will be described in one of the following paragraphs. In addition to the apparatus described, each circuit is provided with a high-low current relay and a pilot lamp. This relay is so adjusted that when the normal line current of 100 milliamperes falls below 80 or rises above 120 milliamperes, the relay causes the closure of a pair of contacts which close a local circuit through the pilot lamp and through a trouble bell common to all circuits, as an indication of trouble. A suitable cut-off key allows for the cutting off of the trouble bell, but the pilot lamp remains lighted until the trouble is cleared. Other keys furnish means for cutting out of circuit any auxiliary apparatus, such as the common register, the main register, etc. These keys are suitably marked to designate their functions. A jack is provided for each circuit to enable the operators to plug into the circuit either a register, a meter or a telephone set when tests are being carried out on the line. The primary alarm boards

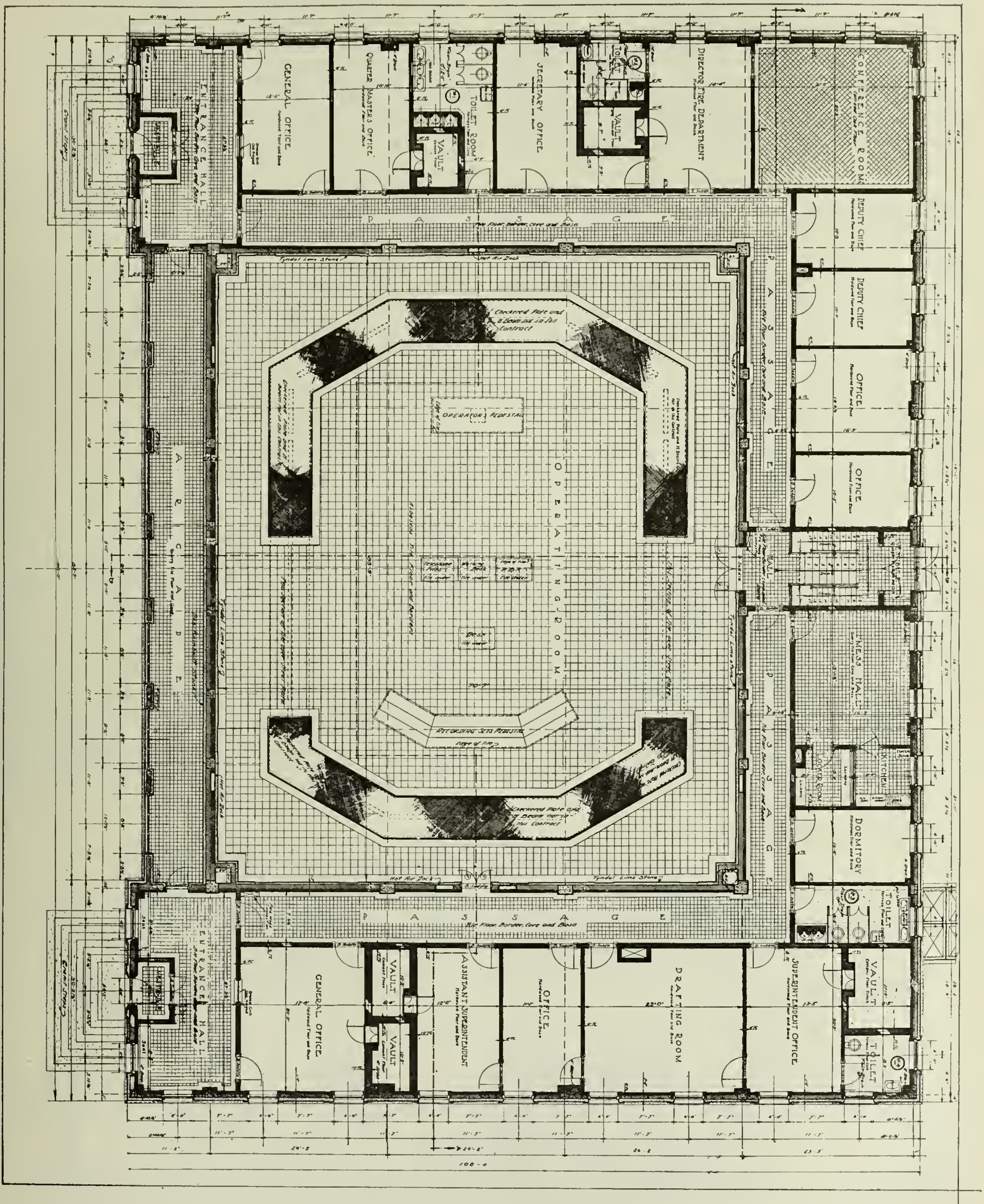

Fig. 2—Ground Floor Plan.

provide facilities for circuits through the fire engine houses for the transmission of signals at one-half second interval between blows, and the secondary alarm boards provide facilities for circuit through the fire engine houses for the transmission of signals also at three-quarter second interval between blows. These boards differ from the box boards only in the colour of the bull's-eye, which is red for the box line circuits, green for the primary alarm circuits, and amber for the secondary alarm circuits. On each is painted the number of the circuit. Power for the lamp in the bull's-eye is provided from the lighting service through a transformer.

Protector Board

The protector board is located at the north end of the operating room and facing the relay boards. On it is mounted for each side of each line circuit the necessary apparatus for the protection of the central station equipment, that is, a first fuse of a capacity of ½ ampere for protection against sneak currents, a second fuse of a capacity of 3 amperes at 2,000 volts for protection against heavy currents due to crosses between the fire alarm wires and high tension wires, and a lightning arrester for protection against lightning.

The central panel of this board is equipped with a voltmeter and with the necessary switches to provide means for taking voltmeter readings between the two sides of a circuit, or between either side of a circuit and ground.

In front of these various switchboards are two pedestals, one for the registers and the other called the operator's pedestal.

Recording Set Pedestal

The recording set pedestal has mounted thereon thirty-five registers, each of five circuits capacity, and thirty-five paper take-up reels. Every time a fire signal is transmitted from a street box, the main line relay is actuated as described above, thus closing the second pair of contacts on its armature a number of times corresponding to the box number. Every time these contacts come together, a local circuit through a register is closed, thus causing a puncturing blade in the register to puncture a triangular hole in a moving strip of paper. Thus, if box number 3912 be pulled for fire, the blade would puncture in the paper three holes, about one-half inch apart followed by a blank strip of paper, then nine holes about one-half inch apart followed by a blank strip, a single hole followed by a blank strip of paper and then two holes about one-half inch apart followed by a blank strip of paper longer than the first three, and then the same series of holes and blanks three times over. In other words, each box repeats its number four times and a corresponding number of series of holes with blank intervals is punctured in the paper. The holes are punctured in such a way as to prevent reverse readings. One blade is provided for each individual line circuit and the register is so designed that the blades operate independently. It would be possible to receive fire signals from five different circuits at the same time on the same register and the series of holes would appear in five neat rows, one above the other, on the same strip of paper. The paper take-up reel is set in motion as soon as the register starts operating and merely winds the paper tape on a drum.

Operator's Pedestal

The operator's pedestal is one of the main features of the central station equipment, as it provides means for manually transmitting through the engine houses all fire signals received from street boxes. On this pedestal are mounted two common recording sets, each consisting of a register, a take-up reel, and a time and date stamp. All signals received at the central office are recorded on one of the individual registers as described in the preceding paragraph, and also in the same manner on one of the common registers. At the end of a series of signals, the magnets of the time and date stamp are energized, thus causing to be printed on the paper tape the hour and the minute, and the day, the month and the year, that the signal was received. This device takes care of long and short months, also of leap years. The time magnets are controlled by a master clock mounted in the superintendent's office, which closes a local circuit once every minute, thus advancing the minute wheel one notch. This wheel controls the hour wheel, which in turn controls the day wheel, this one in turn the month, and the month wheel controls the year wheel. This arrangement enables the operator to check on the tape any fire signal received. On each side is a transmitter so arranged that the operator by means of dials can set up the number of the street box transmitting a fire signal. When the number is set up, the mechanism is set in motion by means of a lever and this causes the coded signal to be transmitted to the fire engine houses. Each signal is repeated two, three or four times as desired by the

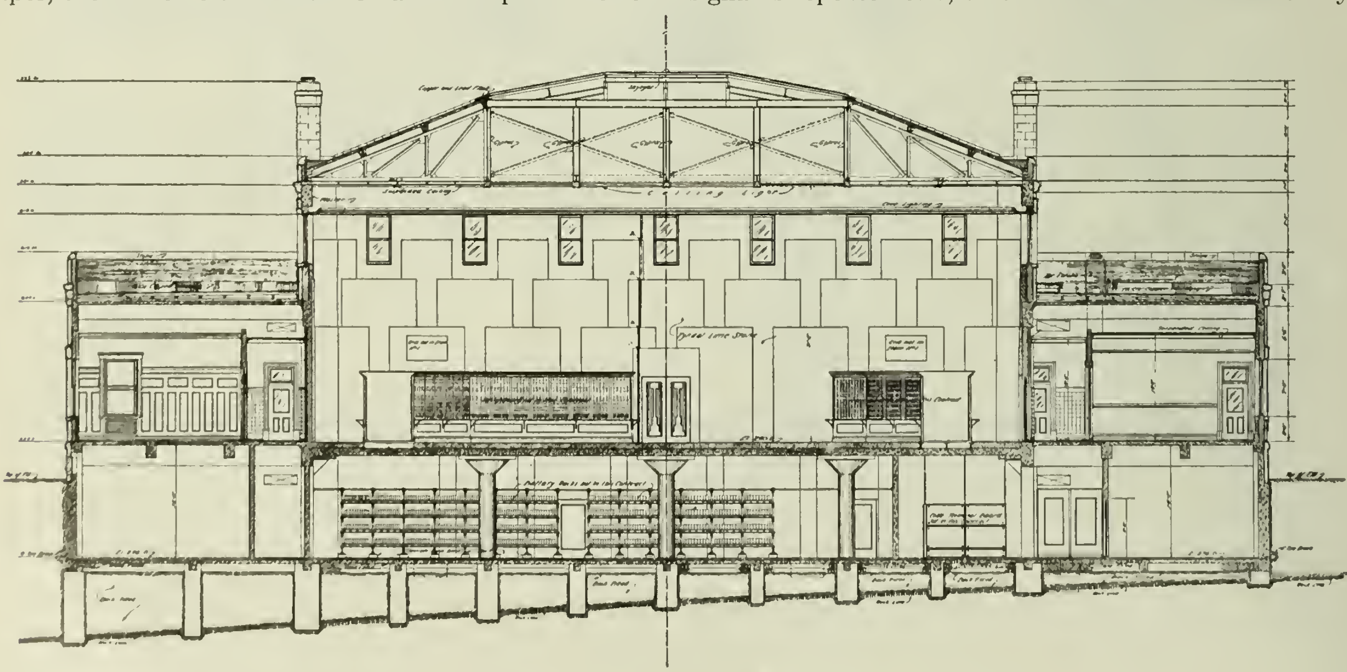

Fig. 3—Longitudinal Section.

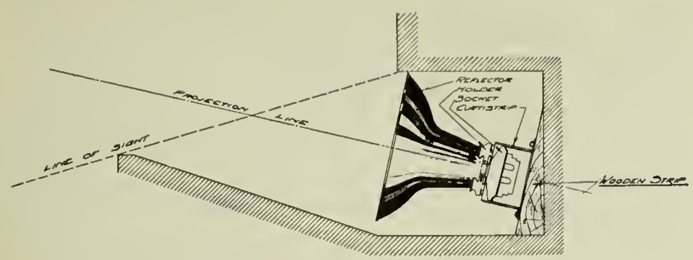

Fig. 4—Cove Light.

operator, and is received at the fire engine houses on a small bell and on a register. As soon as this first transmitter comes to rest the second one, on which the same coded signal has been set, is started by means of a lever, and the signal is caused to be repeated on a big gong in the fire engine houses, on a gong in the police stations and other public places such as newspaper offices. On this pedestal are also mounted two multiple telegraph keys to stop the transmission of signals by the transmitters in case of error in setting up the coded signal, and a set of cut-off switches to cut out of the transmitter circuit any alarm circuit which is out of commission, or which should not receive certain signals.

Batteries and Racks

The above completes the description of the equipment in the operating room. The equipment in the basement will now be described. First of all the battery room houses all the storage batteries required to provide the necessary direct current power for the operation of the fire alarm system. These are arranged in duplicate sets on metal racks especially designed for the purpose, with four tiers of double shelves on each rack. The "A" batteries are installed on one side of the racks and their mates or duplicate "B" sets are installed on the other side. The batteries have a capacity of 12 ampere-hours. Should trouble develop in the operation of the low current equipment associated with the batteries, a daily check of them would bring it to light before any serious damage was done. Yet each battery has enough capacity to supply safely the necessary power to its circuit for a period of ninety-six hours should trouble develop in its duplicate set of a nature such as to require the setting up of new cells.

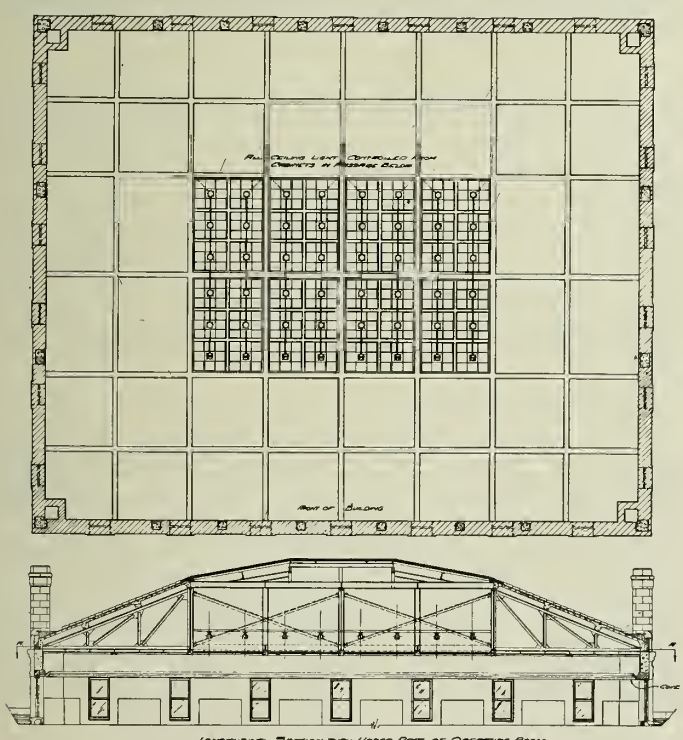

Fig. 5—Cove and Skylight Lighting System Operating Room.

Charging Equipment

In the power room is located the charging equipment for these batteries. It consists of a motor-generator set made up of an alternating current motor coupled to a shunt wound direct current generator, of a suitable size. A duplicate machine has been provided to prevent interruption of service in case of break down of the first machine. A motor control panel shall be installed on which shall be mounted the necessary control switches for the motors and the generators, fuses, generator field rheostats, and also a voltmeter and an ammeter to provide facilities for taking meter readings.

Historical Side of the Fire Alarm Department*

There is no department of municipal service which has been the subject of more thoughtful and patient experiment than that of fire alarm and this is reflected in the high state of perfection to which it has been brought in recent years.

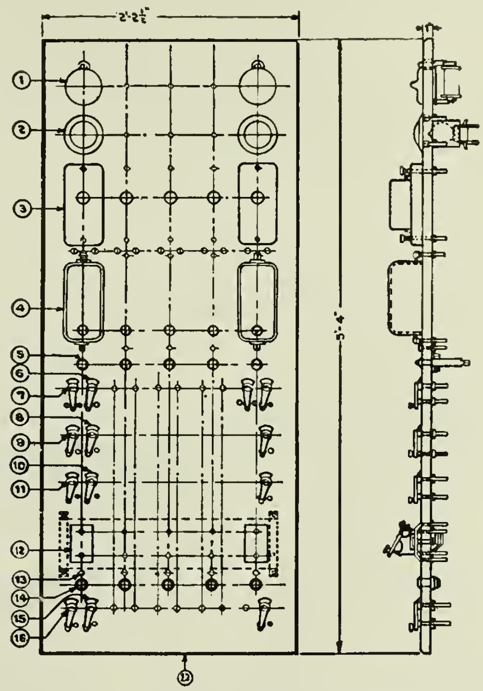

Fig. 6—Layout of Relay Board, Main Line, Primary Alarm and Secondary Alarm.

Description of Material

1, Tap Bell; 2, Red Bull's Eye Annunciator; 3, Supervisory Relay; 4, Main Line Relay; 5, Supervisory Pilot Lamp; 6, Common Register Switch; 7, Line Register Switch; 8, Annunciator Switch; 9, Main Line Relay Switch; 10, Telegraph Key Switch; 11, Tap Bell Switch; 12, Telegraph Key; 13, Number Plate; 14, Instrument Jack; 15, Trouble Bell Switch; 16, Supervisory Relay Switch; 17, White Marble Panel, 2′-2½′ × 5′-4′ × 1′.

Fifty or sixty years ago, no adequate means of locating a fire existed. On the breaking out of a fire, it took hours to bring the firemen, who were usually volunteers, to the scene of their labours. Buglers were despatched through the town to arouse the citizens and naturally it took time to collect the entire brigade. Another tremendous handicap to the effectiveness of the fire corps lay in the fact that no means existed of guiding the men to the proper locality, unless an unusually large blaze could be distinguished. The companies were thus frequently misled and precious time wasted.

*By Mr. Ls. A. Charest.

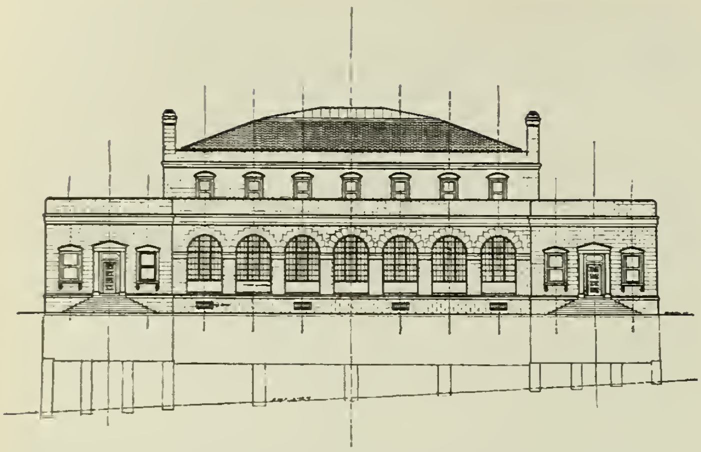

Fig. 7—Front Elevation, New Fire Alarm Central Station.

The origin of the fire alarm telegraph is due to the late Dr. W. F. Channing of Boston, who died in 1901 at the age of eighty-one, having lived to see the idea which he had given to the world brought into successful operation, he having conceived the idea of the fire alarm in 1845.

The trend of modern inventions is towards simplicity and accuracy in apparatus as opposed to the complicated fittings of former years.

No city can afford to neglect an opportunity of improving its fire alarm service, as this investment is one which never fails to pay.

The original installation of the Montreal fire alarm service was inaugurated in the year 1863 with Mr. F. Badger as its first superintendent, he having come from the city of Boston where a system was then in operation.

In March, 1909, the present system was put in operation and at that time it was planned that the system would be sufficient for the next forty years, but increased population together with annexation of bordering municipalities made conditions such that for the past few years the Department could not extend sufficiently to meet even present requirements let alone to take care of the future.

In the year 1905 the city was divided into numerical districts in order to overcome the conditions of box location, for at that time, for example, box 95 was located in the extreme eastern part of the city while 96 was located in the extreme western part. However, under the new district system, boxes 95 and 96 are located in district 9 and this relation is maintained throughout.

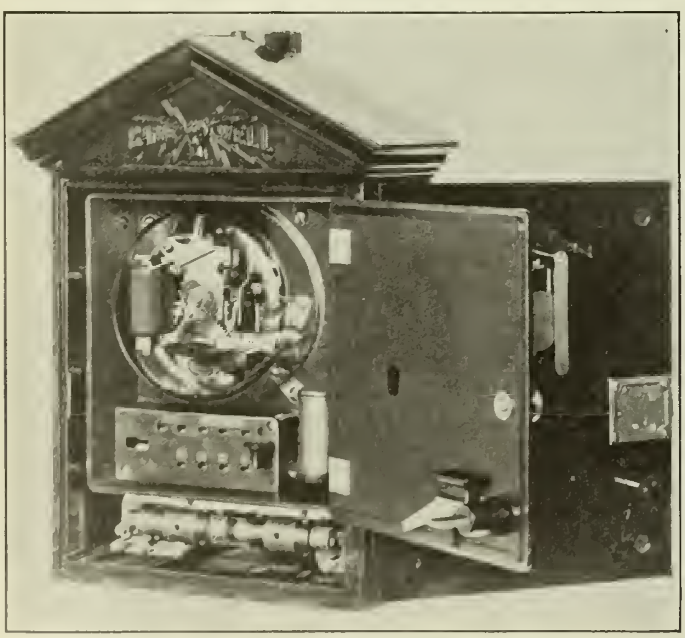

Fig. 8—Positive Non-Interfering Successive Alarm.

At present the city has three types of fire alarm boxes, the old sector type, the non-interfering type and the positive non-interfering successive type; the sector and non-interfering boxes have for various reasons been condemned, as not being capable of giving adequate security to the citizens of the city.

A Comparison of the Three Types of Boxes

"Sector."

This type of box was constructed in such a simple way that when two or more of them were pulled at the same time, on the same circuit, it caused such a confusion of signals that only a conglomeration of blows were received at the central office, resulting in no definite number being given, consequently, no direct location of the fire could be transmitted to the fire department.

"Non-Interfering."

Many years elapsed before the next modern improvement took place, in what became known as the "Non-Interfering-Type." This improvement made possible the receiving of a first alarm as well as succeeding ones, providing there was no open circuit and the outside door of the box was closed before attempting to give the alarm, as these two points were absolutely essential to the successful operation of the alarm. If the outside door of one of these boxes was open or ajar when a person attempted to give the alarm, especially if another box on the same circuit had been pulled a few seconds previously, no alarm could be given due to the non-interfering feature of this particular box having been interrupted when the operation of the first box took place with the outside door contact removed from its normal position. However, this type of box was later improved as it did not give the citizens the entire security and reliability necessary for the protection of life and property.

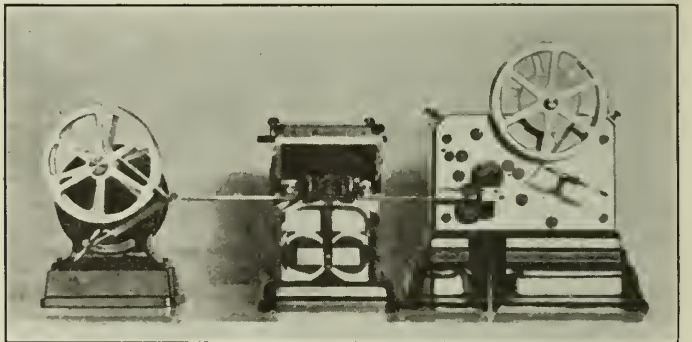

Fig. 9—Date Stamp—Operator's Pedestal.

"Positive Non-Interfering."

The latest and most modern improved fire alarm box is the "Positive Non-Interfering Successive" type. This is so constructed as to be not only non-interfering in its make-up, but it can also be used by citizens in giving additional alarms from other boxes on the same circuit even though a previous box has the right of way in sending in its alarm and this without any further manipulation of either box on their part. Each succeeding box pulled, after a first is set in motion will follow automatically due to the successive feature of its equipment.

The three different types of boxes may be briefly explained as follows:

Sector Box: An alarm from this type of box *may* be received from it providing no other box is set in motion on the same circuit.

Non-Interfering Box: An alarm *will* be received from it even though another box is pulled on the same circuit.

Positive Non-Interfering Successive: An alarm from this box *will not only be received but also any others pulled on the same circuit even though a previous box is then sounding its alarm; that is to say, each one will come in automatically when the previous right-of-way box has concluded its own signal.*

There is an additional feature to this latter type in that should an accident to the box take place, it would not prevent signals from other boxes on the same circuit being received.

Demonstration

The following is an illustration of what happens between the time the lever of fire alarm box number 3912 is pulled and the time at which the fire engines reach the street corner where the box is located.

As soon as the starting lever of the fire alarm box is pulled the mechanism is released, thus allowing a wheel in the box about one inch in diameter to rotate around its axis. On the rim of this wheel are a number of protruding teeth, first of all three close together, then a space, then nine more teeth, another space, then one tooth, another space, then two more teeth, and finally a long space. This gives the number of the box thus, 3-9-1-2. There is a definite relation between the space from the top of one tooth to that of the adjoining one, the space between digits, and the long space at the end. No matter what the number of the box may be, the governor of the mechanism is so set that the time taken to travel between the top of two consecutive teeth is always the same, viz., three-quarters of a second. Just over these teeth a pair of springs are located so that the teeth of the wheel will travel under them and will cause one of the springs to fall in the hollow of a tooth, thus opening the circuit. As soon as this happens, the relay in the circuit of this box on the main line relay boards in the central station will be de-energized, thus causing its armature to fall away and close a number of local circuits, and immediately the lamp of the bull's-eye in the central station is lighted and a blow is struck on the bell of the circuit. These operations are repeated for each and every tooth on the wheel. The number 3912 is flashed on the lamp and at the same time struck on the bell, registered on the paper tape of its register on the recording set pedestal, and also on one of the common registers of the operator's pedestal. This operation is repeated four times. When the first blow is struck on the bell, the operator in charge rushes to the operator's pedestal while counting the blows on the bell or the flashes of the lamp. When the round is completed he checks the number on the tape of the common register and sets the same number of the transmitter to the left of the pedestal and then calls it out to his assistant who is now standing at the recording set pedestal. This man checks the number given to him with the number punctured in the tape of the individual register and if found correct, shouts "O.K." The first operator after counting the blows or the flashes of the second round to be sure that the correct number has been received, presses down the starting lever of the transmitter. This releases the mechanism and causes the number 3912 to be transmitted over the primary alarm circuit boards to the fire engine houses, where it is struck on a small bell usually located in the office of the floor man. While this is going on the operator in the central station sets the same number on the second transmitter and as soon as the two rounds of the first transmitter are completed, starts the second one. This causes the alarm to be transmitted over the secondary alarm circuit boards through the fire engine houses, the police stations, etc., where it is struck on a large gong. All these alarms transmitted from the central station are recorded on the tape of the alarm registers and on one of the common registers.

The floor man of an engine house in the district in which the fire alarm box is located immediately causes the local gongs in the engine house to strike and, while the men are getting the apparatus ready, checks the number as counted off the bell with the number punctured in the tape. As soon as the second round is received and he is then positive of the number of the box, he calls the number out to the officer in charge as well as its location. The engines then pull out of the station and proceed to the box.

Elimination of Taste in Water Passing Through Creosoted Wood Stave Pipe

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SUMMARY.—This paper presents the results of an investigation as to the probable results in passing potable water through a very long pipe line of creosoted wood stave construction, having regard to the possibility of objectionable taste arising from the creosote.

Creosoted wood stave pipe provides a very economical means for supplying drinking water to towns and cities. Many such pipe lines have been constructed, and from such reports as have been obtained, the following conclusions are drawn:

(1) The pipes should be flushed out for a considerable time before use—from one and a half to two months.

(2) If no chlorine is used, no complaints as to bad tastes are received.

(3) If the water is chlorinated, in many cases bad tastes are produced, these tastes gradually becoming less pronounced until finally—after in some cases nearly a year—there is no noticeably bad taste.

The Forest Products Laboratories, Forest Service, Department of the Interior, were requested to investigate the possibility of using creosoted wood stave pipe for conveying water up to a distance of about 100 miles. For this length of pipe line it is calculated that the approximate time the water would take to travel the length of the pipe would be slightly more than one week. No information is available for pipe lines of such great length which offer such exceptional opportunities for contamination with creosote. In such long pipe lines it is quite possible that conditions would be so severe that bad tastes would continue for considerably longer periods than has been the case in shorter lines which have been built.

Bad tastes, in water that has been chlorinated, have been experienced by many water-distributing concerns, and considerable experimental work has been carried out to determine the cause. It is believed that the presence of one or more of many substances may cause the bad, so-called "iodoform," taste of water. It has been clearly shown by several workers—see Howard and Thompson*—that phenol and phenolic bodies cause very bad tastes. Now the identity of all the substances present in a sample of normal Grade I creosote has never been established, but it is known that a considerable portion of the creosote consists of what are known as "tar acids," which are of a phenol-like nature. It is very probable that the tar acids are the main cause of the bad taste in creosoted wood pipe lines. However, it is likely that the other constituents of creosote also contribute in a smaller degree. Hence it seemed advisable to make experiments with a special creosote which contained only a small quantity of tar acids, as well as with ordinary creosote conforming to the specifications of the American Railway Engineering Association for Grade I creosote oil.

It has also been shown by Howard and Thompson that the bad, chlorophenol taste in chlorinated water can be removed by a superchlorination treatment. In this treatment the water, after filtration, is given an excessively large dose of chlorine—at least 1 to 2 p.p.m.—the taste-producing substances being destroyed by the chemical action of the chlorine. After the chlorine has been in contact with the water for the necessary period, determined by laboratory experiments, the excess chlorine which would give a disagreeable taste to the water, is removed by the addition of sulphur dioxide.

Tests were carried out on water containing small quantities of creosote in solution, and also on water which had been stored in creosoted wooden pails.

Experimental Work

The analyses of the two grades of creosote used are given in Table I. The Grade I creosote is such as is ordinarily used in treating plants in Canada, and the special creosote was the same as the Grade I creosote with the low-boiling fractions removed. The removal of the low-boiling fractions reduces considerably the percentage of tar acids present.

In the experiments carried out with water containing small quantities of creosote in solution, it was found that:

(1) Water containing 3 parts per million of Grade I creosote oil and 5 p.p.m. of the special creosote could be rendered palatable by a process of superchlorination followed by dechlorination with sulphur dioxide.

(2) Confirming the findings of previous workers, the higher the concentrations of chlorine used for superchlorination, the shorter the contact period required. From the tests, the best contact period appeared to be 24 hours when using 2 to 3 p.p.m. of chlorine on water containing 0.50 p.p.m. creosote.

(3) The length of the contact period of the sulphur dioxide was of no importance.

*Jour. New Eng. Water Works Assoc., Vol. 40, 276-296, 1926.

Table I

Analysis of Grade I creosote

Using the specifications for creosote analysis issued by the American Wood Preservers' Association, the following results were obtained:

Sp. Gr. at 38° C., compared to water at 15° C. = 1.100
Water .... = 0.4%
Insoluble in Benzol .... = 0.5 %
Coke Test .... = 3.5%

Fractional Distillation

Fraction	0° C.–210° C.= 1.0%	Fraction	0° C.–210° C.= 1.0%
"	210° C.–235° C.= 5.2%	"	0° C.–235° C.= 6.2%
"	235° C.–270° C.=15.5%	"	0° C.–270° C.=21.7%
"	270° C.–315° C.=14.2%	"	0° C.–315° C.=35.9%
"	315° C.–355° C.=16.5%	"	0° C.–355° C.=52.4%

Residue above 355° C. = 47.6%.
Sp. Gr. of fraction 235° C. – 315° C. = 1.034.
" " " 315° C. – 355° C. = 1.097.
Float test on residue = 40 sec. at 70° C.

Analysis of special, high-boiling creosote

Using the specifications for creosote analysis issued by the American Wood Preservers' Association the following results were obtained:

Sp. Gr. at 38° C., compared to water at 15° C. = 1.137
Water .... = 0.2%
Insoluble in Benzol .... = 0.08%
Coke Test .... = 3.27%

Fractional Distillation

Fraction	0° C.–210° C.= 0.0%	Fraction	0° C.–210° C.= 0.0%
"	210° C.–235° C.= 0.0%	"	0° C.–235° C.= 0.0%
"	235° C.–270° C.= 0.0%	"	0° C.–270° C.= 0.0%
"	270° C.–315° C.= 7.6%	"	0° C.–315° C.= 7.6%
"	315° C.–355° C.=23.1%	"	0° C.–355° C.=30.7%

Residue above 355° C. = 69.3%.
Sp. Gr. of fraction 235° C. – 315° C. = 1.045.
" " " 315° C. – 355° C. = 1.079.
Float test on residue = 84 sec. at 70° C.

Experiments Using Creosoted Wooden Pails

All previous work was carried out on solutions of water containing definite quantities of creosote. However the concentrations used might be very different from those encountered under actual conditions. Therefore a number

Table II

Details of Treatment of Wooden Pails with Creosote

Initial air pressure: 45 lbs. per sq. in. for 20 min.
Cylinder pressure: 180 lbs. per sq. in. for 1 hr.
Final vacuum: 20 in. of mercury for 20 min.
Temperature of creosote: 130° to 180° Fahrenheit.

Creosote Used—Grade I				Creosote Used—Special			
No. of pail	Weight before treatment in lbs.	Weight after treatment in lbs.	Creosote absorbed in lbs.	No. of pail	Weight before treatment in lbs.	Weight after treatment in lbs.	Creosote absorbed in lbs.
21	2.8	3.8	1.0	1	2.8	4.9	1.5
22	2.9	3.8	0.9	2	2.9	4.2	1.3
23	2.8	3.7	0.9	3	3.0	4.1	1.1
24	3.0	4.0	1.0	4	2.9	3.8	0.9
25	2.9	3.8	0.9	6	2.8	4.1	1.3
26	2.9	3.8	0.9	7	2.9	4.2	1.3
27	3.0	3.9	0.9	8	3.0	3.9	0.9
28	2.9	4.0	1.0	9	2.75	3.75	1.0
29	2.9	3.7	0.8	11	2.8	3.9	1.1
30	3.0	3.8	0.8	12	2.75	3.95	1.2
34	3.0	3.9	0.9				
35	2.8	3.9	1.1				

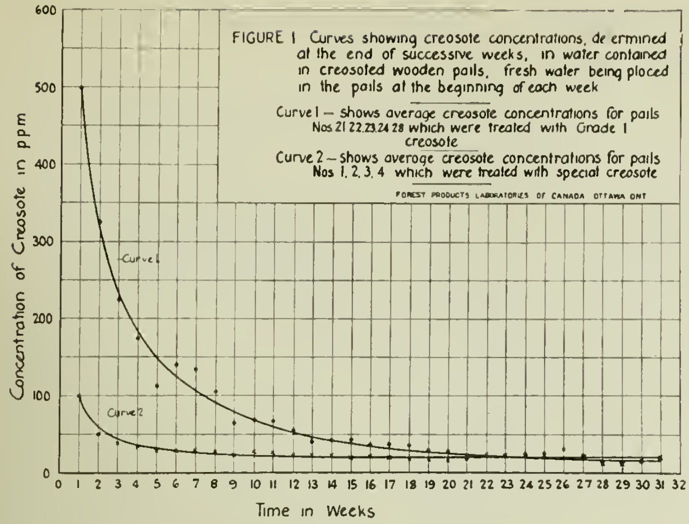


Fig. 1.

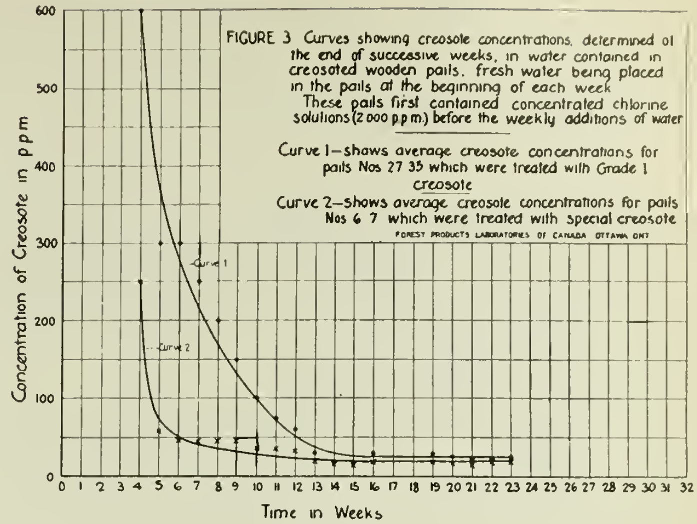


Fig. 3.

of wooden pails were creosoted, some with the Grade I creosote, and some with the special creosote. The pails were impregnated under pressure, using the Rueping process. Details of the creosote treatments are given in Table II.

The procedure adopted was to allow the pails to stand filled with water for one week, and then determine the percentage of creosote in the water in parts per million. The pails were then filled with fresh water and allowed to stand for another week. Fig. 1 shows the percentage of creosote found in pails containing Ottawa tap water up to and including thirty-one weeks. Fig. 2 shows the same information for water which was chlorinated with 6 p.p.m. of chlorine before being placed in the pails. These tests were carried out for twenty-three weeks. Fig. 3 gives the results of tests on pails which had been filled with concentrated chlorine solutions (2,000 p.p.m.) before the weekly additions of the water. It will be noted that in all cases, the special creosote caused less contamination than ordinary creosote.

Chlorinating the water with 6 p.p.m. of chlorine before it was placed in the pails greatly increases the contamina-

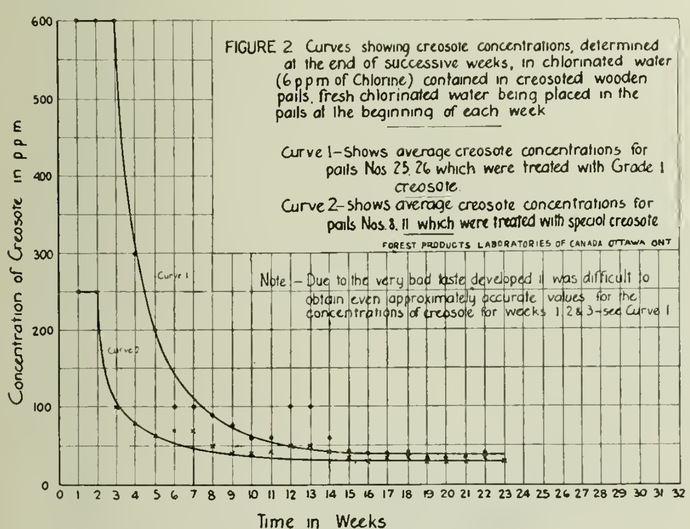


Fig. 2.

tion for the first twelve weeks, as shown in Fig. 2, and from that point on, the contamination is slightly greater than when untreated water is used. There would be no advantage in flushing pipes with highly concentrated chlorine solutions, judging from the results given in Fig. 3.

It should be emphasized that the concentrations of creosote shown in Figs. 1, 2 and 3 are only approximate. The method used to determine the percentage of creosote in the water was as follows:

It had been found that for Grade I creosote, the highest concentration that was rendered drinkable by superchlorination was 3 p.p.m., and for the special creosote, 5 p.p.m. In order to determine the concentration of creosote in any particular sample of pail water, a mixture was made up of Ottawa tap water and 1, 5, 10, etc. percent of the pail water. By assuming that the highest percentage of the mixture that can be rendered drinkable by superchlorination and dechlorination contains 3 p.p.m. of Grade I creosote or 5 p.p.m. of special creosote, the concentration of creosote in the pail water can be calculated. This assumption is not strictly tenable, as the creosote dissolved in the pail water is not necessarily of the same composition as the original creosote used for the pail, and creosotes of different compositions probably produce different tastes in water containing the same concentration.

As shown by Figs. 1, 2 and 3, the concentrations of creosote in water stored in the pails were far greater than could be removed by superchlorination and dechlorination. Experiments were therefore carried out on filtering water from the pails through activated carbon. The water obtained from the pails during even the first week of the tests could be rendered palatable in spite of the high concentration of creosote, by filtering through activated carbon. The same carbon was used each week with satisfactory results as long as the tests continued, and at the end showed no signs of deterioration. The water could be chlorinated with 0.25 p.p.m. of chlorine after filtering, without producing an objectionable taste. A total of 600 litres of contaminated water was passed through 250 grammes of activated carbon without destroying the effectiveness of the filter, but this, of course, does not give an indication of the cost of using activated carbon on a commercial scale.

Conclusions

It is considered that filtration tests should be continued to determine the cost of using activated carbon, since there does not appear to be any prospect of obtaining satisfactory taste removal by superchlorination followed by dechlorination.

The Canadian Torpedo-Boat Destroyers *Saguenay* and *Skeena*

We are indebted to "Engineering" for material for the following article and for permission to reproduce Figs. 2 to 8. Additional information and the photograph in Fig. 1 were kindly supplied by the Department of National Defence, Ottawa.

The list of vessels of the Royal Canadian Navy has recently been increased by the arrival in Canada of two new destroyers, H.M.C.SS. *Saguenay* and *Skeena*. These ships were ordered by the Canadian government, in February, 1929, from Messrs. John I. Thornycroft and Company, Ltd., Woolston Works, Southampton, after a number of competitive tenders had been examined.

The *Saguenay* was launched in July, 1930, and the *Skeena* in the following October. Satisfactory steam trials of both ships were run on the Clyde early in 1931. The former vessel was completed and delivered on May 21st, 1931, and the latter on the 9th June. Both ships left Portsmouth in company on the 25th June for Halifax, being the first vessels of the destroyer class to cross the Atlantic direct by the northern route. It is noteworthy that on arrival in Halifax the ships had used less than half of their oil fuel supply. All the officers, and with a few exceptions, the ratings manning these ships, are Canadians. The Assistant Canadian Overseer for building, Engineer Commander G. L. Stephens, R.C.N., M.E.I.C., is now Engineer Officer of H.M.C.S. *Skeena*.

Consideration of the conditions of service obtaining in Canada led to some modifications in the design when contrasted with standard British construction. The climatic conditions under which the vessels will operate are extreme, viz.: from the sub-zero of northern regions to the tropical temperatures of the West Indies.

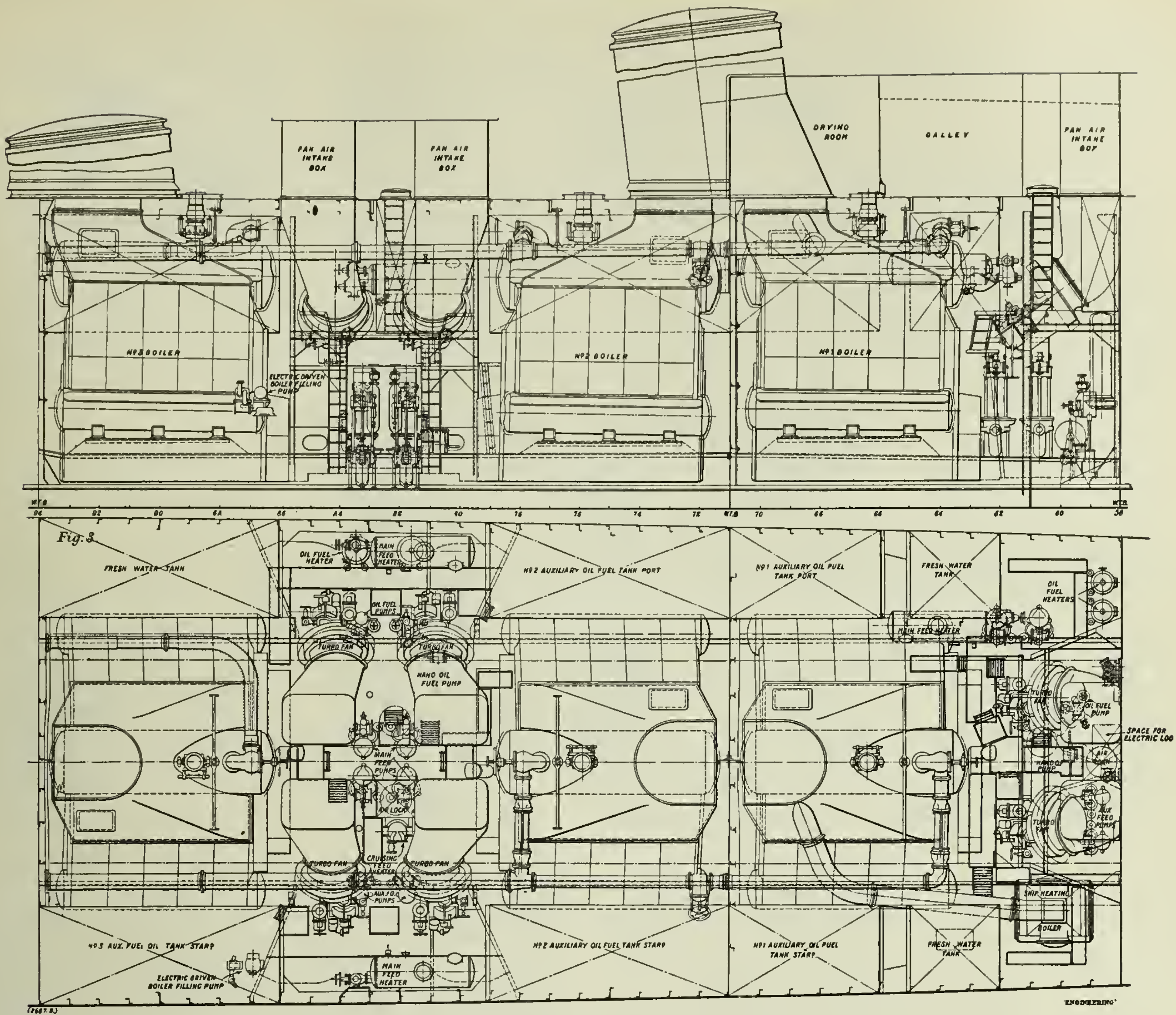
Winter service in northern waters implies accumulation of ice, not only in the water in which the vessel is floating, but also on her upper decks, bridges, rigging, etc., and this, in turn, involves both heavier scantlings and an increased degree of stability. The extreme cold also, bearing in mind the arrangement of the accommodation of a destroyer, has necessitated the provision of a somewhat elaborate heating system. On the other hand, periods of service in a hot climate have made imperative an equally complete ventilating system, ice-cupboards, shower baths, etc. Such provisions, though they have had some effect on the structure and machinery lay-out, have had yet more on the living accommodation. This, moreover, is extraordinarily spacious and well-found, the officers' cabins, for example, being not far behind those of a modern liner, while the crew is excellently berthed in distinct rooms, according to rating, and, in addition, a recreation room is provided.

The departures from recent Admiralty design on the part of the technical officers of the Canadian Naval Service to meet their particular requirements have necessitated modifications of standard practice which Messrs. Thornycroft have skillfully developed, and the results show an advanced type of ship which is not only capable of service as an independent vessel, but is also suitable for operating with destroyers of the Royal Navy.

The type of destroyer selected as the basis for the *Saguenay* and *Skeena* was the *Acasta* class, and the British Admiralty assisted in ensuring that there was practical correspondence between the two types by the examination of all designs, and the supervision, in conjunction with the Canadian officials, of the material and building of the ships. The vessels, then, are very similar in dimensions, speed and armament to the corresponding British destroyers, as the following figures will show:

	H.M.C.SS. *Saguenay* and *Skeena*	Standard British vessels *Acasta* class
Length between perpendiculars.....	309 ft.	312 ft.
Length Over all.......	321 ft.	323 ft.
Breadth..............	32 ft. 6 ins.	32 ft. 3 ins.
Displacement.........	1,320 tons	1,330 tons
Designed Speed.......	35 knots	35 knots

Fig. 1—Skeena at Portsmouth, June 1931.



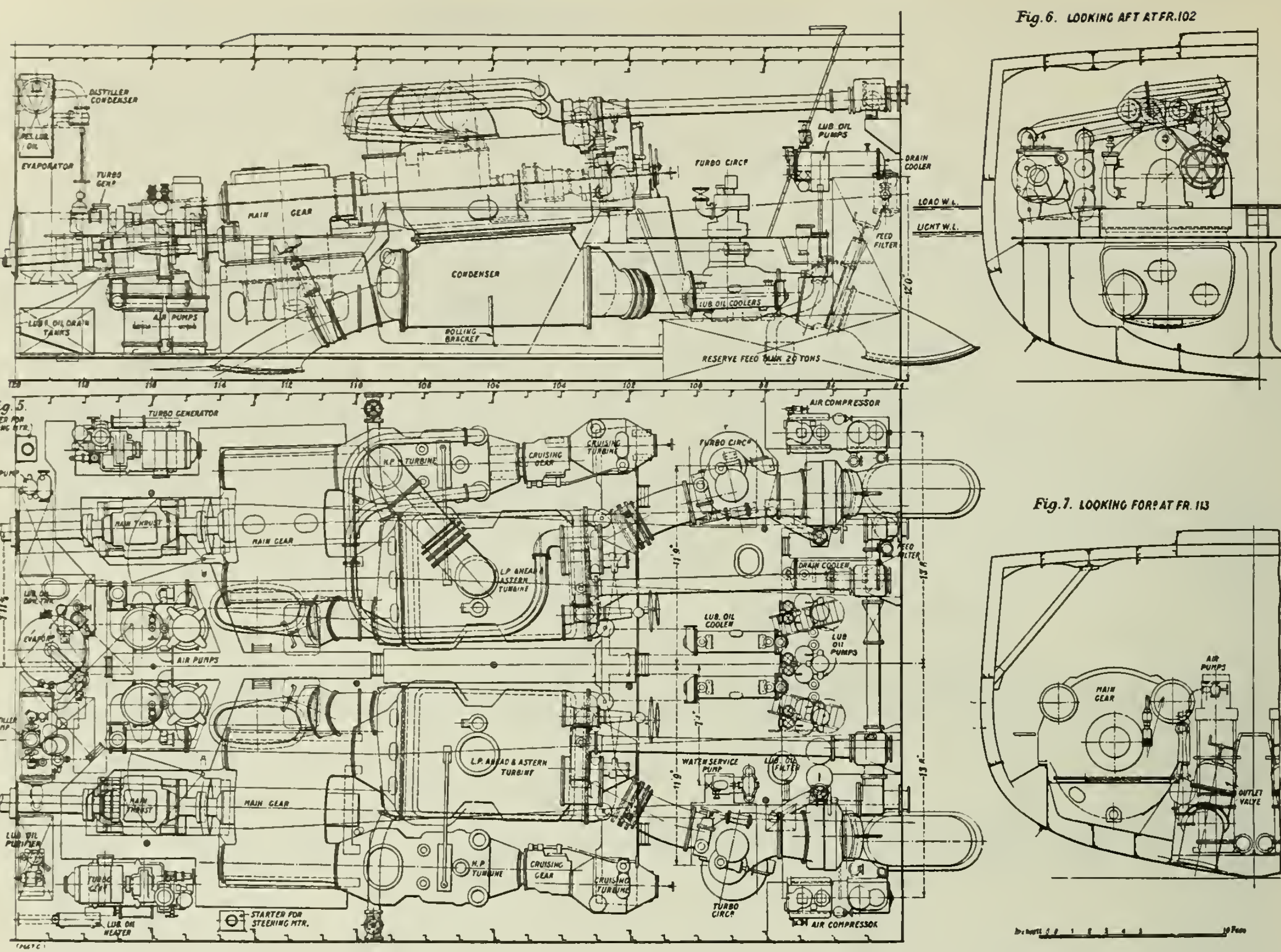
Figs. 2 and 3—Arrangement of Machinery in Boiler Rooms.

The main armament in both cases, includes four 4.7-inch guns, and eight 21-inch torpedo tubes.

The general appearance of the *Skeena* is shown in Fig. 1, taken at Portsmouth in June last. The bridge is accessible both by means of the usual external ladders from the decks and also by internal ladders communicating with the accommodation. There are two funnels and two masts, the main mast being unusually tall. This is to comply with the new International rules which lay down that a second steaming light has to be carried at a height of 15 feet above the forward light. The masts are of the steel-pole type which have proved very successful on the six Chilian destroyers recently built by Messrs. Thornycrofts. Steel masts are, as a matter of fact, becoming almost imperative as the weight of wireless gear, signalling lamps and yards increases.

The propelling machinery consists of two independent turbines arranged in a common engine room. Steam is supplied by three water-tube boilers of the Thornycroft type arranged in two boiler rooms as shown in Figs. 2 and 3. The engine-room lay-out is shown in Figs. 4 and 5 with cross sections in Figs. 6 and 7. Commencing with the boiler rooms, reference to the cross section given in Fig. 8 will show that the boilers are of the three-drum pattern. They are fitted with ten oil burners in two tiers, the burners being of the latest Admiralty pattern. The total heating surface of the three boilers is 25,600 square feet, and the working pressure is 300 pounds per square inch. There are no superheaters, it having been decided that saturated steam together with cruising turbines was the most satisfactory arrangement for the conditions of service. The forward boiler is situated in a boiler room extending aft from frame 58 to frame 71, the uptake being carried above the main deck to clear the bulkhead between the two rooms, the after one of which, extending from frame 71 to frame 94, houses two boilers. Boilers Nos. 1 and 2 share the forward funnel.

It will be clear from the several figures that the closed-stokehold system of forced draught is used, there being six turbo-fans set at an angle as shown in Fig. 8, and driven by geared turbines. Other auxiliaries situated in the boiler rooms include six main feed pumps, four auxiliary feed pumps, and three oil-fuel pumps. There are three main feed heaters which are capable of dealing with the whole of the auxiliary exhaust at all powers, and a drain cooler for taking the drain from the heaters or for use as an auxiliary condenser when the ship is in harbour. A small steam-driven centrifugal pump supplies circulating water to the drain cooler. An auxiliary boiler is provided for heating the vessel in port when the climatic conditions are severe, and is fitted in the starboard wing of the forward boiler room as shown in Fig. 3. Whilst under way, heating steam is supplied from the main boilers. The heating



Figs. 4, 5, 6 and 7—Arrangement of Machinery in Engine Room.

boiler is fired with oil by special burners, and has also a vacuum and circulating pump to ensure a good circulation. Automatic devices are fitted for regulating the temperature and oil and water supplies.

The main turbines consist of two independent units. The total horse-power developed on the official trials of the *Skeena* was about 34,500, but at this power the vessel was exceeding the guaranteed speed; thus on the measured mile a little over 36 knots was reached with 35½ knots as the average of a six hours' trial. As the machinery was not forced in any way, and it is stated that these results can be readily repeated on service, it may be taken that 34,500 h.p. is the full power output. At this load, the air pressure in the boiler rooms was 3 inches of water and the fuel-oil consumption worked out to 0.85 pound per shaft horse power hour. This result, considering the high rate of working and the fact that no superheat is employed, may be considered good.

Each turbine consists of a high-pressure cruising turbine geared to the shaft of the main high-pressure turbine, which is arranged parallel to the low-pressure turbine, both these turbines driving pinions on opposite sides of the shaft gear wheel. The gear is single reduction with double-helical teeth. At full power the high-pressure turbine runs at 3,100 r.p.m. and the low-pressure turbine at 2,100 r.p.m., the propeller shaft running at 375 r.p.m. The cruising turbines, which have two impulse wheels, can be disconnected when not required, and are designed to produce up to about 4,000 shaft horse power each.

They may, however, if inadvertently left in gear when the main turbines are running, be safely run at the full power speed. The high-pressure turbines consist of two impulse wheels followed by three reaction stages. The low pressure ahead turbine is of the Parsons double-flow reaction type. The astern turbine is incorporated in the low pressure casing and is of the impulse-reaction type.

The condensers, as will be seen in Figs. 4 and 6, are underslung from the low-pressure turbine casing; the tubes, which are of cupro-nickel, can be withdrawn in the space under the starting platform. The total cooling surface of

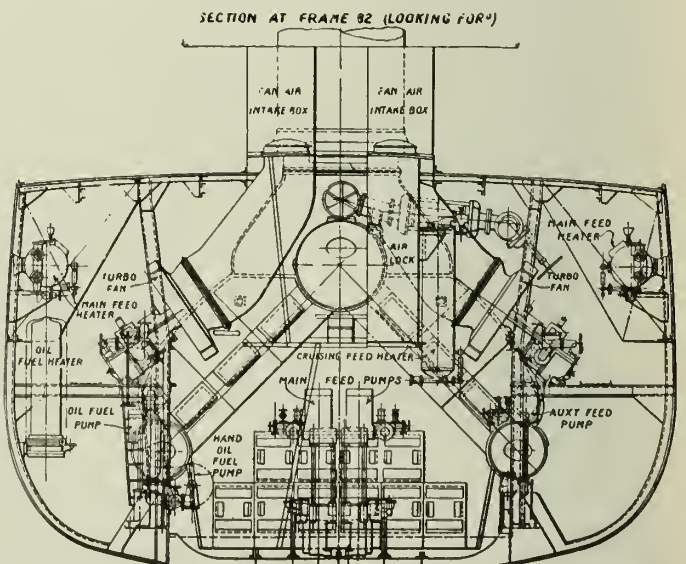


Fig. 8—Starting Platform in Engine Room.

both condensers is 12,000 square feet. The inlet and outlet connections with the hull are, as will be clear from Fig. 4, to some extent streamlined, and the outlets are situated near the centre line of the vessel, while the inlets are more in the wings, as shown in Fig. 5. This arrangement has rather a remarkable effect on the water circulation, since the full vacuum can be maintained by means of the natural flow of water as the vessel moves, without using the circulating pumps at all. This effect can be obtained with all powers up to 20,000 shaft horse power, i.e. for nearly sixty per cent of the full power. The vacuum at full power is 28½ inches and is easily maintained.

Electric current for harbour use is supplied from two 20-kw. petrol-driven generating sets. Other auxiliaries, including a 40-ton evaporator, can be identified in the several figures of the engine and boiler rooms. The steering gear is of the electro-hydraulic type. It may be said that the engine-room is not only well arranged, so that the whole of the machinery is very accessible, but is also well lighted naturally by side-lights. The first of these two points also applies to the boiler rooms, the whole of the propelling machinery forming an excellent example of modern warship layout. In the *Saguenay* and the *Skeena* the Canadian government has been supplied with two outstanding craft, and both it and the builders are to be congratulated on the results attained.

The design and construction of these ships was carried out on behalf of the Canadian government under the direction of Engineer-Commander R. C. Phillips, R.C.N., M.E.I.C., the principal technical officer of the Naval Service of Canada.

Care and Use of Explosives

E. Godfrey,

Explosives Division, Canadian Industries Limited Montreal.

Presented before the Cape Breton Branch of The Engineering Institute of Canada, October 17th, 1930.

SUMMARY.—The author treats briefly the precautions necessary in the use of explosives for various industrial purposes and the requirements for their safe storage. He also touches on the methods of drilling and spacing holes and the type of explosives required for quarrying, mining and construction work.

The use of explosives is a very live question, for if the source of practically all our industrial processes is investigated it will be found that their development was made possible through the use of explosives. It has been said that explosives are almost as indispensable as capital and labour. Every year millions of pounds of explosives are used for a great variety of purposes, and in view of the manner in which they are used or misused it is noticeable that there are surprisingly few accidents.

As sold today, commercial explosives will not explode of their own accord; they are carefully made from tested ingredients mixed in the proper proportions and thoroughly incorporated, so that the resultant mixture, when exploded, will give off certain predetermined gases, of such volume and speed that their concentrated power will be exerted on objects which it is intended to disrupt or shatter. Therefore, if it is necessary for the explosive manufacturer to exercise great care when making explosives, it is evident that care should also be taken by the consumer to see that the explosive is handled and stored in such a manner that the explosive ingredients are in no way changed, as any change will alter the characteristic of the explosive.

Storage

The addition of moisture will affect all explosives, especially the ammonia brands (practically all coal mining explosives are of this class), and cause them to become insensitive; old age has a similar effect; therefore, all explosives should be stored in well ventilated, dry, magazines and old stock always used first. Where possible, regulate the stock so that explosives over six months old will not be used. Cases of explosives should be stored right side up and piled so that a man can easily lift off the top case. Cases should not be opened in the storage magazine. When opening cases use only a wooden wedge and mallet—never iron or steel instruments. Explosives should be checked into the magazine, and on going out, and a record kept showing the quantities in stock at all times, also the persons to whom explosives are issued. The magazines should be kept clean and free from grit of all kinds, and no metallic substances should be permitted there.

Generally speaking, all results, both good and bad, from the use of explosives are directly due to either human direction or misdirection. A careful man who understands what he is handling is far safer while using explosives than he is crossing some of the busy streets of our large cities; but a careless man who knows nothing of the character of the explosives or their use is a source of danger both to himself and others. Blasting accidents are generally not due to explosive deficiency but to human deficiency. On rare occasions accidents have been traced to stray ground currents, storms, hot sparks, and lightning, but all these causes can be guarded against by a foresighted blaster. The most frequent cause of blasting accidents is carelessness and next comes ignorance as to the proper and safe use of explosives. Accidents from explosives will be rare if they are used in a sensible manner.

To prevent blasting accidents the consumer must know how they have been caused or may be caused. We find the chief causes of accidents can be grouped under the following heads:—

1. Proper cover not taken.
2. Playing with blasting caps.
3. Premature blasts.
4. Boring into unexploded charges.
5. Hang-fires.
6. Striking explosives in blasted material.
7. Preparing charges.

1. Proper cover not taken. Accidents under these heads could have been prevented if reasonable precautions had been taken. It hardly seems credible that many accidents should occur due to persons being hit by flying material from a blast, yet we find practically half the accidents laid at the door of explosives come from this source, and they can only be laid to carelessness or ignorance. When no natural cover exists, cover should be provided, and in all cases plain and timely warning should be given before a blast is made.

2. Playing with blasting caps. Children particularly do not know the danger of these caps and every year a number of them are maimed for life. Blasting caps should be issued only to reliable persons and they should be held responsible for their safe keeping. Parents who know what blasting caps are should instruct their children regarding them.

3. Premature blasts. Accidents under this head are more or less conjectured—usually the cause is removed by the blast. The majority of such accidents are due to careless handling such as ramming explosives into a hole of insufficient size, and especially ramming the primer cartridge. Using too short a length of fuse and being caught by a blast is often called a premature blast.

4. Hang-fires. As a rule the blaster attributes hang-fires to a slow fuse. It is far more likely that the number of fuses ignited have been miscounted and the blaster returns too soon to the face. If in doubt as to whether all the shots have gone, take plenty of time—do not guess—consult a watch.

5. Boring into unexploded charges. With reasonable care this type of accident can be eliminated. In block-holing boulders in quarries or mines a careful examination of the rocks should be made before commencing to drill. It frequently happens that a blockhole is loaded and not fired and a nearby blast turns the boulder over and unless an examination is made disaster may result. Drilling into old bottoms or "bootlegs" is forbidden by law, which states that "No drilling shall be done in any hole that has been charged or blasted."

6. Striking explosives in blasted material. Cut-off holes are the most frequent cause of powder being found in blasted material. These can probably never be eliminated entirely but an examination of the working face after the blast will generally indicate whether or not there are cut-off holes, and if any are found muckers should be warned and instructed to use care in shovelling or picking into the material.

Another cause of powder being found in this material is due to stemming not being used in the holes, particularly in uppers or holes having an upward slant. This sometimes results in the shock or air disturbance of the blast throwing the cartridges out of a nearby hole. This could not occur if stemming was used.

7. Preparing explosive charges. When making up primers care should be taken and a wooden or copper punch used for making holes. The fuse should not be forced into blasting caps, also it should never be screwed or twisted when in contact with the detonating compound. When making up charges of explosives all lights should be placed at a safe distance and no smoking allowed. If a steam shovel or locomotive is in the neighbourhood care should be taken that no sparks can fall around the explosives. In fact always treat explosives with respect. It is often the old hands who should know better who are the cause of accidents. It is difficult to correct the methods of old blasters but efforts must be made. When damp or oily stains appear on the cartridge wrapper or when the explosive is wet and soggy it should not be used before obtaining the advice of the manufacturer's representative. He will know whether it should be used and, if not, the manner in which it should be destroyed. High explosives will stand a lot of abuse when in a normal condition, but this cannot be made an excuse for rough handling, which should be avoided. The Dominion, the provinces and the municipalities all have acts which include some regulations regarding the handling, use and storage of explosives as does also the Mines Act, and where applicable these should be carried out.

Explosives are used for a great variety of purposes in developing our industries. The more important uses of explosives are in coal mines, metal mines, quarries, railway construction, hydro-electric development work, farming and demolition.

Coal Mines

The rules and regulations governing the use of explosives in coal mines are, of necessity, very strict and should be enforced to protect both the employee and employer. Practically all high explosives used in coal mines are of the ammonium nitrate class and in most of our coal mines before they can be used they must have passed a specified test. When they have passed this test they are placed on the permitted list. This list states the maximum charge which shall be used in any one shothole and also the strength of blasting caps which must be used to detonate the explosive. After an explosive has been named and defined as a "Permitted Explosive" under the Mines Act, it is not used in a permitted manner if one or more of the following conditions prevail:—

1. If a greater weight than the charge specified is used in any one hole.

Therefore, the charge limit should not be exceeded as the heavier charge might prove dangerous.

2. If stored under improper conditions until it undergoes a change in character.

Improper storage will cause deterioration of the explosive and may lead to misfires or partial misfires with their attendant dangers.

3. If used in a frozen or partially frozen condition.

Frozen explosives are less sensitive and less efficient.

4. If more than one class, grade, or quality of explosive is used in one hole.

Different kinds of permitted explosives placed in one hole may lead to a combination which would not act in the same manner as either one of them separately and the result may be erratic, dangerous, and likely to give off bad fumes.

5. If fired without stemming.

Stemming should always be used to prevent the flame from the shot being projected into the atmosphere, and also to ensure the maximum results with a minimum of danger.

6. If fired with combustible stemming.

Combustible stemming may be ignited and thrown from the hole by a blast.

7. If fired in the presence of a dangerous percentage of combustible gas.

Before a shot is fired, the place must be examined for gas, which, if found, must be removed.

8. If fired in a place which is dry and dusty without first thoroughly watering, rock dusting, or treating in an equivalent manner all contiguous accessible places within a radius of 60 feet therefrom including the floor, roof, and sides.

When blasts are made in a dusty atmosphere there is danger of a dust explosion. Therefore, the hole should be cleared of fine coal dust, all fine coal from the undercutting machine removed, and after the shot has been fired sufficient time should be allowed to elapse to permit the dust to settle before another shot is fired.

9. If the shot is a depending shot or the hole is bored into the solid or has a burden so heavy that the shot is liable to blow out.

Blown-out shots are generally accompanied with a projection of flame from the hole, therefore, the firer must see that the shot holes are properly placed and not drilled beyond the undercut.

10. If more than one shot is fired at any one time in any one place except only in tunnels, shafts, and slopes driven in rock.

When more than one shot is fired in one place at one time it increases the danger. This is not good practice, as better judgment of charge can be made after an examination of the results of each shot.

11. If an electric blasting cap of less strength than that specified for use with the particular explosive is used.

Weak blasting caps may cause incomplete detonation or a burning charge, resulting in bad fumes and other attendant dangers. The fact that an explosive is on the permitted list is not a guarantee that under all circumstances it will not cause an ignition of firedamp or coal dust, and it cannot be too strongly emphasized that there must be no relaxation in any way of the rules and regulations governing the use of explosives in coal mines on the ground that "Permitted Explosives" are being used.

To blast coal safely and to produce a good marketable product it is necessary that care be taken in preparing the coal before blasting. The coal should be properly undercut, shot holes drilled in the proper place and to the proper depth, and no hole should be fired which is drilled into the solid or has too much burden for the permitted charge to break. It pays to experiment before laying down hard and fast rules. One pound of explosive may break from four to seven tons of coal depending on the nature, thickness, etc., of the coal seam.

New men starting in a mine are often a source of danger. They may be old miners, or men with short experience gained at other mines, and do not know the proper manner to go about their work under the new conditions. The mine officials may think that someone will take care of such cases but this does not always follow, and the new men may be the cause of injury to themselves and others through ignorance of proper methods. Therefore, someone should be definitely detailed to instruct every new man thoroughly in regard to the best method of mining and use of explosives.

Overcharging of shots is expensive for the miner and operator as it means less marketable coal. Usually the miner does not concern himself about the condition of the coal and would rather shoot every hole too hard than do the pick work necessary should an occasional shot hang up. It would pay to have a foreman instruct each miner how to produce the grade of coal which sells best and, at the same time, save money by decreasing the quantity of explosives used. Explosives are used in coal mines to bring down the coal in as large blocks as can be conveniently handled because fine coal is of less market value than lump coal, and, as quick, dense, and strong explosives tend to shatter material, it follows that they are not suitable for coal blasting, but a low density, low bulk strength explosive will usually produce coal of the required size.

Metalliferous Mining

This branch of mining is usually carried on in hard rock and shafts have to be sunk, drifts and cross-cuts driven and raises put through from level to level. This is termed 'developing the mine' and the explosive best suited for this is quick and dense. Gelatin explosives have these characteristics and are recommended for general use in metal mines. When the mine has been developed and the extent and quality of the ore has been ascertained, stopes are usually opened up in the ore. In places where the veins are narrow and tight a gelatin explosive should be used, but where the stopes are of good width a less dense explosive can be utilized with a saving over gelatins. Ammonia dynamites are being used satisfactorily in this class of work. The object of blasting in metal mines is to reduce the ore to a size which will conveniently flow through the various chutes and feed into the existing crusher without undue secondary blasting.

Blasting of shafts, drifts, cross-cuts, raises, etc., is arranged by drilling a number of holes to a predetermined depth in a certain direction. This is called a round of holes and usually consists of two or more holes to take out a cut. These are blasted first and open up the centre of the work leaving a free face to which other holes may break. No one arrangement of holes has yet been found suitable for blasting all kinds of rock and the different arrangements are too numerous to be described in a paper of this nature.

When drilling cut holes they should be directed so as to bottom together then they will all explode at once and have a greater tendency to pull the cut clean than if each hole is fired separately. The cut should be blasted first and should the holes not pull to the bottom, they should be blasted a second time with the square-up holes because the square-up holes will not pull beyond the depth of the cut. For this reason it is generally wise to blast the cut holes first, then charge and fire the square-up holes.

Care should be taken in cutting fuse lengths for rotation firing because if one hole fires before it should, it is likely to spoil the whole round. For rotation firing when using safety fuse a difference of three inches in the length of the fuse should be allowed. The same sequence of rotation of firing can be obtained with the use of delay electric blasting caps. The amount of explosives used per cubic yard of rock broken in drifts, shafts, and other tight work varies from 5 to 7 pounds, in stoping work from .8 to 1.5 pounds.

Quarry Work

By this is meant work in open pits producing materials such as stone, gravel, sand, shale, and other non-metallic minerals, also open pit, metallic ore operations. In this type of work practically all the holes are drilled vertically and if an even or predetermined quarry floor is to be maintained it is necessary to drill from two to six feet below the desired bottom depending on the nature of the material to be broken. In quarry work the tendency is to fire a large number of holes at one time for the purpose of getting better fragmentation of the material, reducing stoppages for blasting and often to maintain a sufficient quantity of broken material in front of the power shovel.

Well drills, making holes from four to six inches in diameter, are very popular for this class of work where faces 25 feet and over in depth are to be broken. The advantage of such large holes is that explosive charges large enough to break a large quantity of rock can be placed without enlarging the holes by the old and dangerous method of springing smaller holes. In spacing well drill holes in quarry work it is rarely wise to drill them more than 15 feet apart in the row and 18 feet back from the face of the quarry. From 3 to 6 tons of rock should be broken per pound of explosive with explosives ranging in strengths from 35 to 60 percent. However this depends upon the nature of the rock, what the rock is to be used for, and the equipment for handling the rock.

When charging a large number of holes as few men as possible should be employed. All loose material should be taken away from around the holes and every care should be taken to prevent any foreign substance falling into them. Explosives of a diameter suitable for the holes should be used; there will then be no necessity for slitting the cartridges and forceful tamping of the explosives.

Railroad Construction and Hydro-Electric Development Work

In this class of work the main object is to break the rock so that it can be economically handled with the equipment on hand. Approximately one pound of explosive, 40 to 60 per cent strength, is used to break one cubic yard of rock. Occasionally large blasts are made with the object of wasting the rock. To do this the shot is over-charged, sometimes to the extent of 6 pounds to the cubic yard, depending on the location of the work with respect to probable property damage. Practically all blasts of this nature are carried out by driving small tunnels under the material to be wasted and the explosive charges are placed in the tunnels.

Farming

The farmer is now saving time and money by the use of explosives for blasting out stumps, blasting ditches, and breaking boulders. Much land has been reclaimed from swamps and turned into profitable farm land by blasting out drainage ditches. Stumps, that in the old days were burned out, resulting in months or years to clear an acre or so, are now blasted out in a few hours. A low grade dynamite is used for blasting stumps, and a higher grade for boulder breaking and ditching.

Demolition

Taking out concrete engine beds, breaking concrete walls, blasting down chimney stacks, wrecking sunken ships, etc., is now done in a much shorter time with the correct explosives properly used than by any method previously used.

Aeronautics as a Branch of the Engineering Profession

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Paper presented on October 16th, 1930, before the Aeronautical Section of the Montreal Branch of The Engineering Institute of Canada (Montreal Section, Royal Aeronautical Society).

SUMMARY.—In this address the author discusses the relations between the principal divisions of aeronautical engineering and the corresponding branches of structural, mechanical and electrical engineering, and draws attention to the extent to which aeronautics is indebted to workers in other fields for its development. He shows that aeronautical engineering problems, while solved by the application of accepted engineering principles, present characteristic difficulties and require the co-operation of the physicist, mathematician and skilled investigator.

Introduction

Although the author was invited to give this address before the Aeronautics section of the Montreal Branch of The Engineering Institute of Canada, he was given to understand that the greater part of the audience would consist of engineers engaged in the older branches of the profession, and consequently it was thought that it might be of interest to show how aeronautics is not a thing apart, requiring a highly specialized early training, but on the contrary has its roots in the very soil of the profession, and that the aeronautical engineer is but an ordinary member of the brotherhood whose art is to bend the forces of nature to their will and make them pay dividends on the dollars expended on their taming.

The Scope of Aeronautical Engineering

Though aeronautics, like all other engineering activities, demands the services and co-operation of the metallurgist, chemist, physicist and a host of other scientists, it may be said that aeronautical engineering is compounded of structural, mechanical, and aerodynamic engineering. The first and last of these are in eternal opposition, forever placing limitations on each other, and the highest art of the aeronautical engineer lies in forcing them to be friendly. An excessive sacrifice of aerodynamic requirements will result in an aircraft which will not fly well, while a neglect of structural needs produces one which will not hold together, and in either case one may expect a crash. For this reason, although there is already room for specialists in the subdivisions of the profession, it is better that the specialist should be a person recruited from the general ranks, who, having had his attention turned by natural inclination or by force of circumstances towards a particular division, is none the less entitled to be styled an aeronautical engineer.

As an illustration of this specialization in subdivisions take the man who designs airscrews. Time was when every aeroplane designer produced his own drawings and specifications for this component. This is no longer the invariable rule and the services of the airscrew specialist are being sought more and more. This man's work, based upon a bed-rock of aerodynamics and buttressed by a knowledge of mechanics and strength of materials, is an art in itself. Again, the present rule is for aeroplane manufacturers to design and construct their own wings and control surfaces, but the time can be foreseen when this construction will be concentrated in a few big plants to whose engineering staffs the individual designer will bring his specification of plan form, aerofoil section and loading, leaving the detail internal structure to their expert care. As a matter of fact such a development has already commenced in England.

In addition to the subjects already mentioned the aeronautical engineer should have a knowledge of meteorology and navigation. The extent of this knowledge necessary for the individual depends of course upon the direction in which he is applying his engineering. In the remainder of this paper, however, it is only proposed to discuss the main divisions, namely structural, mechanical and aerodynamic engineering. As the aerodynamic aspect is the first to be considered in any aircraft it will be dealt with first.

Aerodynamics

Aerodynamics is the science of the motion of bodies through the air, or of the air flowing past bodies, and of the resulting reactions created by virtue of this motion. It is the only one of the three main sections within the scope of the aeronautical engineer, the study of which can at present be said to be peculiar to aeronautics. There is no doubt that at some time in the future a course of aerodynamics could, with benefit, be included in the curriculum of general engineering training. Dealing with the motion of a fluid, aerodynamics is very closely allied to hydraulics, and any one conversant with the latter subject can read the text books on the former with a strong sensation of familiarity. Aerostatics, which is so essential to the "lighter than air" engineer, that is the balloon and dirigible man, has close analogies to hydrostatics. The future course mentioned above would deal in a comprehensive way with the laws which govern the actions of the compressible fluids or gases, and the incompressible fluids or liquids. In practice, the compressibility of air enters into the aeronautical engineer's sphere in only two important ways as yet. First, and most important, there is, of course, the variation in density, as well as pressure, with altitude. Secondly, compressibility has to be taken into consideration when dealing with airscrews whose tips travel at a speed of a very high order. At the speed of sound, viz., 760 odd miles an hour, it has been found that compressibility alters the ordinary "square law" relationship between force and speed. When the highest speed that aircraft have yet attained has been doubled, then we shall be dealing with projectiles and we shall have to resort to a study of ballistics for the furtherance of our aims.

The man in the street probably has the impression that aeronautics as a science is of comparatively recent birth. He knows that there exist records of crude and unscientific attempts at flight, some of which records are legendary and date back many hundreds of years, but does he know that aerodynamics as a truly scientific and mathematical study has written records from 1686, more than two hundred and forty years ago. Galileo and Mariotte in the 17th century, Newton, Bernouilli, Euler, Borda, Coulomb and a number of others in the 18th century, prosecuted researches on the resistance of the air. The earlier work was most likely prompted by a very pure enthusiasm for fundamental research, then later on, investigations were made which had a direct application to the needs of the day. Thus Smeaton, builder of lighthouses, who experimented in 1759, was evidently interested in determining the possible wind loads upon his structures. The windmills in Holland and Denmark were the subject of some research. The Englishman, George Cayley, who described his experiments in his "Aerial Navigation" of 1809, appears to have been the first to apply the study of aerodynamics solely towards the development of aeronautics. This man was a genius and far ahead of his time. The germs of the present day aeroplane are easily recognizable in his designs, and there is little doubt that had he had a reasonably light power plant at his disposal, the 19th century would have seen the successful commencement of power driven flight in heavier than air machines. It is possibly the lack of such a power plant that diverted many good men from entertaining dreams of "heavier than air" flight in the early 19th century. During the first half of that century, the needs of the naval architect, the structural and general engineer, and of the artilleryman, continued to be responsible for the greater part of the experiments which were undertaken on the resistance of the air. In the second half of the century, the application of aerodynamic research to aeronautics came strongly to the fore, and a number of names in the honour roll of aviation appear: names such as Lilienthal, Horatio Phillips, Ader, Langley, Eiffel and Hiram Maxim.

The earliest experiments, such as those of Newton, were performed by dropping spheres vertically through still air, then a little later on the common medium for investigation was the "whirling arm" which is, in its simplest terms, a long arm or beam rotating about a vertical axis. The model is mounted on one end of the arm and moves in a circular path, the forces on the model being measured by means of balance weights. The disadvantages of the methods employing a rotary motion are the introduction of the complication of centrifugal effect and the generation of a rotary motion in the air containing the apparatus. Nearly all the experimenters of the 18th century employed the method of a moving body in still air, though Rouse in 1759 appears to have been the first to reverse the process and experiment with fixed bodies in moving air. He measured the forces on bodies exposed to the direct action of the wind. His method has the obvious disadvantage that the relative velocity was entirely out of his control. It depended on the weather. It was not until 1864 that the modern method of experimentation made its first crude appearance. Wenham in 1864 put his models into the draft of a ventilator. Twenty-one years later Horatio Phillips built and used the first recognized wind tunnel. The flow of air in this tunnel was created by means of a steam jet and a steady velocity of nearly 60 feet per second could be maintained. The methods of the whirling arm and of the free drop survived until the early nineteen hundreds, but today all pure and applied aerodynamic research, except full scale work in real flight, is carried out in the wind tunnel.

One of the phenomena associated with aerodynamic research is that of "Scale Effect." The same effect appears in connection with the flow of liquids through pipes and channels. It has been found that the value of coefficients of resistance depend upon a factor called the "Reynolds Number." This factor is the product of velocity and a linear dimension, divided by the kinematic viscosity of the experimental medium. The linear dimension chosen for aeronautic work is generally the span of the model. Measurements made at equal Reynolds numbers will result in coefficients of equal value. There is a great disparity between the Reynolds number of a full scale aeroplane or airship and the corresponding number for a model in an ordinary wind tunnel, consequently, though qualitative results may be dependable, there enters some element of doubt as to the exact relation of the quantitative results as between model and full scale. There is no simple formula connecting results at different Reynolds numbers. In the United States, ahead of the rest of the world in the matter of physical equipment, the problem has been dealt with in a royal manner. There are two possible lines of attack, the most direct one being to build a wind tunnel large enough to take full sized models. This they have done, and the Propeller Research Tunnel of the National Advisory Committee for Aeronautics has a throat diameter of 24 feet, and is capable of wind speeds of 100 miles an hour, which require upwards of two thousand horse power for their creation. The other method is to change one of the variables in the Reynolds number function. An increase in velocity above full scale speeds is obviously too wasteful of power, an increase in linear dimension is clearly absurd, so nothing remains but to alter the kinematic viscosity, which can be done by altering the density of the air by compressing it. This method has also been followed in the United States and they have a completely enclosed tunnel in which the air is operated at many atmospheres above normal pressure. The construction of such a tunnel has now been undertaken in England. It will be obvious that such equipment is a thing for governments and not for private enterprise.

It may be asked of what benefit will a knowledge of the flow of air be to the average engineer and why should its study be included in a general engineering course? Possibly the improvement to be derived from this knowledge will be minute compared with the sacrifices involved in the inevitable compromise between ideal theory and practical economics. But the compromise which is permissible today, tomorrow becomes a crudity, and there are fields in which a proper application of aerodynamic knowledge would be of benefit. It is highly probable that this application has already been considered in most of the fields to be mentioned, but if practice in the use of air in general engineering falls as far short of the ideal as admittedly it does in aeronautics, then there is still room for considerable improvement.

Combustion and ventilating engineers are among the largest users of air today. For instance, every ton of coal burnt in a furnace requires 15 tons of air which often pass through the flues at a speed approaching 2,000 feet a minute. This is a low velocity in aeronautics, but it is high enough to create appreciable reactions on any obstructions in the stream. It is not necessary to use streamline lumps of coal, but unavoidable obstructions should be designed to create as little turbulence as possible, and where changes of direction are required, the use of guide vanes for combing out turbulent flow might well be considered. We are only at the beginning of the application of guide vanes in aeronautics. The air-cooled radial aero engine has a terrible shape aerodynamically, but recent developments of guide vane devices placed in proper relation to the engine have resulted in tremendous reductions in resistance to forward motion. The N.A.C.A. cowling produced in the United States and the Townend ring developed in England are merely annular guide vanes cunningly disposed. The conservation of energy in wind tunnel plants has been the subject of much work, the records of which should be of direct interest to the combustion and ventilating engineers.

The transportation engineer, whether automotive or railroad, might conceivably profit. At the lower speeds air resistance probably merits little consideration, but at high speeds it becomes appreciable. On the basis of one square foot of projected area the resistance at 60 miles per hour of a flat plate is of the order of eleven pounds, while that of the corresponding streamline form is less than one-fifth of a pound, that is one-fiftieth times as much. Minimum air resistance may come very low down on the list of the transportation engineers' requirements, but where it can be obtained at little cost, the closer attainment of the aerodynamic ideal should not be neglected. The accepted form of closed automobile of today has a better streamline form going backwards than it has going forwards. Every winter illustrates the aerodynamic imperfections of the under side of an ordinary railroad passenger coach. After passing through a sleet storm almost every obstruction under the coach will be clothed in a frozen streamline form manufactured by nature itself. A general cleaning up of the vehicles if it did nothing else would reduce the dustiness of railway travel.

It is generally understood that the rules used by structural engineers for computing the wind loads upon buildings, bridges, cranes and other structures are of a most empirical nature. Are these loads not calculated on a basis of projected area without taking cognizance of shape? It is known that a flat plate offers far more resistance to the wind than a rectangular prism whose cross section has the same shape as the plate, and also that where intersections are rectangular in the plane transverse to the direction of motion, the resistance at the joint is less than where the intersections are acute. A more exact application of the knowledge already available would result in a refinement of design tending towards greater safety or greater economy while wind tunnel tests could easily be undertaken for tackling special problems.

The naval architect is interested in the wind pressure exerted on the side of his ships and he might well employ the wind tunnel in addition to the water channel to improve the upper form as much as he has perfected the form below the water line.

The hydraulic engineer should benefit indirectly by the extension of knowledge of fluid motion and its applications which are due to the recent intensive study of the subject stimulated by the needs of aeronautics.

Structural Engineering in Aeronautics

The difficult part of the problem of the structural strength of aircraft in flight is the determination of the external loads. This information is supplied by aerodynamics and from then on the computations of the loads in the members are clear cut and fairly precise and should be easy for any engineer familiar with the theory of structures, once he has accustomed himself to dealing with structures that are never rectangular, are usually full of redundancies and are subject to different combinations of loading under different attitudes and speeds of flight.

When it comes to the design of the various members, however, one must revolutionize the scale of relative values commonly accepted in heavy engineering and modify considerably one's trend of thought.

Considering first the relation of the designed strength to the loads imposed, it must be realized at the very outset that there is no such thing as a "Factor of Safety" in the structural part of aeronautics. "Load Factors" are used, which in turn are increased by a further factor which provides a margin of safety of somewhat indeterminate value. The loads upon an aeroplane in flight at a uniform velocity can be computed with a fair degree of accuracy, but when a change of attitude is imposed, a change in magnitude and point of application of the resultant force takes place, producing linear and angular accelerations which cause considerable increases or decreases and a redistribution of the loading. The meeting of a sudden gust of wind is equivalent to an acceleration imposed upon the aircraft. The magnitude of the accelerations which occur during the various manoeuvres of an aircraft have been determined and some very dangerous work has been done to fix the maximum acceleration possible. Records of values exceeding nine times the acceleration due to gravity have been obtained. Such violent movements are beyond the ordinary capacity of the human frame, and, if repeated often in a machine strong enough to withstand them, would result in permanent injury to the pilot. Roughly speaking, a value of three times g is near the limit of ordinary human comfort and is of the same order of magnitude as the acceleration which bumps one's head against the roof of an automobile. The values of the accelerations determined, whether they be maximum possible values, or ordinary values appropriate to certain manoeuvres, are used as a basis for laying down the "load factor" required in a particular condition of flight and the additional factor required to provide a margin of safety is purely arbitrary, though it may be judged a little on the probabilities of exceeding the basic load factor, a little on consideration of inaccurate manufacture, deterioration caused by age or use and other similar indeterminate influences, and finally a little by the very human desire to stick to nice easy round numbers and simple fractions. Some people have advocated yet another variable factor to look after uncertainties in the properties of certain materials largely used in the construction of aircraft. Such a factor might well be christened a "factor of ignorance." A much better way is to take cognizance of this uncertainty when specifying the maximum working stresses permissible in a certain material. In this way the design load is not changed, but remains the same whether the member to resist that load is made of metal or wood. The specification of design load factors is the most critical and the weakest link in the whole chain of the design, but in this matter aeronautical engineers have by no means reached finality. A concrete example will show the sort of way in which the total design load factor can be arrived at. An aeroplane is flying at its maximum horizontal speed. By pulling roughly back on the elevator control it is found that a normal acceleration of three times g is imposed, while at the new attitude the centre of pressure moves forward towards the leading edge of the wing. The probabilities of exceeding the three times g in moments of excitement are fairly high, so an arbitrary margin or "safety factor" of two is imposed, thus the design load factor for the centre of pressure forward condition becomes six. That is to say, the loads calculated for flight at a uniform velocity corresponding to the forward position of the centre of pressure are multiplied by six. Another way of looking at it is that the design loads correspond to a speed $\sqrt{6}$ times the normal speed. The inertia of the aeroplane supplies the power required to maintain this speed for a fraction of a second.

The federal government is in most countries the authority which lays down the design load factors to be used for different classes of aircraft.

The aeronautical structural engineer holds an attitude towards weight which is essentially different from that adopted by his confrere in the heavier line.

Except for very large structures where the dead load constitutes the major proportion of the total load, the steel and concrete man's greatest incentive for refinement in design and economy in material is reduction in cost. The finished price per ton varies slowly with total tonnage and extra weight costs money in raw material, in fabrication, in transportation and in erection. The aeronautical engineer's job, however, is to reduce weight to the utmost possible degree without incurring too great an increase in cost, under penalty of producing an entirely unsuccessful aircraft. Every pound added to the structure is a pound taken away from the profit paying load of the vehicle, but extra lightness costs money in design, in fabrication and in the price of special materials, and it is necessary to strike a very nice balance. The situation is complicated in aeronautics by the fact that a certain sacrifice of lightness is justifiable in order to attain a decrease in resistance having a greater economic value. For example, the ideal section for a long thin pin-jointed column is a circular tube, but where such a member is exposed to the wind the aeronautical engineer prefers to use a tube of streamline section or he clothes his circular column with a thin metallic or wooden streamline covering which has no structural value whatever. The desire for reduction in weight imposes the necessity for making every bit of material included in the structure carry a stress as near to the limiting design stress as possible, and this, coupled with a trend towards the use of metal to the exclusion of wood, has led aeronautical engineers to great lengths in the design of thin walled sections made of special steels and aluminum alloys. The walls of these sections are ingeniously crinkled in a variety of ways to guard against failure by local instability.

Other influences on the structural design of aircraft are inertia and rigidity. Large inertia of the structure as a whole is unfavourable to controllability, manoeuvrability and stability, while a large inertia of some component part coupled with a lack of rigidity may result in dangerous undamped oscillations in the region of that component.

It has been said that once the external loads have been determined the stress analysis of an aircraft should be easy for a structural engineer. This is not strictly true of rigid airship structures, where new methods of analysis entirely outside the range of ordinary structures have had to be devised to cope with the intricacies of this type of elastic and highly redundant frame.

Mechanical Engineering in Aeronautics

The chief mechanical problem in aircraft is most evidently that of the power plant. This problem is so vast and has so many subdivisions of its own that it has become a separate branch of the aeronautical engineering profession, and it is that part of aeronautics which has the most common ground and the closest relationship with non-aeronautical activities. It might be said that aeronautics has fathered a good big healthy child whose mother is automotive engineering. Aeronautics is the father, for though admittedly the invention of the internal combustion engine preceded flight and made it possible, it is notable that the Wright brothers were constrained to build a special aero engine for themselves because no existing motor would meet their needs. Later on automotive engineers entered the new field in force, with the result that today the four-cycle electrically ignited gasoline aero-engine has reached what the economists call the "marginal stage." Any further improvement in thermal efficiency can only be gained very slowly indeed and at great sacrifice of labour. Much larger rewards from research are to be looked for in the development of motors working on a different cycle and at much higher compression ratios than are possible with a poppet valve design. For an interesting outline of present and possible future research reference should be made to a recent number of the English publication "Aircraft Engineering," to which Ricardo has contributed an article forecasting the line of progress. It is needless to emphasize that the refinements necessitated by the stringent demands of aeronautics have reacted to the benefit of the parent automotive industry.

The distinctions between the power plant of aircraft and the power plant on the ground are all incidental and with one exception involve no factor which is not absolutely common to all forms of internal combustion engineering. The excepted factor is the variation of atmospheric pressure and density with altitude. For example, at a height of 20,000 feet the atmospheric pressure is roughly one half the pressure on the ground. This variation is responsible for the development of special carburettors which are designed to maintain a proper mixture strength under widely different conditions and also for the peculiar use of the device known as the supercharger. This device when fitted to automobile or boat engines performs the functions which its name implies and boosts the mean effective pressure and the power output of a given plant by increasing the weight of the charge. The name, however, is an ill chosen one to describe the most common application of this device to an aero engine, which is made not to boost the power of the engine on the ground but to maintain ground level power or rated power at an altitude. Admittedly there are engines with gear-driven superchargers which can be operated at full throttle on the ground and are therefore known as ground boosted engines, but the ordinary kind of gear-driven supercharged engine actually has to be throttled down on the ground so as not to exceed the rated mean effective pressure, and full throttle opening and full power are not attained until a certain altitude has been reached.

In a manner analogous to that already mentioned in the structural section of this paper, the aeronautical mechanical engineer has a different scale of values to that held by his counterpart on the ground. Their guiding principles are identical and the sum of their final objects may be the same, but their motives are different. Safety, economy of weight and compactness are the factors of overwhelming influence and the other desiderata have to give place.

Consider for a moment the motive behind the search for fuel economy. The main motive is emphatically not the reduction of operating costs but the reduction of overall power-plant weight including fuel. The aircraft designer does not merely consider the weight of a motor on a pounds per horse power scale but in pounds per horse power hour on a six hour, seven hour, or longer basis.

Take again the matter of cost. The aero-engine maker cannot juggle with quality, and there is no such thing as producing a "line" to suit the capacity of every pocket. Engines of a similar power have a similar cost and if your pocket is small you can only afford to buy a small engine; you cannot buy a cheap big one.

Leaving the power plant aside, the aeroplane as a vehicle offers some scope for the mechanical engineer in the design of alighting gears, control gears, and so on. The automatic gyroscopic control of aircraft is now being satisfactorily perfected. An enormous amount of ingenuity has been displayed in the design of fixed and retractable undercarriages, combination ski-wheel and ski-float gears and many other accessories. Most of the problems involved are the application of well known mechanical devices in the simplest and lightest possible way and the aeronautical engineer borrows freely from the products of his brethren. It is difficult to see how there can be much beneficial return to the profession in general from these borrowings.

The scattered paths of engineering are today many and varied and each reveals such lengthy vistas that the ordinary pilgrim cannot afford to wander far on any but his chosen way. Few of the paths are straight, and every little while one crosses another and perhaps for a space merges with it to make a broad highway. It is hoped that some who read this paper may perhaps be led to journey further along the highways of aeronautics.

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The Engineering Institute of Canada and the Provincial Associations of Professional Engineers

All members of the engineering profession in Canada are naturally concerned with the inter-relation of the activities of our various professional and technical organizations. The present situation is sufficiently complicated. Among distinctively technical societies we have, to begin with, The Engineering Institute of Canada, a Dominion-wide, Canadian organization, whose objects need not be described here, and which includes engineers of all branches of the profession. Another Dominion-wide organization, The Canadian Institute of Mining and Metallurgy, ably represents the mining industry as well as the professional mining engineer. Further, there are in Canada a number of active branches or sections of American engineering societies, who deal with specific subdivisions of engineering work, and who naturally look to the United States rather than to Canadian sources for professional guidance.

With aims distinct from those of the voluntary bodies just named, eight Provincial Associations of Professional Engineers have been created to deal with questions regarding the licensing of professional engineers and the protection of the public against incompetent practitioners. Membership in them, in most cases, is compulsory, their activities are definitely regulated by provincial enactments, and they are now in existence in all of the provinces of the Dominion except Prince Edward Island.

The difficulties arising from this complex structure have, for some years, received consideration from the Council of The Engineering Institute, particularly with respect to The Institute's relations with the Provincial Associations, and there has developed a general desire for some real progress towards an ideal condition in which the activities and requirements of all these bodies will be mutually co-ordinated. Some have even expressed the hope that eventually engineers will not be faced with the necessity of belonging (and contributing) to a multiplicity of entirely independent organizations.

The question of the relations between The Institute and the Provincial Associations is thus one of the important topics on the agenda for the Fifth Plenary Meeting of Council, and at this time it seems desirable to place in the hands of members of The Institute a brief account of the activities of The Institute in regard to this matter up to the present time.

In 1918, shortly after the transformation of the Canadian Society of Civil Engineers into The Engineering Institute of Canada, it appeared desirable that further and more consistent development should take place in regard to the legal registration and licensing of professional engineers. This movement had been initiated by the Society in regard to Manitoba (1896), and Quebec (1899), and it was then realized that provincial (not federal) legislation had to be secured, the protection of the public being essentially a provincial and not a federal responsibility.

A committee appointed by the Council of The Institute drew up a Model Act (see Engineering Journal, May, 1919, page 411), which it was thought would be suitable for submission to the various provincial legislatures, and this act served as a basis for the legislation which was obtained shortly thereafter, establishing Associations of Professional Engineers in nearly all of the provinces of the Dominion. In British Columbia, the passing of the act in 1920 was largely due to the activities of a body formed for that specific purpose, and called the British Columbia Technical Association. The resulting acts, however, were by no means alike in their provisions, the legal powers of the various associations differed in degree, and from time to time amendments to several of the acts have rather tended to emphasize this lack of uniformity.

In February, 1926, in order to consider this situation and other points affecting the common interests of the then seven provincial associations, delegates from these bodies met at the Headquarters of The Institute and discussed points of mutual interest for three days, the resulting recommendations being submitted in due course to the Councils of the several professional associations. The Institute was not represented at this conference.

In October, 1927, the first Plenary Meeting of the Council of The Engineering Institute of Canada took place, and at this time the hope was definitely expressed that The Institute might aid in the co-ordination of the work of the various provincial associations, a committee being appointed under the chairmanship of George R. MacLeod, M.E.I.C., to report regarding this. The committee, consisting of Institute members from all of the provinces, was unable to commence work for some time, the chairman ultimately being compelled to resign through pressure of other work, and being succeeded by S. G. Porter, M.E.I.C., of Calgary. (See Engineering Journal, November 1927, page 497.)

In the same year The Institute's Board of Examiners, on instructions from Council, exchanged views with the Boards of Examiners of a number of the professional associations to see what could be done towards obtaining uniformity in examination requirements, and in 1928 a revised examination syllabus of The Institute was prepared and communicated to the associations. No further progress in this respect seemed possible at that time without meetings for discussion.

At the second Plenary Meeting of the Council of The Institute in 1928, The Institute's Committee on the Relations of The Institute with the Professional Associations was continued, the committee not yet being ready to present a report.

At the third Plenary Meeting in 1929, the committee presented a report indicating that there was a general sentiment in favour of closer relationship between The Institute and the associations, and making definite recommendations as to the course which should be taken by The Engineering Institute. This report was adopted by Council, and it was agreed that it should be submitted for the consideration of The Institute membership at the next Annual General Meeting. This was accordingly done, and at the Annual Meeting of 1930 the report led to prolonged discussion, being finally received and adopted, attention being drawn to the fact that effect could not be given to all of its recommendations immediately. (See Engineering Journal, March, 1930, pp. 191-194.) The recommendations with which the report terminated, and which were thus endorsed by the Annual Meeting of The Institute, are as follows:

1. That this committee or a similar one be continued.
2. That at least one member of Council in each province be added to the committee to act during his term of office in all cases where Council is not already represented.
3. That this committee be authorized to appoint a small sub-committee whose duty it shall be to approach the provincial associations and in conjunction with them devise a detailed proposal to bring about a co-ordination of the interests and activities of the various professional associations and The Engineering Institute of Canada; and further it is recommended that a sum of $1,800 be appropriated towards a fund to provide for the expense of this work.
4. That The Engineering Institute of Canada, through The Journal and otherwise, continue to encourage and support the activities of the professional associations and contribute in every reasonable way to their success.
5. That immediate steps be taken to arrive at an agreement among the professional associations and The Institute for the adoption of standard uniform requirements for admission to membership and that these requirements be rigidly adhered to.
6. That upon the acceptance of such standard requirements The Institute should adopt the policy of accepting membership in a professional association as sufficient evidence of qualifications for admission to The Engineering Institute of Canada.
7. That steps be taken to secure the necessary amendments to the By-laws so that membership or registration in a professional association be one of the requirements for admission to corporate membership in The Engineering Institute of Canada for all applicants residing in a province where an engineering professions act is in effect.

The committee was accordingly continued, and at the meeting of Council held on April 11th, 1930, Past-President H. H. Vaughan, M.E.I.C., was appointed chairman in succession to Mr. Porter, and a sub-committee was appointed in accordance with recommendation No. 3 to approach the provincial associations.

At the fourth Plenary Meeting of Council in September, 1930, Mr. Vaughan presented a report from his committee, including the views of the sub-committee, which recommended that a study of the possibilities in the matter should be made by a committee nominated by all of the provincial associations and The Engineering Institute, to be known as the National Committee. This proposal was to be communicated to the provincial associations, who would be asked to nominate members, after which an analysis and comparison of the various provincial acts and requirements for admission would be made, which it was hoped would lead to the working out of a draft set of by-laws and requirements for membership that could apply to all the provincial associations and to The Engineering Institute of Canada. This work of analysis and drafting was to be done by a sub-committee of three (afterwards changed to four) members of the National Committee representing the Maritime Provinces, Quebec and Ontario, the Prairie Provinces, and British Columbia respectively. It was thought that when such a draft had been prepared and had been criticized by all members of the National Committee it might then be submitted to the Councils of the associations and of The Engineering Institute of Canada for their consideration.

At The Institute's Annual Meeting in February, 1931, the Committee on Relations of The Institute with the Provincial Associations of Professional Engineers presented a further report (see Engineering Journal, February, 1931, page 102,) which stated the situation, and announced that the proposals for a National Committee were under consideration by the governing bodies of the professional associations, and that some of these had already approved of the suggestion and had appointed their members on that Committee. Ultimately members of the National Committee were appointed by the Councils of seven of the eight professional associations, who thus concurred with the course proposed.

The Council of one of the provincial associations, however, maintained that co-ordination of all activities of engineering associations throughout Canada might be obtained more readily by developing a plan which would at first apply only to the provincial associations. Definite objection was made to any plan which would at once include The Engineering Institute of Canada. Further, the Council in question was unable to approve of the proposed Committee of Four unless its members were accredited by the associations alone, The Institute taking no further active part for the time being.

The President of The Institute and the Chairman of its committee allowed this objection and a committee of four representatives of the provincial associations was convened in Montreal August 24th. The first report of this committee was made to the Councils of the provincial associations in September.

The German Engineers' Society's Meeting, 1931.

By Robert W. Angus, M.E.I.C.,
Professor of Mechanical Engineering, University of Toronto, Toronto.

The well-known Verein deutscher Ingenieure (German Engineers' Society) celebrated this year at Cologne, from June 26 to June 29, their 70th General Meeting and also the 75th Anniversary of their establishment, since the Society was organized in 1856. With a membership of nearly 30,000, it far exceeds in size any other similar society, but, of course, it includes many classes of engineers; its technical publications are of very high order.

That the meeting was a success every one attending it would testify, for about 1,000 were at the main meetings and considerably over 1,200 sat down to the dinner in the evening. The regular sessions of the meeting were devoted entirely to technical papers, differing in this respect from the practice of some other engineering societies, and the papers were of decidedly high order on the whole. In one session that I attended there were some excellent papers on the subject of cavitation in turbines, etc., but the papers were not printed beforehand, although some of them will appear later in the Society's "Zeitschrift."

The two anniversary meetings were held on June 28th, the first being the formal meeting and the second one the dinner. The afternoon meeting was held in the Fest Saal of the Gurzenich, a building well known to all who visit Cologne, for it was erected in 1452 and was designed with this hall for the special entertainment of distinguished visitors to the city, so that the elaborate interior decorations may be readily imagined. The setting was, I thought, very fine.

An opening address by the Chairman, Dr. Köttgen of Berlin, outlined the history of the Society from its inception. He was followed by Dr. Konen, Rektor of the University of Bonn, who gave a learned address on "Stream Flow Problems."

The rest of the afternoon session was taken up with reading the greetings of universities and of engineering societies from various parts of the world. The German delegates were, of course, most numerous, but addresses were presented by various British, American and other societies, all of the foreigners being well received. Some honours were also bestowed and as the addresses were usually long, the session was not a short one. I almost omitted to say that the first message was from President Hindenburg and was received by the audience standing, and was accorded a hearty "Hoch" at its conclusion.

The dinner at night was a notable and unusually interesting affair, being attended by over 1,200 men and women, who met in the new and very tastefully decorated "Grosse Halle," in the Rhein park on the Deutz side of the Rhine. The dinner proper lasted from eight till eleven o'clock, and was preceded by a fine selection on the large organ. But three courses were served and the speakers came between them, but as there was no head table each speaker came, unannounced, to a rostrum at the end of the room and delivered his speech, so that there were no tiresome "Chairman's Remarks." Smoking did not begin till about eleven, and the diners moved about the room and chatted together and drank their wine in a friendly way. During the latter interval, there was a most instructive movie entertainment. It was a memorable and delightful affair and I am glad I was able to attend it.

Visits to various plants and to Aachen and Koblenz, and a final "get together" in the evening concluded the interesting meetings. I attended the meetings both by special personal invitation of the society and also as the representative of The Engineering Institute of Canada.

OBITUARIES

Donald Cameron, M.E.I.C.

In the passing of Donald Cameron, M.E.I.C., at North Vancouver, B.C., on July 26th, 1931, the engineering profession has lost a valued member.

Mr. Cameron was born at Appin, Argyll, on November 5th, 1851, and received his education at school in Appin and Glasgow and at Glasgow University. In 1867-72 he was a pupil with David Smith and Ritchie at Glasgow. After being engaged for several years on sewage disposal work, he was in 1878 appointed deputy city surveyor and in 1883 city surveyor and engineer of Exeter. It was while he was at Exeter that Mr. Cameron patented a system of sewage disposal by passing sewage through a closed tank, to which he gave the name "septic tank." He also devised automatic gears for alternating the flow of effluent to the filters, and was thus one of the chief pioneers of modern sewage treatment. While his ideas were widely adopted and his methods proved successful in practice, there were many attempts to produce something equally effective, and much litigation followed. The failure of certain installations, alleged to be based on the principles he advocated, led to undeserved disparagement of his claims and thus he never received adequate recognition of his great services to sanitary engineering.

In 1902 Mr. Cameron entered private practice. Coming to Canada in 1907, he became engineer to the municipality of North Vancouver and in 1909 entered into partnership with E. A. Cleveland, M.E.I.C.

Mr. Cameron joined The Institute as a Member on February 10th, 1914, and was made a Life Member on December 22nd, 1925.

Charles Lyon Fellowes, M.E.I.C.

Much regret is expressed in recording the death at Toronto, on September 18th, of Charles Lyon Fellowes, M.E.I.C.

Mr. Fellowes was born at Ottawa, Ontario, on September 17th, 1846, and was educated at a private boarding school and at Ottawa College, Ottawa.

During the years 1870-1872, Mr. Fellowes was engaged on a trigonometrical survey for the Welland canal, and in 1872-1881 he was first assistant engineer on the construction of the northern division of the same canal. In 1881 he was a contractor on the Credit Valley Railway, in 1882 he was section engineer on the Chicago and Atlantic Railway, and from 1882 to 1886 he was in private practice. During the year 1887 Mr. Fellowes acted as assistant engineer at the head office on the Temiscouata Railway and in the same year returned to private practice, in which he remained until 1890. From that year until 1896, he was engaged on special work for the city of Toronto sewers, and was also water-works engineer. In 1896 Mr. Fellowes was appointed deputy city engineer and water-works engineer of Toronto, which positions he held for over thirty years.

Mr. Fellowes joined The Institute as a Member on February 11th, 1907, and became active in Institute affairs, being a member of Council during the years 1911, 1912, 1913 and 1914.

Graham Ferguson Paterson, A.M.E.I.C.

Members of The Institute will learn with regret of the death of Graham Ferguson Paterson, A.M.E.I.C., which occurred at Montreal on May 6th, 1931.

Mr. Paterson was born at Paisley, Scotland, on March 4th, 1890. He received his early education at the Glasgow High School and Ayr Academy, graduating from the Glasgow Royal Technical College in 1909. From 1906 to 1911 he was pupil with Messrs. Warren and Stewart, civil engineers, Glasgow. In 1911, Mr. Paterson became connected with W. P. Weir, civil engineer, on the preparation of plans, specifications, etc., for the Irvine ship-building yard and slip-dock. From 1912-1913 he was assistant on the staff of engineers to the joint railways committee of the Caledonian and Glasgow and Southwestern Railways, being in charge of permanent way maintenance, Glasgow and Kilmarnock section. Coming to Canada in 1913, Mr. Paterson was employed in the Sewer Section, Works Department of the city of Toronto. From 1914 to 1919 he served overseas, first as a lieutenant and later as a captain in the Royal Engineers (Imperial Forces). After the war he accepted a position with the Maxwell Motor Corporation, Detroit, in charge of inspecting and supervising work in the erection of a new plant, and in 1920 was appointed assistant on the staff of the chief engineer, department of sewer construction for the city of Detroit. In 1921 Mr. Paterson became designer, sewer section, city of Toronto, and in 1922 resigned that post to join the Technical Service of the city of Montreal.

Mr. Paterson became an Associate Member of The Institute on June 27th, 1922.

George Fillmore Swain, M.E.I.C.

It is with deep regret that the death is recorded of George Fillmore Swain, S.B., LL.D., M.E.I.C., which occurred on July 1st, 1931, at Holderness, N.H.

Professor Swain was born at San Francisco, Calif., on March 2nd, 1857, and graduated from the Massachusetts Institute of Technology in 1877 with the degree of S.B., and from the Berlin Banakademie in 1880.

In 1887 Professor Swain became consulting engineer for the Massachusetts Railway Commission and in 1894 was appointed as engineer member of the Boston Transit Commission. The latter Commission has built all subways in Boston and a number of bridges. In 1880-1883 Professor Swain was expert on the Tenth Census on water power. In 1909 he was in charge of the Department of Civil Engineering at the Massachusetts Institute of Technology and in the same year was appointed McKay Professor of Civil Engineering at Harvard, which appointment he held up to the time of his death.

While his active nature carried him into many fields, including transportation, structures and hydraulics, yet throughout his entire life Professor Swain remained true to his primary calling—he was one of the great engineering teachers.

Professor Swain joined The Institute as a Member on January 11th, 1913.

PERSONALS

James C. Neufeld, S.E.I.C., has been appointed instructor in the Faculty of Engineering at the University of Manitoba, Winnipeg, Man. Mr. Neufeld graduated from that university with the degree of B.Sc. this spring.

O. S. Platou, A.M.E.I.C., is at present engaged on the Saint John Harbour Reconstruction, at Saint John West, N.B. Mr. Platou was formerly designing draughtsman with the Power Corporation of Canada, Ltd., at Montreal.

M. F. Dixon, S.E.I.C., formerly with Jenkins Bros. Ltd., is now associated with Crane Limited, Montreal, as sales engineer. Mr. Dixon is a graduate of McGill University of the year 1930.

C. D. Evans, Jr.E.I.C., has joined the staff of the Canadian Gypsum Company, Ltd., Montreal. Prior to accepting his present position, Mr. Evans was estimator and engineer with Gypsum Lime and Alabastine, Canada, Ltd., at Toronto, Ont.

Earl M. Brydon, A.M.E.I.C., formerly assistant engineer, Public Service Corporation of Northern Illinois, Chicago, Ill., has returned to Canada, and is now connected with Canadian Line Materials Limited, Scarboro Junction, Ont. Mr. Brydon graduated from the University of Manitoba in 1924 with the degree of B.Sc.

E. L. Miles, M.E.I.C., has been transferred by the Standard Paving Limited from Toronto where he was promotion engineer, to Halifax, N.S., where he is connected with Standard Paving (Nova Scotia,) Limited. Before joining his present company, Mr. Miles was for some years county engineer and superintendent of roads, county of Victoria, Ontario.

C. L. Kenney, S.E.I.C., is now located in Saskatoon, Sask., where he is employed on the construction of the new Canadian National Railways hotel. Mr. Kenney, who graduated from the Nova Scotia Technical College in 1929 with the degree of B.Sc., was formerly with the Otis-Fensom Elevator Company Ltd., Montreal.

A. G. Tibbits, S.E.I.C., has joined the staff of the Acadia Sugar Refining Company Limited, as assistant engineer, and is located at Woodside, Dartmouth, N.S. Mr. Tibbits graduated from the Nova Scotia Technical College this year with the degree of B.Sc.

NOEL J. OGILVIE, M.E.I.C.

Noel J. Ogilvie, M.E.I.C., Director, Geodetic Survey of Canada, Ottawa, has been appointed international boundary commissioner by the British Government, to act with a representative of the United States government in arranging all matters pertaining to the boundary between Canada and the United States. Mr. Ogilvie is chairman of the National Committee of Canada of the International Geodetic and Geophysical Union, and is also chairman of the Association of Geodesy of that Committee.

T. H. Nicholson, A.M.E.I.C., announces that his company, T. H. Nicholson Limited, Montreal, which was recently formed for the distribution through Canada, Newfoundland and the British West Indies of domestic electrical devices, has been appointed exclusive representative for Dennisteel products in the province of Quebec. Mr. Nicholson's company intends to specialize on that general line of equipment.

Major W. M. Miller, A.M.E.I.C., Royal Signals, has been appointed chief signal officer, Burma. This is a special appointment due to the Burma rebellion. Major Miller is responsible for all the telegraph, telephone and radio arrangements for the troops engaged in quelling the rebellion. He was formerly stationed at Trimulgherry, Deccan, India.

H. W. R. Shepherd, A.M.E.I.C., lately with United Engineers and Constructors, Canada, Ltd., at Newcastle Creek, N.B., is now with the Saint John Harbour Reconstruction, Saint John West, N.B. In 1928 Mr. Shepherd was resident engineer at the Seven Sisters Falls development, Whitemouth, Man., for the Northwestern Power Company, and prior to that was resident engineer with the Foundation Company on the construction of the Ghost river dam for the Calgary Power Company. Mr. Shepherd, who was at one time resident engineer for the highway department of the province of Alberta, was overseas with the Alberta Dragoons and the Second Battalion of Canadian Engineers from 1914 to 1919.

R. N. Blackburn, M.E.I.C., Retires

R. N. Blackburn, M.E.I.C., Chief Mechanical Superintendent, Department of Public Works, government of Saskatchewan, Regina, Sask., retired from the service of the government on September 1st. Prior to taking over the duties of the office which he now relinquishes, he was Chief Inspector of Steam Boilers for the province.

Mr. Blackburn was born in England, and was educated in that country at the Liverpool of Science, obtaining first

R. N. BLACKBURN, M.E.I.C.

class honours in mechanical engineering at the City and Guilds of London in 1888. Before coming to this country, Mr. Blackburn was in private practice as a consulting engineer at Liverpool. During his official career at Regina, his technical advice has been sought on many important engineering questions affecting the welfare of the province, more particularly as regards the utilization of local fuel resources, the generation and distribution of electric power, and the problem of water supply.

Joining The Institute as a Member in 1920, Mr. Blackburn has always taken a keen interest in its affairs. He served on Council from 1923 to 1925, and is a past-chairman of the Saskatchewan Branch.

Lieut.-Colonel W. A. Steel, M.C., A.M.E.I.C., Appointed to Staff of National Research Laboratories

Lieut.-Colonel W. A. Steel, M.C., A.M.E.I.C., who as an officer of the Royal Canadian Corps of Signals has directed the radio development of the Department of National Defence, has been appointed to the staff of the National Research Council, to have charge of its radio research programme.

In co-operation with other officers of the Department of National Defence, Colonel Steel has invented a direct reading radio compass which is now in general use both on this continent and in Europe. As a result of his investigations important transmitting and receiving equipment and directive beacon apparatus have been evolved. At several international radio conferences he has been the Canadian representative, and he accompanied the Prime Minister to the last Imperial Conference.

Lieutenant-Colonel Steel commenced his military career in the ranks of the 2nd Field Company, Canadian Engineers, Toronto, and served in that unit from 10th October, 1911, to September 30th, 1914, when he transferred to the Toronto University Contingent of the Canadian Officers Training Corps, in which unit he was appointed to a commission as Lieutenant on the 21st February, 1916. He served in the Canadian Expeditionary Force as an officer of the Canadian Signal Service, was twice mentioned in despatches and was awarded the Military Cross.

During the last year and a half of the World War he had charge of all the radio work of the Canadian Corps in France.

He was engaged on radio research work at the University of Toronto under the direction of Professor T. R. Rosebrugh, from the time of demobilization in 1919 until June 1, 1920, when he was appointed to the Permanent Force with the rank of Major in the Royal Canadian Corps of Signals. He received promotion to the rank of Lieutenant-Colonel on August 7, 1930, in recognition of the outstanding technical work in signals and communication which he had performed for the Department of National Defence.

The Economic Status of the Engineer in the United States*

Abridged (by permission) from the report published in Mechanical Engineering for September 1931

1930 Earnings of Mechanical Engineers

The following conclusions are based on replies from over 50 per cent of the membership of the American Society of Mechanical Engineers in the United States on questionnaires where identification was impossible. Some 9,199 engineers replied. The results are believed by the committee to be the most reliable that have been obtained as to engineering earnings.

In studying the figures, it is important to keep in mind that (*a*) They are based on 1930 earnings, and the effect of the present depression had not been felt; (*b*) figures refer to professional incomes only and consequently can only be compared with other figures which refer exclusively to professional incomes; (*c*) the figures do not refer to average, but to "median" earnings;† (*d*) throughout the report, earnings are figured for groups based on years after graduation and on comparable ages. By using this method instead of individual years, more reliable figures were obtainable due to the larger numbers in the group for which the median is taken.

Fig. 1 indicates the 1930 professional earnings of mechanical engineers in the United States as a whole. Comparison of these curves indicates the years in which the increase is greatest, and it will be noted that engineering earnings do not decline seriously with age.

An examination of the median earnings which are roughly typical of all comparative earnings of mechanical engineers in the main geographical areas of the United States indicate that these are affected to some extent by location. The New York Metropolitan district gives the highest median earnings at all ages below 63. These are not substantially above the earnings in the mid-Atlantic states, except for men over 40, or the middle West, except for men over 50.

Numerical distribution of members of the Society in the separate geographical areas, together with the maximum median earnings in each area, can best be observed in Table 1.

Table 1
Distribution of Membership

Geographical Area	No. of Members‡	Per Cent of U.S. Membership	Maximum Median Salary
Metropolitan	4,928	27	$10,000
Middle Atlantic	3,857	22	8,000
Middle West	4,506	25	7,300
New England	2,038	11	7,200
Southern	1,097	6	6,000
Pacific	1,015	6	6,000
Prairie and Mountain	469	3	6,000
	17,910	100	

‡*This figure is the total membership of the Society in each area, and does not indicate the number who replied to the questionnaire.*

Fig. 2 indicates the effect of education upon earnings. "Engineering B.S." comprises only men who had received a degree of B.S. in engineering from an engineering school of recognized college rank. "Engineering B.S. plus" comprises those men who added to their B.S. degree a year or more of technical graduate work at a recognized engineering college. "Non-graduates" are those men who had completed at least three years of work at a recognized engineering school, but who did not get their degree. "Sub-collegiate" includes all men whose education comprised a course of study of at least three years in a night school or school of less than college grade. "Non-technical" includes all men whose training is less than "non-graduate" or "sub-collegiate."

*Prepared by the above committee of the American Society of Merchanical Engineers under the chairmanship of Conrad N. Lauer. The survey and the preparation of the report were directed by Professor Elliott Dunlap Smith of Yale University. The statistiscal computation was directed by Professor Hudson B. Hastings of Yale University.

†To get the "median" earnings in any classification, the salaries of all the engineers in the classification are arranged in a column in order of size. The total number of entries in the classification is then counted, and the salary of the man who comes in the middle of all the men in the classification is then taken as the "median" of the classification.

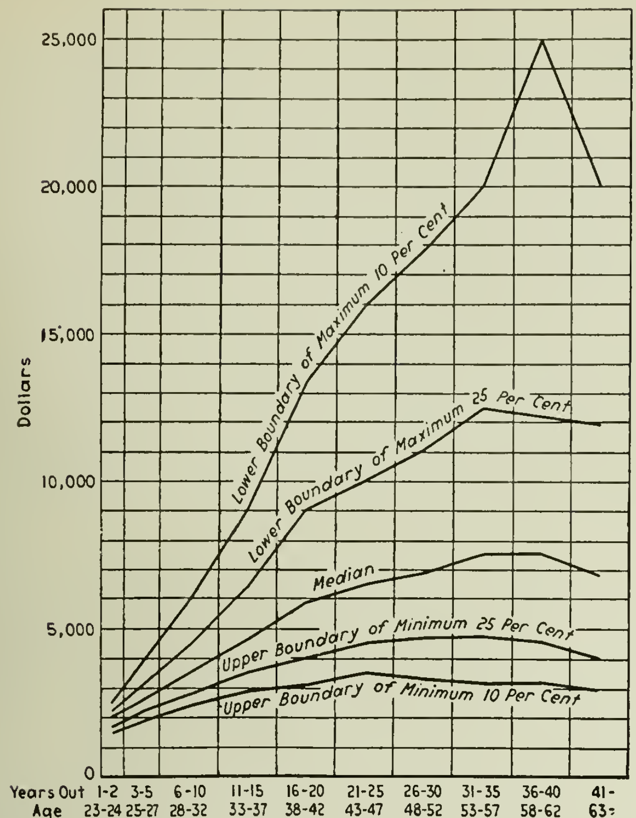

Fig. 1—1930 Earnings of Mechanical Engineers—United States as a Whole.

The fact that men with training of sub-collegiate rank at almost all ages earn less than men without technical training, may be partly due to the fact that men without technical training are not likely to take out membership in the Society unless they have made a moderate success in engineering, while men with night-school or similar training are more likely to register as engineers regardless of success.

The distribution of members who replied to the questionnaire among the various industrial classifications is shown in Table 2.

"Machinery manufacturing" and "chemical" follow closely the United States median. "Consulting," "construction" and "non-metal manufacturing" industries show slightly higher pay for ages up to 50, at which age they come down close to United States median earnings. Although the number of returns from railroads is small, the results at

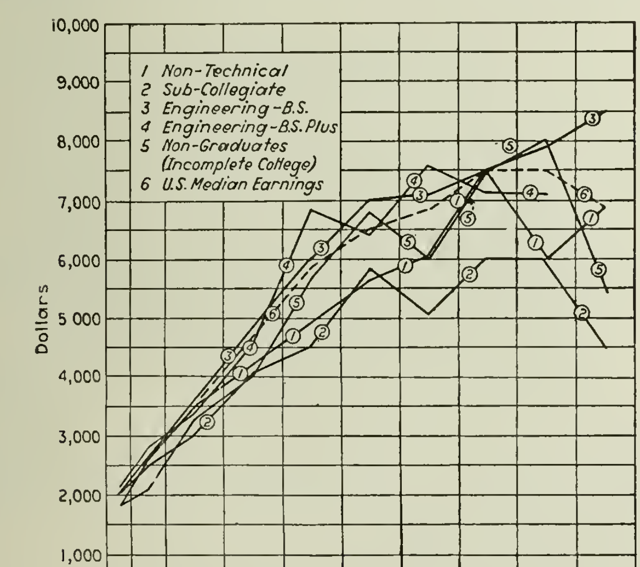

Fig. 2—1930 Median Earnings by Type of Education.

TABLE 2

DISTRIBUTION OF ENGINEERS BY INDUSTRIES

	Number of Replies	Per cent of total
Machinery manufacturing	3,051	38
Power Machinery manufacturing	934	12
Public Utilities	776	9
Consulting	755	9
Non-metal industries	648	8
Academic Institutions	593	8
Chemical	585	7
Construction	251	3
Railroads	127	2
Financial	91	1
Commercial	74	1

all wage boundaries are so consistent as apparently to justify the inference that railroads pay below the median wage almost from the start.

Median academic wages begin to fall below the median of the country as a whole at 28, and by 55 are approximately $2,000 below.

Fig. 3 gives comparative median earnings in the various sorts of work in which engineers engage. "Designing" includes all industrial research. "Technical operation" includes all maintenance, inspection, production control and similar technical work relating to operation. "Consulting" as a type of job includes only actual consultants and does

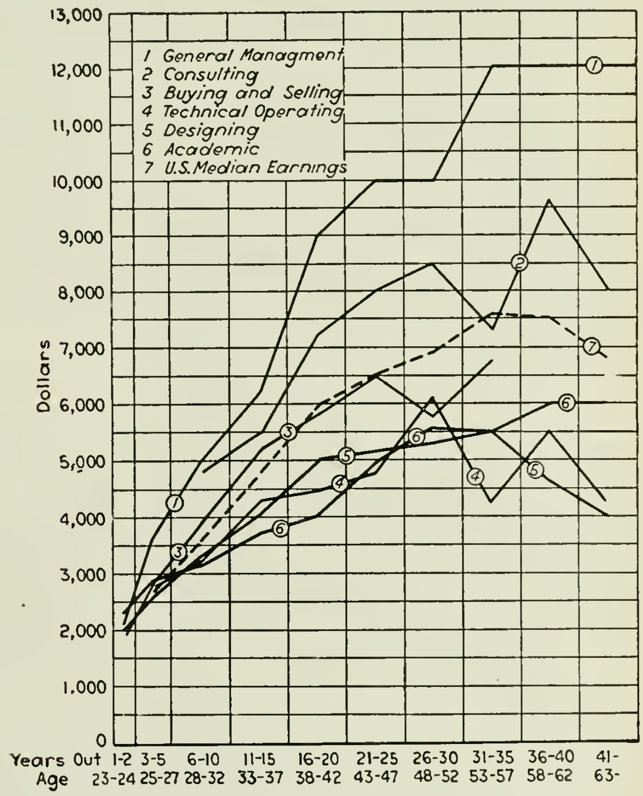

Fig. 3—1930 Median Earnings by Type of Occupation.

not include consultants' employees as consulting as an industry does. "General management" includes all men in general executive work from assistant foreman up.

The relations between the median earnings of the different types of jobs also hold at other salary ranges, the differences becoming more emphatic, however, as higher wage levels are reached. This is illustrated by the salary boundaries of men in the "designing" and in the "general management" classifications at typical ages, and by the percentage by which managerial earnings exceed designers' earnings.

Not only is there this striking difference between general management and consulting on the one hand, and design research and technical operation on the other, but there is a significant difference in earnings, especially among designers and research men, between those engineers doing technical work who have managerial duties and those who do not.

SUMMARY

The outstanding points about earnings in 1930, brought out by the survey are:

1. That the maximum professional income of the typical mechanical engineer is $7,600. One quarter age over $12,500; one tenth age over $25,000.

2. That the age of maximum earning power of the typical mechanical engineer is 55, earning power ordinarily not declining seriously with age even in the 60's.

3. That the differences in earning power between high-paid men and men in the middle salary ranges are strikingly great, the lower boundary of *the highest 10 per cent* at its maximum being 233 per cent higher than the maximum of median earnings.

4. That salaries are distinctly lowest in the far West, and that the New York Metropolitan district has much the largest percentage of high-paid men above the age of 50.

5. That a good education is worth while.

6. That apart from railroads and academic institutions, the differences between industries as regards salary opportunities are not great at most ages.

7. That the differences in earning power between men whose work is exclusively technical and those who combine with their technical ability the capacity to handle independent businesses or to manage men or affairs, are great—so great as to indicate the importance of most engineers seeking to develop themselves in this respect, and of engineering schools bending their curricula somewhat toward this end.

BRANCH NEWS

Hamilton Branch

John R. Dunbar, A.M.E.I.C., Secretary Treasurer.

The first meeting of the Hamilton Branch this season was held in the Royal Connaught hotel on September 17th, and took the form of a dinner meeting. E. P. Muntz, M.E.I.C., was in the chair. The speaker, Lieut. Col. W. P. Wilzar, M.E.I.C., of Queen's University, was introduced by L. W. Gill, M.E.I.C.

Engineering of the Ancients

The speaker commenced by stating that while it can be proved that man existed 350,000 years ago, all we have historical record of is 10,000 years. Into that comparatively brief time have been crowded all the discoveries of engineering principles as they have been handed down to us.

The earliest records we have are the dwellers of Ur, the Chaldeans. Between the Tigris and the Euphrates, a canal was built. The Tower of Babel was built of brick, on each brick was stamped the name of the ruler. A high degree of civilization was reached by these people. They instituted customs for revenue and wrote receipts.

One of the earliest forms of engineering was that of mining and metallurgy which the ancients brought to a high level in the working of gold, silver, tin and copper.

Many of our records showing engineering achievements of the past have been made interesting by Herodotus, who wrote entertainingly although perhaps not accurately of these.

In earliest times miners were nearly always criminals and the mines were state owned. It is said that Rameses II drew an annual income of sixty-five million dollars from this source.

In the olden times the engineer made weapons for war, after that he became a civil engineer. Caves, sepulchres and monuments bear testimony to their enduring work. The earliest text book on engineering was written two thousand years ago. Brick arches were constructed six thousand years ago. The Romans were perhaps the greatest engineers of the past. The Aqua Julia and Aqua Claudia, which were respectively fourteen and ninety-seven miles long, still show the features of construction. It is said that the Romans built altogether 47,000 miles of road; they understood the various principles of road building, such as piles, mortised caps, dirt roads, macadam, drainage.

The Egyptians have left many monuments, chiefly pyramids, the most famous of which is that of Cheops. In the building of these pyramids, stones weighing as much as seventy tons were drawn to a height of 700 feet and in the construction of Cheops the Egyptians used only a pulley and the inclined plane, yet the accuracy of measurement has always been a matter of wonder to subsequent engineers. In the placing of this pyramid in such a position that the Pole Star shone on the face of the dead Pharoah the Egyptians showed no small knowledge of astronomy. The speaker read extracts from Petrovius, a Roman engineer who drew up a code of ethics, many of the items being startlingly apt to-day.

F. W. Paulin, M.E.I.C., moved a hearty vote of thanks to the speaker for his instructive address which R. K. Palmer, M.E.I.C., seconded.

The chairman then gave an address on the prospects of the Branch for the coming year and exhorted the members to give something to the Branch rather than look only for the good that they might get out of it. E. H. Darling, M.E.I.C., councillor, outlined some of the points that were to be discussed at the plenary meeting to be held in Montreal the to be discussed at the plenary meeting to be held in Montreal on September 21st. There were thirty-two members present.

Ottawa Branch

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

Thomas Telford, Father of Modern Civil Engineering

The fall programme of the Ottawa Branch was inaugurated with a luncheon at the Chateau Laurier on Thursday, September 17. The speaker was Sir Alexander Gibb who was in Canada making a survey of the national ports on behalf of the Federal government. Among those at the head table, in addition to the speaker and to G. J. Desbarats, C.M.G., M.E.I.C., the chairman, were the Honourable Alfred Duranleau, Minister of Marine; Alex Johnston, Deputy Minister; E. Hawken, Assistant Deputy Minister; Dr. Charles Camsell, M.E.I.C., Deputy Minister of Mines; Commander C. P. Edwards, A.M.E.I.C., F. H. Peters, M.E.I.C., Surveyor General; John Murphy, M.E.I.C.; J. McLeish, M.E.I.C.; J. L. Rannie, M.E.I.C.; and the following members of Sir Alexander's party, E. Palmer, T. Paton and H. Beaver.

Sir Alexander spoke upon the career, character and achievements of "Thomas Telford, Father of Modern Civil Engineering," a subject which was felt to be most appropriate when Sir Alexander explained that his own great grandfather, John Gibb, was a personal friend of Telford's and was, in fact, one of the great engineer's superintendents.

In tracing the life history of Thomas Telford, Sir Alexander characterized him as the father of professional engineering as we now know it and the honoured founder as well as the first president of the Institution of Civil Engineers of Great Britain, the "doyen" of civil engineering institutions throughout the world. The sum and total of his works during the course of a busy lifetime would be staggering if, indeed, it would be possible to completely enumerate them today. They related to the construction of canals, roads, bridges, docks and harbours, involving expenditures ranging into the tens of millions of dollars at a time when such sums signified a great deal more than they do now.

Telford was born in 1757 at Westerkirk in Eskdale, Dumfriesshire, Scotland, his father being a poor shepherd who died three months after the birth of his son, leaving his widow practically destitute. However, adversity did not affect Telford's disposition and he early in life earned the sobriquet of "Laughing Tam." While a boy he was employed as a herder, occasionally attending the parish school of Westerkirk where his quickness and diligence helped to make up for his lack of opportunity. At an early age he was apprenticed to a journeyman mason and in this capacity was engaged on works in various parts of the country.

Filled at all times with a restless ambition, he found time to gain a sufficient acquaintance with Latin, French and German to enable him to improve his knowledge in all branches of science.

His first great step forward was his appointment in 1793 as engineer of the Ellesmere canal, for which he built the Chirk and Pont-y-Cysyllte aqueducts. This work, the most important of its kind in the country at the time, led on to other work, so that he quickly became recognized as the principal canal expert in the world. Another canal upon which he was engaged and upon which he set high hopes, visualizing it as a means of making Scotland "the emporium of commerce," was the Caledonian canal. It, however, failed of its purpose and was not properly completed until thirteen years after his death.

The range of Telford's activities, in addition to his canal work, covered nearly a thousand miles of road and twelve hundred bridges, and it was stated also that there was scarcely a harbour with which he was not connected. Among the latter were the St. Katharine's docks of London, constructed in 1828. These were nearer to the heart of London than any others previously built; for their time they were a marvellous construction and under Telford's direction in order to meet the desires of the authorities were an exceedingly short time in building. Telford himself, however, protested against this haste in building such important structures, claiming that the practice involved dangerous risks to life and reputation.

In his work of bridge building, the masonry constructions ranked as high as any others built and the ingenuity and skill exercised in the design of his cast-iron bridges were truly remarkable. As an evidence of the durability of Telford's structures, Sir Alexander stated that in connection with his own work for the Ministry of Transport he investigated the state of the famous Menai straits suspension bridge over a hundred years after its construction and found it to be in sound condition, having due regard to the change of type of transport over that period of time.

Telford was never married. His tastes were simple and pecuniary reward had no great interest for him. He had an intense love for his motherland and a deep pride in the country's efforts. Combined with his own personal modesty was a readiness to give praise to others wherever it was due. He died in 1834 at the age of 77.

The De Laval Steam Turbine Company, Trenton, N.J., have recently published a leaflet describing and illustrating single-stage, double-suction centrifugal pumps of the horizontally split casing design. This type of pump was introduced by the De Laval Company in 1901, and is characterized by relatively high speeds, high efficiencies and the ability to work against high heads per stage. The catalogue, B-2, "De Laval Single Stage Double Suction Pumps," may be obtained from the company's office at Trenton, N.J.

The Garlock Packing Company, Palmyra, N.Y., have issued a new folder describing and illustrating the Garlock 701 brake lining, which is constructed of high quality asbestos cloth, impregnated with a special rubber compound, folded, moulded and vulcanized under 2,000 pounds pressure. The booklet, which may be obtained from the company at the address given above, also includes a price list of the brake lining.

Canadian National Exhibition, Toronto, 1931

Electrical and Engineering Building

During the past few years there has been a considerable increase in the number and importance of the engineering exhibits at the Canadian National Exhibition. These are doing much to indicate the progress of Canada in this field, and as a result, this section of the exhibition is becoming a recognized feature of the engineering world.

Readers of The Engineering Journal will be interested in a brief resume of some of the leading exhibits. Space does not permit the inclusion of all displays of an engineering nature, and it is unfortunate that so many items of importance were placed away from the main exhibits in the Electrical and Engineering building.

Busfield McLeod Limited

The chief exhibit of Busfield McLeod Ltd. consisted of a Gardiner 3-cylinder 54-h.p. 400 r.p.m. full Diesel marine engine in operation; the cylinder bore was 8 inches and the stroke 9¾ inches. This was manufactured by Norris Henty Gardiners Limited of Manchester, England, and is a modern direct reversing engine compression ignition cold start. It is of the type which has recently been supplied to a number of Canadian installations. While this is primarily a marine engine, the same type is used for stationary purposes such as for direct connection to generators in power plants. In Fig. 1 a 4-cylinder engine of similar type may be seen.

A interesting exhibit was a complete working model of a 3,000 i.h.p. North-Eastern marine Diesel engine, built by the North Eastern Marine Engineering Company Ltd., of Wallsend-on-Tyne, England, and installed on the 8,000-ton motorship "Raby Castle." This model shows the operation of the direct reversing system applicable to large engines of this type.

The Lux system of fire protection such as used for protection of generators and other electrical equipment, and for combating oil and inflammable liquid fires, was also on display. The exhibit consisted of a number of the portable Lux units which operate in principle exactly the same way as large built-in installations.

The latest model of a standard domestic type Permutit water softener was shown.

In the material handling field, there was also to be seen a standard heavy weight type clamshell bucket, suitable for either the handling of heavy materials or for digging work, manufactured by Priestman Brothers, Ltd., of Hull, England.

An additional exhibit was a complete standard diving outfit by Siebe, Gorman and Company, Ltd., and of the type used as standard equipment in the Royal Navy.

The Canada Machinery Corporation

The Canada Machinery Corporation exhibited a number of machine and woodworking tools manufactured in their factory at Galt, Ont.

Fig. 2 illustrates a 32-inch by 36-inch heavy duty crank shaper of a type suitable for shipyards, railway and machine shops. The ram has a maximum stroke of 32½ inches and the table a maximum cross travel of 36 inches; the rise capacity is 16 inches between the jaws. The column is a single-cored casting and all bearings are cast integral with the column including the bull gear bearing which is of large diameter providing ample wearing surface. The base is a heavy single piece casting, and is made with an extension with a planed surface for holding table support and is provided with flanged sides to collect oil and chips.

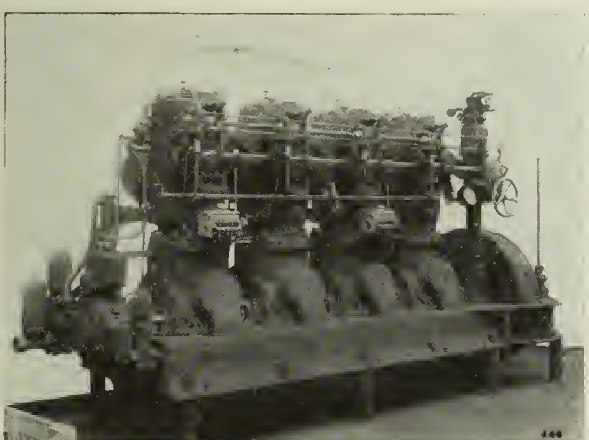

Fig. 1—Gardiner Diesel Engine.

The tool head is of improved design, having both automatic and hand feed which can be set to feed either up or down at any angle. Swivel is graduated so that the head may be set at any angle up to 90 degrees to right or left. The raising and lowering screw is provided with micrometer index collars, graduated in thousandths. The wear on the tool head slide is taken up by means of a taper gib which is also used for clamping the head when cross feeding.

The down feed mechanism is provided with nine changes of feed and can by a convenient crank handle be instantly stopped or reversed. It is provided with an automatic throw-out which disconnects the feed in case of over travel of ram and is also equipped with friction washers which slip in case of obstruction or overrun of tool slide.

The drive is direct from the line shaft or constant speed 15-h.p., 1,200-r.p.m. motor through single pulley and twin disc clutch to gear box built right into the machine containing heat treated nickel steel gears. The driving pulley is mounted on the opposite side to the operator but the main feature is that all speed changing, start, stop and brake operating levers are on the operating side of the machine, the latter being extended along the side of the shaper to operator's working position, to give him perfect control of the ram when tool setting. The rocker arm and bull gear are placed directly in the line of the cut and the rocker is attached to the ram by a double link which ensures an even motion and further eliminates the tendency of the rocker to lift the ram at the beginning of the stroke, and also neutralizes the upward thrust of the tool. The eight speeds provided give a range from six to one hundred strokes per minute to the ram.

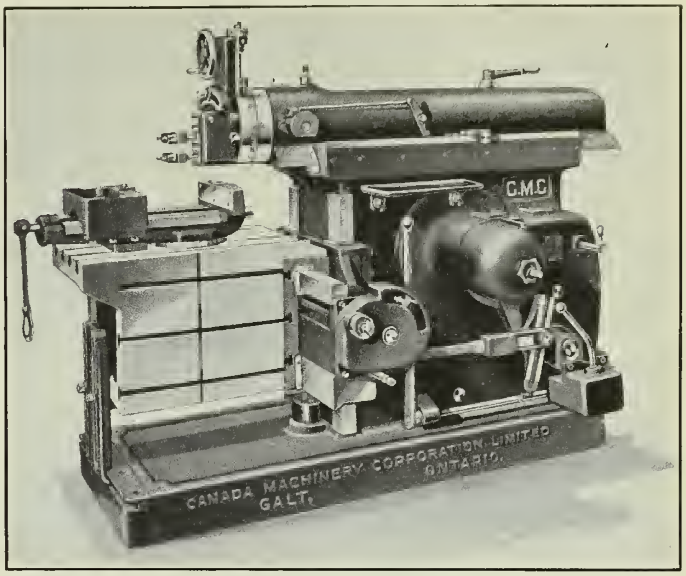

Fig. 2—Heavy Duty Crank Shaper.

A 35-ton power press was on view. This is intended for heavy duty; weighs 4,400 pounds and is operated by a 3-h.p. motor, either a belt or motor drive can be supplied.

In woodworking machinery a 43-inch revolving bed sander fully motorized was of interest. This was equipped with individual motors on each drum, the first two drums revolving at 1,200 r.p.m. and having 12-h.p. motors, the third revolving at 1,800 r.p.m. and having a 7½-h.p. motor. The shafts of these drums rotate in ball bearings of the self-aligning spiral type. The bed is 43 inches in width having a full rubber surface. The feed is by an independent 3-h.p. motor and the first reduction is by a V-belt drive through a gear box giving three rates of feed. The control is by push button.

The Sandilands Valve Manufacturing Company of Galt, a subsidiary of the Canada Machinery Corporation, were also exhibiting on this stand and displayed a 1½-inch, 150-pound pressure regrinding bronze gate-valve, which they claim effectively overcomes the high cost of maintenance while retaining every commendable feature of the gate valve, in that it can easily be reground without removing it from the line in precisely the same manner as a globe valve, and without the use of any special tools. This is made possible by a solid wedge type disc similar to the frustrum of a cone.

Canadian Atlas Steels Limited

Canadian Atlas Steels Ltd., of Welland, Ont., exhibited a large range of the finer types of steels from fine machinery steels to rapid cutting alloys. Also "No-Kor-O" stainless steel which is a low carbon ferrous metal containing 8 to 10 per cent nickel and 18 to 20 per cent chromium and having a specific gravity of 7.6. In addition there were various sizes of hollow mining drill and hollow stay bolt steel.

Canadian Blower and Forge Company Ltd.

Unit heaters, ventilating fans, blowers and air filters made up the largest portion of the exhibit of the Canadian Blower and Forge Company, Ltd., of Kitchener, Ont.

Among the more outstanding was a No. 300 Highboy unit heater, with electrically controlled damper. This is operated by a one-h.p. motor and with five pounds of steam pressure, and the entering air at 60 degrees F., gives 300,000 B.t.u. per hour and is designed particularly for the heating of industrial plants.

A 5½ E electric blower for industrial oil or gas furnaces and combustion systems was on exhibit. This is driven by a one-h.p. motor and has a maximum capacity of 1,000 cubic feet of air against 3-inch static press.

Also "Compact" and "Krimpak" air filters for use with various types of commercial equipment where filtered air is required. The manufacturers claim a rating of 800 cubic feet per minute each for standard "Krimpak" units 20 inches by 20 inches, with the initial resistance of 10 inches water gauge—this for average conditions.

Canadian Carborundum Company Ltd.

Carborundum brand silicon carbide and alonite brand aluminum oxide grinding wheels and discs of various grades and grits and shapes were on exhibit by the Canadian Carborundum Company Ltd., of Niagara Falls, Ont., from which some idea may be obtained of the large number of uses for which grinding materials may be employed.

Canadian S K F Company Limited

The Canadian S K F Company exhibited various sizes and types of ball and roller anti-friction bearings. Models of C.N.R. locomotive 6100 with tender and C.P.R. locomotive 2335 with tender and two cars, gave an opportunity to show the application of spherical type roller bearings to railway rolling stock and indicators pointed to places on these models where S K F bearings were used on the actual equipment.

Combustion Engineering Corporation Ltd.

The C.E. fire-tender stoker of which we reproduce a photograph, Fig. 3, was an exhibit of considerable interest by the Combustion Engineering Corporation, Ltd. It is a simple, rugged mechanical stoker, manufactured in Canada to their design, which automatically feeds coal to a boiler furnace by the underfeed method. It is an electrically operated, self-contained unit which consists primarily of a coal hopper, a conveyor screw, an electric motor and a variable speed gear case, a forced draft fan, air tuyeres and dead plates.

The operation is simple, the coal being fed from the hopper to the retort by means of a screw which operates in a barrel within the air duct. Air supplied by the fan is controlled by a butterfly damper and enters the air chamber supplying the air for combustion uniformly into the four sides of the fuel bed through the tuyeres. The dead plates accumulate the ash which is worked over on to them by the underfeed agitation of the fuel bed. The motor is direct connected to the fan and operates the conveyor screw through a six-speed gear case. Any of the six rates of coal feed may be obtained through adjustment.

A standard automatic control supplied with each stoker maintains uniform operation of the boiler at any desired steam pressure or water temperature. The unit on exhibit develops 150 h.p., consuming 600 pounds of coal per hour, and a 3-h.p. Lincoln motor, 550-volts, 1,500-r.p.m. drives a Sheldon forced draft fan and the screw conveyor through a silent chain drive.

The stoker body can be shipped completely assembled ready for placing under a boiler. The entire stoker is self-contained and all parts of the stoker under the furnace are supported by the air chamber casing. The dead plates rest on heavy ribbed transverse bars, also supported by the air chamber casing.

This stoker has been designed for firing small boilers ranging in size from 15 to 100 B.h.p. such as are found in apartment houses, schools, factories, etc., and can burn cheap grades of fuel efficiently.

Delamere and Williams Limited

Delamere and Williams Limited of Toronto, automatic machinery designers and manufacturers, displayed bottle fillers and washers, and in operation, a mixer. a "Vacu" draft blower and a conveyor table with conveyor belt in centre. This type of conveyor table with a conveyor belt running down the centre operated by a small electric motor, is exceedingly useful in general assembly plants and packing houses for facilitating the handling of equipment. This firm also manufactures a large range of testers, cutters and weighing and packaging machines for all kinds of materials.

Dominion Bridge Company Ltd. and Associated Companies

The Dominion Bridge Company exhibited an interesting example of the Kane System of Composite Construction which it is claimed combines the advantages of steel frame structures with the economy of reinforced concrete construction in buildings where welded steel construction is used. It consists of a structural frame of either built-up or rolled columns and welded trusses designed to carry the construction loads but which, when fireproofed with concrete, acts as a reinforcing and results in a composite structure in which both the steel and concrete act together in supporting the superimposed loads. This struction can be used with any type of floor system and owing to the use of built-up members, all material is obtainable from Canadian mills. Fig. 4 gives an example of this type of construction. It lends itself to economical and flexible construction in the field and facilitates the placing of piping through the use of the open web type of steel joists and floor girders.

Another display was a gear and pinion of a type now standard and manufactured by this company; that is, a pinion with a tooth having a long addendum meshing with a gear having a tooth with a short addendum. This tooth form is a correction of the 20-degree involute equal addendum type making it suitable for cranes, and other machinery handling heavy loads. The gear centres are standard with the equal addendum type.

Among the advantages claimed for this type of gearing is that there is no undercutting of the teeth and a thicker and stronger section is obtained at the base. Pinions with twelve teeth are as strong as those with twenty-three teeth of the equal addendum type and when operating the teeth roll on each other with a minimum of slip.

Also to be seen was a 10-ton electric travelling crane, the hoist operated by a 7½-h.p. motor and the drive by 2-h.p.

The display of the Dominion Engineering Works, Ltd., consisted of samples of a few of the many lines manufactured by them, a Farrell Sykes reduction gear, type S-15, ratio 8.3 to 1 with continuous herring-bone teeth, a five-inch Larner Johnson hydraulic valve manufactured to the patents of I. P. Morris de la Vergne, and a Dominion gearflex coupling , designed for 500 h.p. at 100 r.p.m. Also test models of a Francis turbine runner, an adjustable blade propeller type turbine runner, and a propeller type.

Canadian Pipe and Lining Company, Ltd., exhibited a section of 42-inch pipe manufactured in Canada at Montreal according to the Hume process, W. R. Hume, an Australian, being the inventor. This is welded steel pipe with the interior lined with concrete applied by centrifugal action and the exterior treated to resist corrosion. This is used for carrying water supplies under high pressure and has the advantage of not being subject to interior and exterior corrosion in

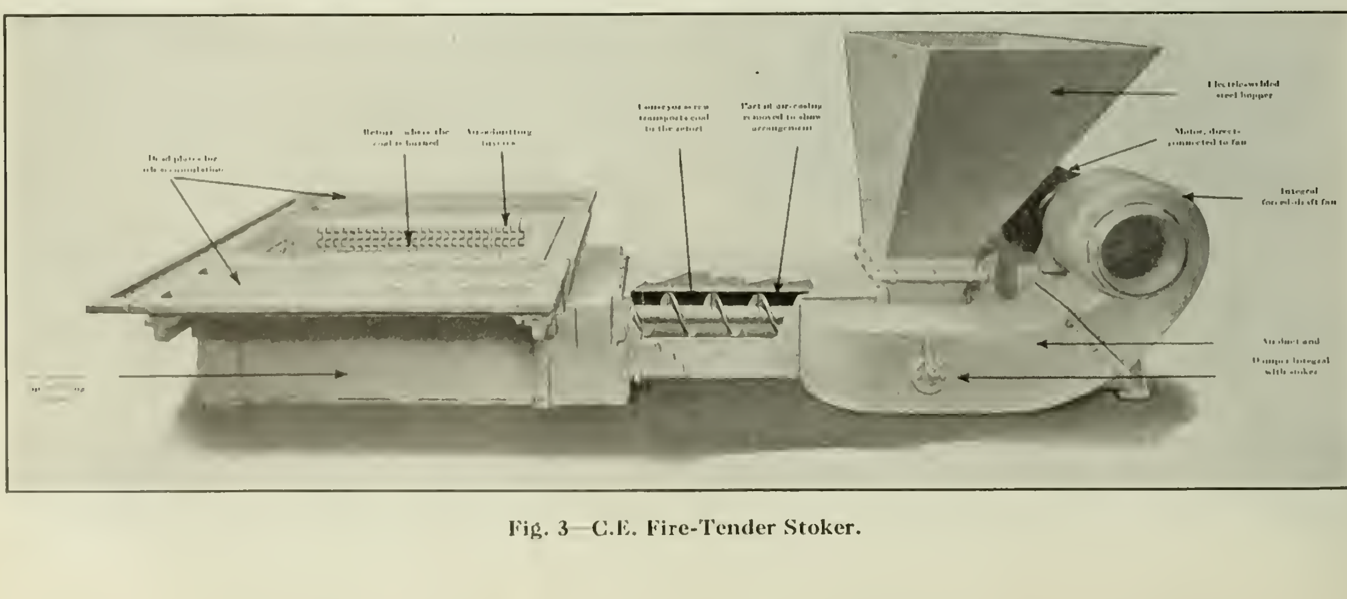

Fig. 3—C.E. Fire-Tender Stoker.

the same manner as steel pipe. An important feature of this pipe is the expanded reinforced faucet, an example of which is shown in Fig. 5 and which is believed to be more efficient than the usual type of joint.

The Dominion Hoist and Shovel Company Ltd. had on view a 1-yard gopher shovel crane as a sample of the excavating and materials handling equipment which they manufacture at Montreal. This is adaptable for shovel, crane, hook, clamshell or dragline work and can be operated by gasoline, electric or Diesel motors, approximately 85 h.p. being necessary. The weight is about 65,500 pounds, the continuous chain treads are of cast chrome steel and of the multiple hinge type, fully enclosed bevel gears drive across shaft which drives the tread sprockets by means of roller chains. The control is from an all-steel cab and all machinery rollers, shafts, etc., are of exceptional quality.

Manitoba Bridge and Iron Works Limited, of Winnipeg, were showing a Canadian Fire-King automatic stoker which they are now manufacturing. This is designed to burn Canadian slack coal and screenings and is built in eleven sizes from 10 B.h.p. for the home to a heavy duty unit for 500 B.h.p. boilers. They are built with the intention of competing against oil burners gas furnaces and central steam heat and large savings in fuel costs are claimed.

It is the underfeed type of stoker, the coal being fed to the retort by a spiral feed worm. The electric motor which drives the worm also operates a forced draught fan which delivers the proper proportion of air to the fuel bed. A variable speed drive is used, automatic controls provide a constant pressure or temperature under all conditions.

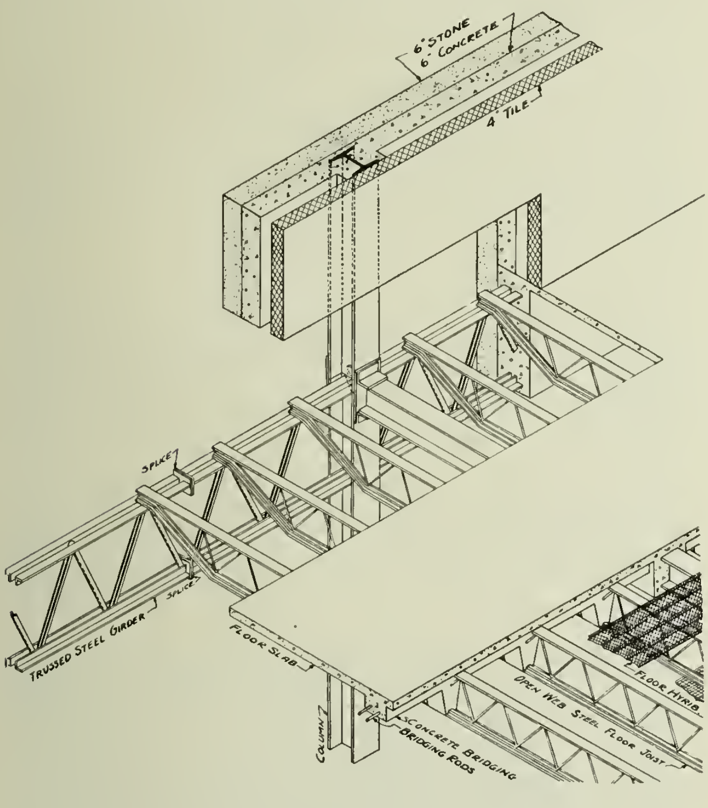

Fig. 4—Kane System of Composite Construction.

McGregor-McIntyre Iron Works Ltd., of Toronto, had on view samples of steel railings, stairs and safety gratings manufactured by them. These are for use in various types of buildings and industrial plants.

Robb Engineering Works, Ltd., of Amherst, N.S., exhibited two "Victor" boilers manufactured by them and of a type designed either for steam pressure up to 15 pounds per square inch or hot water heating, and constructed of steel with electrically welded seams. The two types can each be equipped for either hand, stoker, oil or gas firing. These are built in sizes from 74 square feet to 2,658 square feet of boiler heating surface and may be used for domestic or industrial use.

Elliott and Whitehall Machine and Tool Co.

Drills, dies, jigs and fixtures, small tools and parts, mining machine parts, gauges and air valves, were displayed by the Elliott and Whitehall Machine and Tool Company of Galt, Ont., who manufacture a fine range of equipment in these lines.

Ferranti Electric Limited

The display by Ferranti Electric Limited consisted of samples of their large range of standard watthour meters and instrument transformers, also a neon sign transformer, the core and coils of a 300-kv.a. transformer and cross section of the core and coils of a pole type transformer manufactured in Toronto, Ont. The new hand hole cover which is now standard equipment on distribution transformers was being shown for the first time, and prevents the necessity of removing the top cover of a transformer when changing taps.

A compact instrument which appeared in this booth was the Clip-on-Ammeter, see Fig. 6, which affords a quick and convenient method of measuring the current in any A.C. leads of bus bars without disconnecting them for the insertion of the usual current transformer or ammeter leads. This consists of a split-core current transformer, the primary of which is formed by the conductor whose current is to be measured. The secondary is connected to a high grade damped Ferranti 2½-inch dial milliammeter with a 2½-inch, 110-degree scale calibrated for direct reading in amperes.

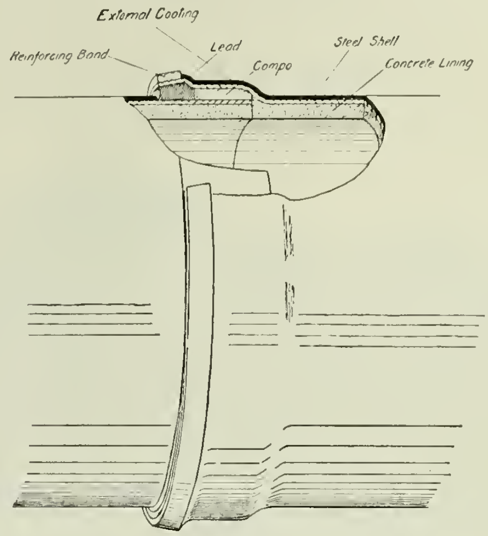

Fig. 5—Section Through Hume Pipe Joint.

The operating handle is well insulated from the core legs of the current transformer and is tested to withstand 15,000 volts from the handles to a bare copper bar placed within the core and adjacent to the coils, but the instrument is not intended for use on circuits above 600 volts without the use of rubber gloves. A conveniently placed trigger for opening and closing the core enables the instrument to be used with one hand. The core is self-aligning and is insulated to minimize the danger from accidental contact with live conductors. The maximum overall dimension of cable which can be accommodated is two inches.

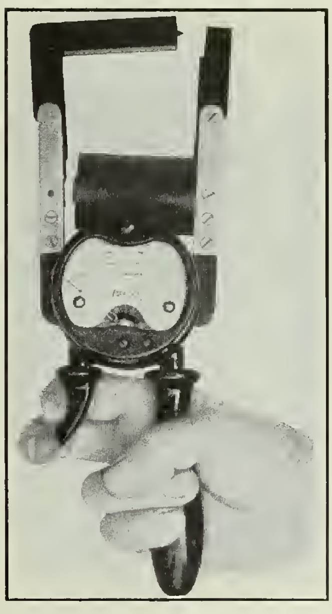

Fig. 6—Ferranti Clip-On-Ammeter.

A switch on the meter changes the reading from the 0-100 ampere scale to the 0-500 ampere scale or vice versa.

There was further shown summation metering equipment of the type being used on the English Grid system, eight sources of power being recorded separately and totalized.

WILLIAM AND J. G. GREEY LIMITED

A large number of machines for the paint and ink industry, bakeries and also grain working machinery was to be seen on the stand of William and J. G. Greey Ltd., of Toronto, Ont. Among those included were a number of ball mills, the largest being 60 by 60 inches, pony and laboratory mixers and stone paint mills, all for paint manufacture. Grain cleaners, crushers and grinders were included in the display of grain working machinery. This equipment all being manufactured by the above company.

HAMILTON GEAR AND MACHINE COMPANY LTD.

An interesting exhibit of gearing was on display at the stand of the Hamilton Gear and Machine Company, Ltd., of Toronto, Ont., and this included cut gears and pinions of various types. A high speed herringbone gear drive, speed reducers of the worm, herringbone and spur type, rawhide and Celeron silent pinions and flexible couplings for many uses. There was also an example of the Hamilton-Ramsey silent chain drive.

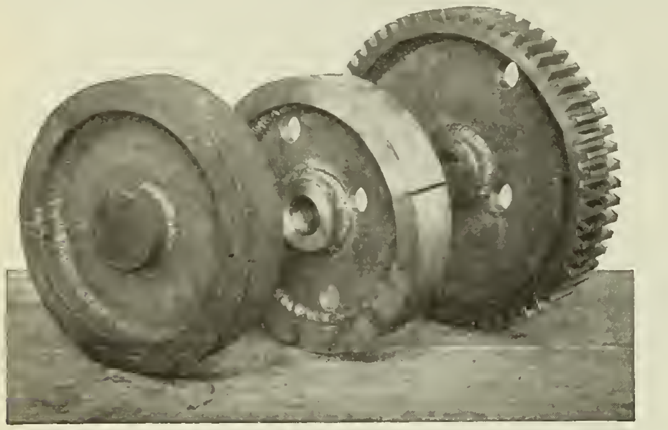

Fig. 7—Three stages in the manufacture of a Roldweld Speed Gear.

A new feature on the stand was the Roldweld spur gear, the rim of which is formed in a hydraulic press from a rolled bar of .45 per cent carbon steel. This material is rolled from selected and chipped billets of forging quality steel. The welding together of the rim, plate web and two hubs is by the metallic electrode process after which the assembled gear blank is heat treated to develop the best combination of strength, toughness and wear resistance. The result is a practically unbreakable gear.

Three stages in the manufacture are illustrated in Fig. 7. These gears are now being made in sizes up to 6 diametral pitch, a maximum face width of 2½ inches with a maximum of one hundred and thirty teeth.

JOHN T. HEPBURN LIMITED

An interesting piece of equipment exhibited by John T. Hepburn Limited of Toronto, Ont., was their 3-ton "Low Head Room" electric hoist for industrial plant use. This is designed and manufactured by them to give the maximum lift for the space available and for this size the standard hook lift is 24 feet, the hoisting speed 25 feet per minute, the motor required is 5 h.p. and the number of ropes, four. It can be made for either hand or electric travel.

The gears used are all machine cut from solid steel forgings and heat treated, the shafts are of steel and the fall block has ball bearing swivel for the hook, the sheaves are at each end of the centre piece and a cast rope guide is placed over the sheaves on each side. The hoisting drum is of rigid construction and has right and left hand grooves to take the cable without overlapping.

The automatic holding brake works on a pulley mounted on the hoist motor shaft. By means of levers and a cam between the shoes it is released when the operator pulls the control lever and is applied when the control lever is released. The automatic mechanical brake is of the helix disc type and controls the lowering. The upper limit control is positive, being connected with the operating lever of the controller. On the controller, a return spring holds the operating lever in the off position, as soon as the operator releases the pull, the controller springs back to the off position. Timken bearings are used throughout.

Further exhibits were a power press of the inclined table type, belt driven with an adjustable table that can be inclined at various angles to accommodate different kinds of work. The portable sandslinger manufactured by J. T. Hepburn Ltd., as licensee for Canada of the Beardsley and Piper Company of Chicago, appeared to be a complete and flexible piece of equipment. This occupies a floor space of 15 feet by 4 feet, has an overall height of 12 feet, and weighs 9,500 pounds. It can be picked up by a crane and moved about a shop.

A number of pumps on exhibit included a vertical ram feed pump for marine or land service and a horizontal ram feed pump with mechanically actuated valves suitable for feeding boilers carrying high steam pressures. This latter pump had a steam cylinder of 8-inch diameter, a water ram of 5-inch diameter and a stroke of 12 inches. The capacity was 1,374 Imperial gallons per hour, it occupies a floor space of 24 inches by 84 inches, and will feed 457 boiler horse power. It is rated at 30 single strokes per minute, and weighs 1,150 pounds. The pipe sizes are steam 1 inch, exhaust 1¼ inches, suction 3 inches, and delivery 2½ inches. The steam cylinders have cast iron pistons fitted with self-adjusting rings and steel rods. The ram is also of cast iron, working in a brass sleeve. Valve seats are brass and pressed into a taper seating and secured by brass stops. These may be lifted out with the valves for examination and repairs without disturbing any pipe connection. A drop lubricator or force feed oil pump can be furnished.

JOHN INGLIS AND COMPANY LIMITED

John Inglis and Company Ltd., of Toronto, Ont. showed a Farasey asphalt mixer and sand dryer manufactured by them to the design of J. D. Farasey Company, Inc., of Cleveland, Ohio.

The mixer exhibited was of one ton capacity, with steam or air used for opening or closing the dump gate. The sand dryer weighed 15 tons and had a capacity of 70 tons per hour, with drying done by an oil burner. This is 66 inches in diameter and 24 feet long, and is principally used for drying and heating sand and stone for hot mix asphalt pavement. It is a self contained unit, that is, it is built on a sub-frame to which all driving mechanism is attached. A 100-h.p. motor is sufficient to drive the mixer, dryer and elevator.

A Bay City shovel of ⅜ yard capacity, manufactured in Canada, was also on display.

An exhibit of three sizes of "Supreme" domestic hot water boilers and one "Supreme" heating boiler provided examples of the large range of boilers of this type manufactured at the John Inglis plant in Toronto. As an example of a medium sized boiler of the domestic hot water type, this has a heating surface of 65 square feet and a grate surface of 5.7 square feet, a shipping weight of 2,250 pounds and under normal load has a capacity of 255 U.S. gallons of water per hour raised 100 degrees F. All are of flange steel construction and electrically welded, with single-tube pass, and the firebox and combustion chamber can be adapted for fuel oil burning.

A. B. JARDINE AND COMPANY LTD.

A. B. Jardine and Company Ltd. showed pipe threading tools and dies manufactured by them at Hespeler, Ont.

A new feature was a new one-die pipe threading tool adjustable from one inch to two inches, also a portable speedomatic one-half inch to two-inch pipe threading machine with receding die head, cut off head and reamer, and with attachable universal joint for cutting pipe to six-inch diameter. This is driven by a two-speed, one-third-h.p. universal motor but can be equipped with a one-h.p. gasoline engine.

H. W. PETRIE LIMITED

The stand of H. W. Petrie Limited contained a fine display of machine tools including a number of foreign make.

The new Capstan Lathe 5-B manufactured by Alfred Herbert Ltd., of Coventry, England, made an exceptionally fine display. The swing over slide covers 15 inches, the over cross side 8 inches and the feed bar capacity is 1⅝ inches diameter. The lathe as illustrated in Fig. 8 has several new features such as the patented covered slides. These

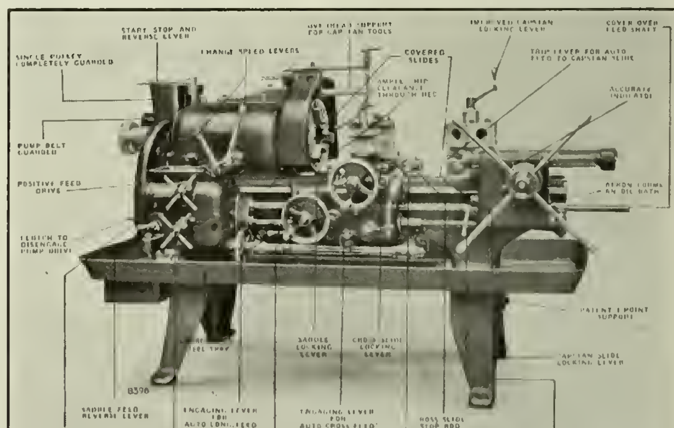

Fig. 8—Herbert Capstan Lathe.

are completely covered by the company's patented system by which the working surfaces of the slides are protected in all positions from chips, dirt, cooling fluid and from injury by dropping work or tools. The slide overs are in actual working contact with the surfaces, so that continuous lubrication of the sliding surfaces is secured. The spindle is provided with a flange to which the chuck can be bolted direct and the same spindle can be used whether the head is "plain," fitted with draw-in chuck, or with an air operated chuck. The single pulley head provides eight spindle speeds in either direction, obtained by sliding gears and friction clutches. The head forms an oil bath for the gears and bearings and all gears are of steel, hardened where necessary.

An improved feed box gives four changes of feed in geometrical progression to the longitudinal and transverse motions of the saddle and to the turret side.

The upper pilot wheel controls the capstan slide feeds, the lower one the saddle and cross slide feeds. The lever on the left-hand side of the lower pilot wheel reverses the saddle and cross slide feeds.

The shafts of the pilot wheels carry large, easily read dials showing the rates of feed in cuts per inch, the figure appearing at the top being the feed in use.

Each feed shaft has a safety clutch preventing injury to the mechanism should an excessive load be put upon it.

The traversing saddle has a loose apron of box form containing the mechanism for the automatic longitudinal and transverse feeds. The transverse feed screw is fitted with ball thrust bearings.

Balanced handwheels are provided to the longitudinal and transverse hand motions. Cross slide is of steel. Hand wheel has an adjustable index disc. Front tool post is of the swivelling, open side type. The back tool post is specially adapted for holding form tools.

The automatic rotation of the capstan can be disengaged when not required. Tool holes are relieved to facilitate easy insertion and removal of tools and to prevent wear in holes.

The capstan slide carries a hexagon stop bar geared to rotate with the capstan; the stops trip the feed and act as dead stops. The slide has a graduated scale with an adjustable pointer; the pilot wheel has an accurate indicator for obtaining lengths within fine limits.

Using a constant speed motor with direct or alternating current, the various spindle speeds, eight in number, are obtained mechanically in the headstock and this gives a range of spindle speeds for general work of from thirty to five hundred and eleven.

The range of spindle speeds can be increased and a very fine gradation obtained by using a direct current variable speed motor.

The control gear for direct current motors is of the enclosed, contactor type, with no-volt and overload releases, fuse and isolating switch. The control gear for alternating current motors is of the enclosed contactor type, with no-volt and three overload releases and isolating switch. With either type of control gear a push button switch arranged for "start" and "stop" is mounted on a bracket in a convenient position for the operator.

Also on exhibit were a Cadem Gap lathe manufactured in Belgium; a portable gasoline engine air compressor with capacity of 180 cubic feet per minute at 800 r.p.m. manufactured by Schram and Company, Westchester, Pa.; a five-foot radial drill manufactured by Sculfort-Fockedey, Vautier and Cie of France and motor driven, was equipped with five automatic feeds and eighteen spindle speeds. There was also a new Hako Rekord power hack saw. Others were a H. W. Petrie 30-inch pedestal band saw, equipped with ball bearings, a 16-18 inch geared crank shaper, manufactured by the Peerless Machine Tool Company of Guelph, Ont., also a combination saw and jointer, with 8-inch circular saw, a boring and routing attachment, and one moulder cutter outfit driven by a half-h.p. motor and manufactured by the Delta Specialty Company of Milwaukee.

Link-Belt Limited

Materials for elevating, conveying and power transmission machinery were on view on the stand of Link Belt Limited, and these consisted of various types and sizes of pulleys, chains, pillow blocks, hangers, a car puller, a bucket conveyor and a No. 1 Reeves variable speed transmission.

Powerlite Devices Limited

Powerlite Devices Limited of Toronto and Montreal featured an instrument panel containing miniature control units for A.C. and D.C. apparatus, using a new size of small rectangular instrument which has been developed to meet the trend of modern switchboard practice towards smaller control boards. These are manufactured by the Weston Electrical Instrument Corporation of Newark, N.J., and the units consist of vertical steel strips mounted with the necessary control instruments, a switch panel and a connecting panel. The strips are five inches wide, and of any desired length, spot welded to angle iron sides by means of which the several units are rigidly bolted together.

The unit assemblies are mounted complete with instruments, switch and connecting panels and completely wired ready to bolt together into a complete switchboard and connect to the external circuits. The instruments, switch and connecting panels are interchangeable in size and mounting. The units are also interchangeable in the complete board assembly.

Instruments of the flush type with flange fronts, four inches wide by four and a half inches high, and a body three and a half inches square projecting through the rack. The scales are three and a half inches long, wide open and legible. Inside the case two miniature 32-volt lamps with reflectors give full scale illumination with freedom from shadows.

The instruments known as Model 610 are made as D.C. ammeters and voltmeters, A.C. ammeters, voltmeters, single-phase wattmeters, polyphase wattmeters and reactive kv.a. meters. The movements are of the same size as are used in the large Weston rectangulars with the exception of the D.C. instruments, which are slightly smaller. The instrument insulation will withstand test voltages as specified by recognized standards.

Switch panels have either one or two switches, each equipped with three control lights, amber, red and green, for use in signalling the operator the condition of his controls. On the generator panels one switch may control the circuit breaker and the other the motor operated field rheostat. On feeder panels one switch may control the circuit breaker and one switch the electrically operated disconnector.

The connecting panel is the same size as the switch panel and instrument fronts and is usually located at the bottom of the rack or strip. The cover is removable from the front, exposing the terminal clips.

They also exhibited a motor-operated controller valve adapted for floating control designed especially for use on temperature control applications where steam is the heating medium, and manufactured by the Bristol Company of Waterbury, Conn., U.S.A.

A new recording seven-day triplex ammeter having three overlapping charts rotated by one telechron motor, which provides visual indication of balance of polyphase circuits, also their new portable duplex recording voltmeter, having two pens each recording on separate arcs the line voltage on polyphase circuits. Also on display was a new duplex controller for controlling the temperature of milk during the pasteurization process. This operates with the Bristol floating motor-operated valve, supplying the heating medium.

Redler Patents

Redler Patents, Sharpness, Gloucester (England), were showing samples of various types and sizes of conveying chains as used with Redler conveying systems, and a section of a 30-inch circuit chain designed to convey 210 tons of coal an hour at a speed of 25 ft./min. or 600 tons of wheat in the same time at a speed of 60 ft./min. These systems are designed to convey coal, wheat, flour, or any bulk materials.

In operation at the stand was a 5-inch Redler Circuit Elevator with H-link type chain conveying wheat. This type operating with a chain speed of 30 ft./min. can convey 5¼ tons of wheat in an hour. The circuit in this case consisted of a horizontal, a vertical and an included conveyor, the one continuous chain being used throughout.

An explanation of this system, which was first exhibited in 1924 at Wembley, should be of interest. First, however, it may be noted that the design consists of a light endless chain operated in a closed or open trough. The type of conveyor and chain varies with the material to be conveyed and may be divided into four classes: (*a*) where the

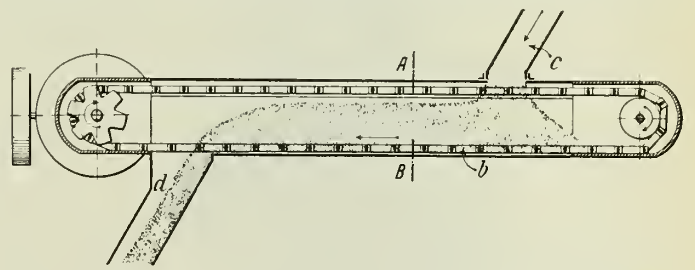

Fig. 9—Diagrammatic Section of Standard Redler Conveyor.

conveying member sweeps one side of the conveyor casing (for conveying horizontally); (*b*) where the conveying member sweeps two inner sides (for conveying horizontally); (*c*) where the conveying member sweeps three inner sides (for conveying up an incline); (*d*) where the conveying member sweeps four inner sides (for conveying vertically).

An example of (*a*) the Standard Redler is illustrated in Fig. 9. In this system the material is not carried bodily as with belt or bucket conveyors, but is induced to flow more or less of its own accord, a condition rendered possible by the friction between the particles of the material. A closed trough *A* forms the body of the conveyor and within this trough is a specially formed endless chain *B*. Material enters at *C* and falls upon the moving chain, the links of which become filled and generate virtually a ribbon of moving material. The remainder of the material rests upon this moving ribbon and is carried along by it. At the point where it is desired to release the material, it is only necessary to cut an aperture in the base of the trough and it will fall away freely through the links of the chain as at *D*. A slow speed of chain travel is adopted, and the material rides along in a body without agitation.

This type of chain, regarded as standard, is suitable for conveyors which are approximately horizontal. When the inclination exceeds the angle of repose of the material a different form of chain is adopted, for instance, to convey vertically the H-type of chain sweeping four sides of the enclosed conveyor is used.

The troughs or casings are constructed in wood and/or metal. The terminals are of simple construction and consist of special driving sprockets mounted on shafts running in dust-tight ball bearings. Reduction gear is either spur or bevel in a gear box and suitable oil bath. The position can be changed to suit any drive required or double reduction employed for direct driving by electric motor.

These conveyors are made in sizes of 3 inches upward to 17 inches and in the smallest size have a capacity of 10 tons per hour with a material weighing 100 pounds per cubic foot. The maximum chain speed is 60 ft. min. A conveying system of this nature has an advantage over many others where first a belt conveyor is used for horizontal movement and then a bucket conveyor to hoist the material vertically in that it obviates the necessity of switching from one type to the other, one continuous chain handling the material throughout the system.

Riley Engineering and Supply Company Limited

This exhibit well illustrates the lines of material handling equipment for factory and industrial use now manufactured by the Riley Engineering and Supply Company, Ltd., at Toronto, Ont., a firm well-known for their power plant equipment.

On display was a Barrett portable elevator. These hoists are manufactured in Canada, to the design of Barrett Cravens Company, U.S.A. They are made in the hand or electric operated types in the telescopic or hinged design, with either gearless or gear enclosed lift mechanism. Capacities range from 500 to 5,000 pounds, with lifts up to 20 feet. All are governor controlled, providing for a controlled descent of the platform. This in conjunction with a clutch on the electrically-controlled type enables the current to be cut off on the descent. Two lifting speeds are provided for loaded or empty platform.

The bearings in the gear shaft are integral with this housing, which makes certain that the bearings are at all times in alignment. The steel platform is removable.

The lifting speed varies according to the size and capacity of the motor and for a motor of ½ h.p. operates at 13 ft./min., for ¾ h.p. 20 ft./min., and 1 h.p. 27 ft./min.

These are exceptionally useful for industrial plants, warehouses, and storage rooms.

Also on display were a ½ and 1 ton "Reco" rapid hoist. These are of the chain block type and are manufactured in capacities up to 20 tons. The gears are of cut steel and the load sheave, driving pinion and gears are supported by S.K.F. bearings, eight in all, and there is also a Timken bearing to ensure easy swivelling. Alemite lubrication is provided.

In conjunction with this a light type of built-up monorail of improved design and new type switching system was to be seen.

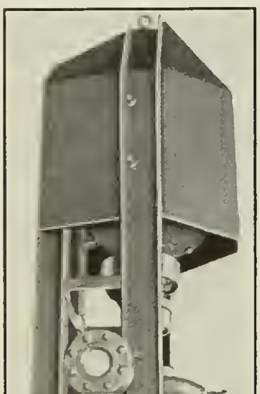

Fig. 10—Vertical Application of Centrifugal Pump.

N. Slater and Company Ltd.

N. Slater and Company Ltd., of Hamilton, Ont., exhibited a large number of specimens of stampings and forgings, also pole line hardware manufactured at their plant in Hamilton.

Smart Turner Machine Company Ltd.

The most interesting piece of equipment displayed on the stand of the Smart Turner Company Limited was a three-inch, multi-stage, double-suction, horizontally split shell, centrifugal pump, used vertically as in Fig. 10.

This pump is built into a steel framework supplied with a lifting eyebolt and the unit is designed so that it may be hung from a cable and operated in any position, vertical or horizontal, and is suitable for mine sinking, well-boring, pumping out excavations, etc. Special precautions have been taken to protect the motor from moisture or water splashing from the walls of a shaft.

Also in operation was a new type domestic water supply pump of capacity of 300 Imperial gallons per hour at 40 pounds pressure, driven by a Westinghouse ¼-h.p., 1,425 r.p.m., motor.

Further exhibits consisting of centrifugal pumps, an automatic cellar drainer, and a six-by six-inch double-cylinder air compressor were to be seen, also a steam-driven direct acting eight-by six-by twelve-inch vertical single-cylinder boiler feed pump, all equipment being manufactured by the Smart Turner Machine Company at Hamilton.

Toronto Technical Schools

The Toronto Technical Schools occupied eight booths and very ably succeeded in demonstrating the work done by the various departments of these schools.

Each booth was devoted to one department, such as art, aircraft, machine shop, metal work, modelling, printing, science and woodworking, and in each were displayed samples of the work done by students. A number of these departments had equipment operating.

A. R. Williams Machinery Corp. Ltd.

One of the largest exhibits of machinery was that of A. R. Williams Machinery Corporation, Ltd., with head office in Toronto, Ont.

The Association of British Machine Tool Makers Ltd. were well represented on this stand, with an exhibit of shapers and drills. Of interest was a crank shaper with an 18-inch stroke manufactured by the Butler Machine Tool Company Ltd., of Halifax, England. A vertical drilling machine manufactured by James Archdale and Company, Ltd., Birmingham, was displayed. This was designed for high production manufacturing duty. The head is a self-contained unit enabling the machine to be effectively arranged in gang form. The frame consists of a massive head casting bolted to a rigid well-ribbed box section column which in turn is mounted upon a pan type baseplate.

The drive to the spindle is by means of belt through fast and loose pulleys and a change speed gear box of the slip-on gear type. All the main transmission shafts run in ball bearings and hardened spiral bevel gears are used for the pulley bracket and for the spindle drive. The machine can be arranged for self-contained motor drive.

The spindle is of high carbon steel, and has six accurately ground driving splines machined from the solid. The drive to the spindle is through heavy duty hardened spiral bevel gears running in ball bearings. The spindle is carried in a hard steel sleeve provided with ball journal bearings and ball thrust washers at each end. The feed rack is cut integral with the sleeve, not bolted to it as in the case of some machines. The spindle speeds are changed by means of hardened steel slip gears.

Four rates of self-acting feed motion are available through the feed box on the head of the machine. For repetition drilling of holes to a pre-determined depth, automatic trip motion is provided, the graduated disc having widely spaced divisions. In addition to automatic feed, quick hand traverse and fine hand feed are also provided.

Under test conditions the machine will drill a 1¼-inch diameter hole in mild steel at a penetration rate of 7 inches per minute, or a 3-inch diameter hole at a penetration rate of 1¼ inches per minute.

The "El Champion" spot and projection welding machine, manufactured by The Taylor-Winfield Corporation, Warren, Ohio, appeared on this stand and is capable of welding two pieces of ¼-inch stock on slow speed with the large size transformer. On projection welding it is capable of welding five projections in an area of seven square inches of 1/16-inch stock at slow speed or lighter stock at correspondingly higher speeds. The transformer capacity of this machine is 20 to 60 kv.a. on 50- or 60-cycle current. Fifteen to thirty kv.a. on 25- to 30-cycle current.

This machine is furnished with a 1-h.p. constant speed motor; however, if desired, a four-speed constant torque multi-speed motor may be furnished.

The four-speed control for this motor, together with the stop position, is incorporated in the base of the machine and operated by a hand-wheel.

The speed at which the machine operates has a direct bearing on the thickness of stock which can be welded.

The operating head is actuated by cam through toggle action which gives a very smooth quiet movement. The slides are 12 inches long with take-up gibs for alignment and wear. There is also a visible water flow connection in full view of the operator at all times. The lower arm has an adjustment up and down of 5½ inches, permitting adjustment up and down by the adjusting nut plainly in view at the bottom of the pedestal on front of the machine. It is equipped with an eight-step selector switch and the clutch and transmission are totally enclosed in the housing of the machine and running in oil continuously.

The contactors are mounted in the base of the machine out of the way of all danger as a safety feature, but are readily accessible by removal of the perforated metal guard for adjustment or inspection.

Another exhibit in operation on this stand was an 10-B.h.p., 1,200-r.p.m. type 1 HK 60 Junkers vertical single cylinder opposed piston Diesel engine, manufactured by Junkers Motorenbau of Dessau, Germany.

A single type is illustrated in Fig. 11 with outer casing partially removed.

A similar type of engine is suitable for various kinds of industrial, agricultural and marine work and belongs to the solid or airless injection type of Diesels. Spray atomization of the fuel by injection with an open nozzle, opposed pistons, and the absence of valves as well as cylinder heads form the characteristic features of the Junkers engine which thus differs fundamentally from all other designs of Diesels.

The two pistons of a pair always work in opposite directions. The space between their faces and the cylinder liner forms the combustion chamber. The upper piston controls the admission of air for combustion by opening the upper scavenging ports, whilst the lower one, which opens the exhaust ports, controls the escape of the waste gases after combustion.

In the outer dead-centre position, the exhaust and scavenging ports are open. The pistons enclose fresh air. As they approach each other, they compress the air and raise it to the temperature needed to ignite the charge.

In the inner dead-centre position, the fuel pump injects fuel into the hot air charge through an open nozzle as a well-atomized spray. The fuel ignites at once and spontaneously. Forced apart by the gases of combustion, the pistons impart motion to the crank shaft

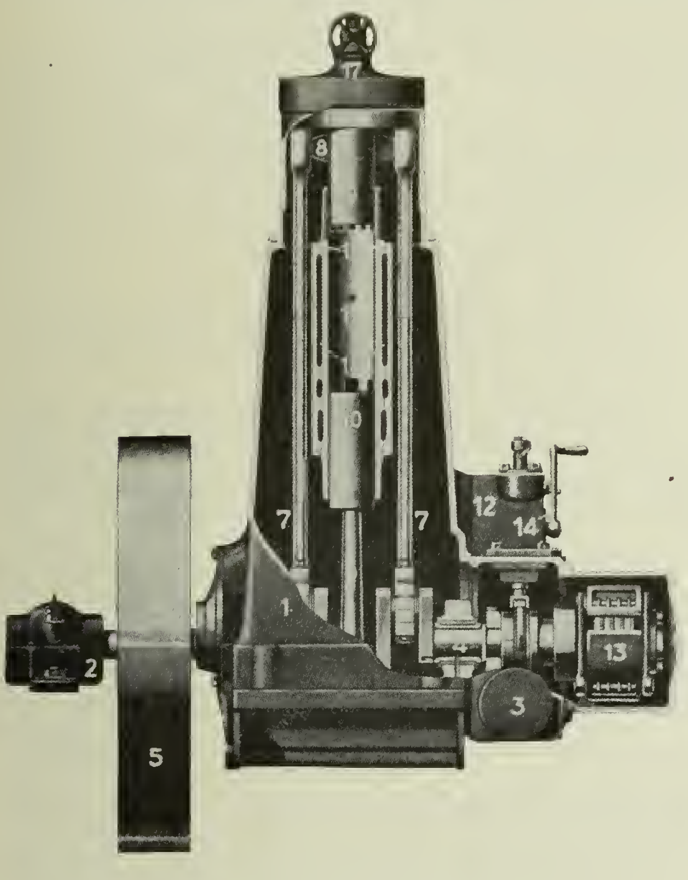

Fig. 11—Junkers Diesel Engine.

1, Frame; 2, Outer bearing; 3, Oil pump; 4, Crank shaft; 5, Fly-wheel; 6, Connecting rods under compression; 7, Connecting rods under tension; 8, Cross-head; 9, Upper piston; 10, Lower piston; 11; Cylinder; 12, Fuel pump; 13, Shaft regulator; 14, Starting lever; 15, Injection nozzle; 16, Scavenging pump; 17, Starting air-pump; 18, Water jacket.

through the pressure and tension connecting rods. Just before the working stroke ends, the lower piston opens the exhaust ports, allowing the waste gases to escape. This is followed by an upper piston opening the scavenging ports. The air previously compressed by the scavenging pump piston rushes into the cylinder, expels the remainder of the burnt gases and then fills the cylinder on the lower piston having shut off the exhaust ports.

As given by the makers the fuel consumption for test runs at full loads amounts to about .350 pounds of oil per B.h.p. hour.

The engine is enclosed in a cast iron housing, automatic lubrication of the entire engine is provided by oil pump (3). Pistons are provided with patent oscillating oil cooling. Cams on the crank shaft drive the fuel pump (12) which at the same time controls the whole process of injection.

The fuel-pump cams are controlled by the shaft governor. The latter instantly adjusts the delivery of fuel according to the momentary requirements and thus keeps the speed of the engine constant. The speed drop from idling to full load is no more than about 3 to 5 per cent.

The shaft-governor can be supplemented with a hand lever which permits of altering the speed of the engine by hand while running. With the aid of the hand-operated speed control gear the number of r.p.m. may be cut down to about 30 per cent of the normal amount.

The fuel-pump is combined with the control gear for starting, stopping and feeding fuel to the nozzle prior to starting. All these operations are performed with a single, positively-acting starting lever.

The starting air-pump is fitted above one of the scavenging-pump cylinders only. Its object is to replenish the compressed-air contents of the starting flasks after the engine has begun to work. As soon as this is finished, the starting air-pump should be changed over to idling when it consumes no further useful work. Engines of small output are started by hand, using a starting crank for the purpose.

Cooling is effected with water supplied either by a geared pump included on the engine itself, or by a plunger pump driven off the engine shaft; as a third alternative the water may be taken from an elevated tank. The cooling water traverses the engine from the bottom to the top, circles round the cylinder and the fuel injecting organs, and finally leaves the engine again at the top of the cylinder after passing through a control device.

Also included were a Universal No. 2, portable pipe cutting machine, manufactured by the Peerless Machine Company of Racine, Wis., various types of woodworking machinery including band saws and drum sanders manufactured by Heath Machine Company of Philadelphia, and four sizes of tool-room lathes manufactured by the South Bend Lathe Works of South Bend, Ind. The smallest of these had a 3-foot bed and a 9-inch swing, and the largest a 6-foot bed and a 16-inch swing. All were equipped with four speeds and a quick change gear, a new feature being that all were motor driven with the motor in the base of the machine.

A quadruple combination punch, plate shear, bar angle, tee cutter and notcher was in operation and appeared most efficient and capable of handling a large variety of work. This was manufactured by David H. Smith and Sons, Inc., of Brooklyn, N.Y., who also displayed a motor driven bending machine for rolling angles, tees, beaver channels, and a variety of other shapes, cold.

Completing the exhibit was a straight line edger manufactured by the White Woodworking Machinery Company of Paisley, England. A combination tool which included an 8-inch circular saw, 14-inch band saw, a lathe bed of 4 feet and 10-inch swing, a boring and mortizing attachment and shaper also a 6-inch joiner operated by a ½-h.p. motor and manufactured by the Woodworking Machine Company of Philadelphia. A full line of small drills, hack saws and a pedestal grinder manufactured at Preston, Ont., by the Williams Tool Corporation.

Williams and Wilson Limited

A number of machine tools were in actual operation on the stand of Williams and Wilson, Ltd., Montreal and Toronto, such as a 6-inch "Rapiduction" pipe threader, a new feature of this being the automatic opening die head, also a 2-inch Willie Williams Pipe Threader, both manufactured by the Williams Tool and Machine Company of Brantford, Ont. In addition, a 21-inch Corona drill was in operation, equipped with two spindles and pickoff feed and speed gear changes, each spindle driven by a 2-h.p. motor, manufactured by F. K. Pollard and Company of Leicester, England.

A Firth "Hardometer" was on display. This is a new hardness

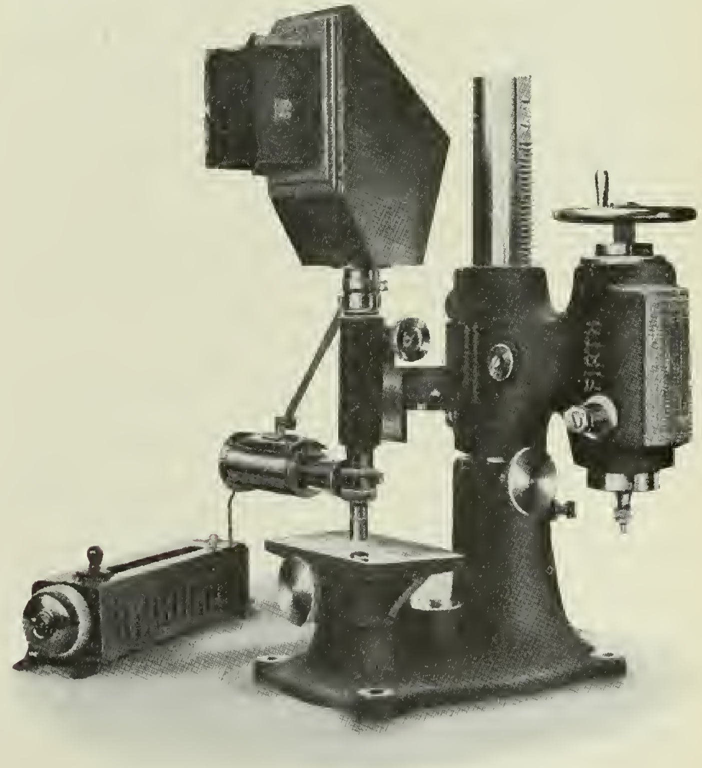

Fig. 12—The Firth Hardometer.

tester manufactured by Thos. Firth and John Brown Ltd., of Sheffield, for testing departments and covers a wide range of hardness testing requirements. This is illustrated in Fig. 12, and the principle embodied in it for determining the hardness of metals is similar to that of the Brinell machine in which a hard steel ball is pressed, by means of a known load, into the specimen to be tested, the hardness being determined by measurement of the impression. Owing to the limitations of the hardened steel ball when testing the harder materials, a pyramidal diamond indenter is recommended and can be supplied with the machine in addition to the hardened steel ball.

The hardness numbers are obtained by dividing the load in kilogrammes by the area of the impression in square millimetres, and this rule applies both in regard to the steel ball and the diamond indenter. In the latter case the hardness numbers obtained should be referred to as the diamond hardness numbers.

The microscopic method of measurement has been adopted rather than the direct dial reading for the following reasons:

(*a*) The direct dial indicator is governed by the depth of impression, which is only from one-eighth to one-sixteenth of the diameter or diagonal of the impression.

(*b*) As the checked microscope reading remains fixed, it is more reliable than a mechanical measuring device which is called upon to function on each reading made, the sensitiveness of which must be from eight to sixteen times as great as the microscope to achieve only the same result.

(*c*) Compression of grease and dirt below the piece being tested has no effect on the reading.

The applied load is spring-controlled and this method was adopted in order to overcome the effect of inertia which is so common a trouble in machines employing the dead-weight or lever principles.

The low stress and the limitations of the stress of the spring are such that no discrepancy is to be feared over a long working period.

The maximum space between the face of the anvil and the head is 8 inches unless otherwise specified. This distance determines the maximum thickness of material which can be tested. The distance between centre of indenter and face of pillar is 3⅞ inches.

On repetition work, readings can be taken at the rate of over 100 per hour on the type "D2" machine. The scale of impression diameters and Brinell hardness numbers corresponds exactly to that of the 3,000 kg. 10 m/m ball Brinell machine.

The type "D2" machine with 30 kg. load cylinder is 19 inches in height, weighs 67 pounds and occupies a bench space of 12 inches by 12 inches, and is complete with microscope, which is equipped with a micro-projection head—this head causes a magnified image to be projected on a screen and allows the operator to use both eyes.

Also on exhibit a 32-inch "Insto" Firth segmented cold saw of new design with inserted tooth segments.

A feature was the operation of a 16-inch 16-speed Monarch lathe with a 5-foot bed manufactured by the Monarch Machine and Tool Company of Sidney, Ohio, and fully equipped with Timken bearings and helical gears.

All Timken bearings are guaranteed to tolerance limits of .0002 inch, and are tested for accuracy by the Monarch Machine Tool Company before being mounted in headstocks. Bearings lapped to tolerance limits of .0001-inch are used in precision tool room lathes.

The Timkenized spindle never has more than .0001 inch end movement. The radial error is never more than .001-inch at a distance of 20 inches from spindle nose.

Noiseless operation, accuracy and absence of wear are claimed by the makers through these features. The drive is a 5 h.p. motor and belt with motor mounted in the leg of the lathe.

RECENT ADDITIONS TO THE LIBRARY

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Liverpool Engineering Society: Transactions, Vol. 52, Fifty-seventh session.

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503: Accidents at Metallurgical Works in the United States during the Calendar Year 1929.
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339: Petroleum Refinery Statistics, 1929.
340: Relationship between Oxidizability and Composition of Coal.
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Prime Movers' Committee, Engineering National Section: Pulverized Fuel.
Foreign Systems Co-ordination Committee, Engineering National Section: The Effects on Noise Frequency Induction of Grounded Neutral Generators.

Technical Books, etc.

Presented by Babcock-Wilcox & Goldie McCulloch, Ltd.:
Steam, Its Generation and Use. [383 pp.]

Presented by National Research Council of Japan:
Reports of Radio Researches and Works in Japan, Vol. 1, No. 1.

Presented by Universal Oil Products Company:
Man Beats Nature on Anti-Knock Gasoline from California Crude, [22 pp.]—Reprinted from Petroleum World and Oil Age, Dec. 1930.

Catalogues

Jones & Laughlin Steel Corp., Pittsburgh:
J. & L. Steel Piling: Bulletin B. [23 pp.].

National Sewer Pipe Company, Ltd.
Salt Glazed Vitrified Clay Liner Plates [16 pp.].
Your Town Needs a Sewer System [12 pp.].

Joerger & Fitzroy, Montreal:
Diesel Engines with Airless Fuel Injection. Type GVu [24 pp.].

BOOK REVIEWS

Engineering Materials

Vol. 3: Theory and Testing of Materials

By Arthur W. Judge. Pitman & Sons, London, 1930, cloth, 5¾ x 8½ in., 498 pp., illus., figs., tables, $6.00.

G. J. Dodd, A.M.E.I.C.*

This volume is a thoroughly revised and extended account of the section of the author's Aircraft and Automobile Materials, Vol. 1, Ferrous; dealing with the theory and testing of materials.

The author devotes two chapters to stress, strain and elasticity and the properties of materials under test. He gives but does not derive all the formulae necessary, assuming that the reader is familiar with their derivation. He discusses their application to testing generally and in many cases in particular.

The third chapter is devoted to the testing of cast iron and contains a description of the Brico piston-ring testing apparatus and a comparison of test results made according to British and American Standards. Chapter IV deals fully with the effect of temperature upon the strength of metals.

Chapters V to X deal with failure of materials under test, modern theories of materials, the fatigue strength of metals, stress

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formulae for design work with an interesting discussion on factors of safety, impact tests and the hardness of metals and the methods of its determination.

Chapter XI describes modern testing machines and methods, and Chapter XII takes up testing machine accessories, such as shackles and grips, extensometers, etc. It omits a description of the Martens extensometer.

Chapter XIII describes the machines for testing hardness and abrasion, and Chapter XIV describes special testing machines, such as the Izod machines, the Cambridge impact machines, etc.

Chapter XV will be found the most interesting to the structural engineer as it describes methods of stress determination, such as by scale model tests for bridge stresses, by optical means using polarized light, by the use of Coker's lateral extensometer. It gives some typical cases of practical application, using the Polariscope method.

The book is well printed and very fully illustrated. The diagrams are pleasing and a great deal of valuable and interesting data is given concisely in a tabular or graphical form. More important are the references from which the information is gathered which would enable the reader to go to the original sources if he so desired. It should prove to be a valuable book of reference for engineers, and especially to those engaged in testing materials in laboratories. It brings the subject up to date and makes available in one volume a great deal of new information which has been found in the many and recent researches which have been undertaken in the last thirty years.

Modern Aviation Engines

Vols. 1 and 2

By Major Victor W. Pagé. Henley Publishing Co., New York, 1929, cloth, 6 x 9 in., vol. 1, 997 pp.; vol. 2, 927 pp.; illus., figs., tables. $5.00 volume, or $9.00 set of 2 vols.

R. J. G.

In this book, which consists of two volumes of approximately 1,000 pages each, the author has collected a mass of information regarding aero engines both past and present. The preface states that it "has been prepared primarily for instruction purposes, and is adapted for students who wish to become aviators or aviation mechanicians, and for mechanics in other lines who wish to enter the aviation industry as experienced aviation engine maintenance and repair men." To complete this intention, each chapter concludes with a short questionnaire, which gives the student the opportunity for gauging whether he has thoroughly digested the contents of the chapter. The author has augmented his own experience by drawing freely from various sources of information, including the reports of leading engineers engaged in internal combustion engine research, national bureaux, and aero engine manufacturers, with due acknowledgment in each instance.

As the book explains the elementary principles and forms of internal combustion engines, and gives considerable space to early types, the word Modern might have been omitted from the title with advantage. There also appears to be too much extraneous matter and one gets the impression that a single well edited volume would have been better than the two volumes which form this work. Alternatively the size of each volume could have been reduced. Apart from these general criticisms, which are not intended to detract from its usefulness, the work contains a wealth of reliable information. The thorough manner in which the subject is discussed, and the various angles of attack, combine to make it one of real value to the student. The same factors and the full acknowledgment of all sources from which information has been extracted, also makes it valuable as a book of general reference for the more advanced enquirer who can supplement it by reference to the original authorities.

In addition to the description of general principles, and detailed design of practically all well known types and many lesser known types of aero engines, are excellent chapters on fuel and lubricating oil.

These chapters and the references they contain are recommended for study by many who pose as experts on aircraft engine operation.

Public-Spirited Engineers

The Cleveland Engineering Society has recently had an opportunity to show what a valuable service can be given the community by an organization of engineers. Cleveland holds its engineers and their society in high regard, an attitude that has been both demonstrated and intensified by recent events. In planning a long viaduct over the Cuyahoga river valley, the authorities were divided on the location of the eastern approach. The commissioners of Cuyahoga county, under whose auspices the bridge is to be built, requested the Regional Planning Division of the society to examine the merits of the two proposed plans and to make a recommendation as to the one to be chosen. In less than two weeks the committee appointed had interviewed the principal engineers and laymen especially interested in the improvement, had had its recommendation approved by the trustees of the society and had submitted its report to the authorities. A subsequent request by the county for a bill for the service was declined. Since much of the work of civil engineers is of direct social import it is not surprising that they should display in a marked degree a desire to be of public service. It is most gratifying that the officials in direct control of the public business of Cuyahoga county show that they appreciate the significance of that public spirit and the value of the service the engineers can render.—*Engineering News-Record.*

Power for Flight

An interesting memento of the early attempts at flying is contained in the following letters, one from the late Edward Dean Adams of New York, giving an account of his experiences when permitted to ride in the Maxim steam-driven flying machine in 1892; and the second from Hiram S. Maxim to Mr. Adams, describing the results obtained with that machine on the occasion when he became convinced that his engine could actually develop sufficient power to lift the machine it propelled.

New York, September 29, 1930

Mr. Alfred D. Flinn, Director,
Engineering Foundation

For your information I enclose a letter from Mr. Hiram S. Maxim. I visited Mr. Maxim at Baldwyn's Park, where he had his laboratory and his trial course for the flying-machine that he sought to build using steam created by the machine itself for the engine he had invented. The machinery was placed upon a platform of two stages, the lower one accommodating passengers. It was about ten feet wide and slightly longer, the wheels similar to railroad car wheels with a pronounced flange. There were two sets of rails, a lower and an upper, the upper one held with its face below, so that the wheels could also when lifted sufficiently run on the upper rail.

There was no brake to control the speed except at the end of the mile, where there were two capstans on each side of the rail, around which a stout rope was wound; both capstans revolved when pressure was brought upon the rope by the curved extensions on the front of the car for the purpose of catching the rope and restraining movement. Experiments had suggested for greater safety of the passengers the use of two additional capstans placed 15 feet beyond the first pair, and an additional rope was provided of considerable length that was expected to fully overcome the movement of the machine.

In order to determine to what extent, if any, the propellers had lifted the machine the rails were painted on the side of each rail that faced the other.

I rode in this machine standing and holding on to the cable guides attached to the second floor. Almost immediately after starting, my eyes began to water as I attempted to look ahead; we were very soon at the end of the line; the jaws of the machine caught each rope successfully and the speed was suddenly arrested. Not far from the terminal there was a grove of trees; you can well imagine as we approached this terminal that I was quite apprehensive that, if the ropes gave out the machine might plunge into or over the foliage before me.

Sincerely yours,
Edward Dean Adams.

Stonyhurst, Crayford, Kent, April 11, 1892

My dear Mr. Adams:

The experiments at Baldwyn's Park must have convinced those who witnessed them that it is really possible to get a grip on the air. One of the principal reasons which has been advanced why Flying Machines could not succeed was that it was not believed that the air was of a sufficiently resisting nature to get a hold on it. The last run at Baldwyn's was most convincing to myself. In this case, three-fourths of the whole weight of the machine was on the hind wheels. The wheels themselves were of solid cast-iron and of great weight. There was 600 pounds of water also 100 pounds of petroleum on the rear end of the machine to say nothing of from 15 to 20 passengers.

Nevertheless the machine actually ran away at railway speed dragging the hind wheels on the track, both wheels being locked to the axle tree. It was found that twenty men could not push the machine back into the shed until the track had been greased.

The two hind wheels had about a pound each of iron taken out of them in this run and will have to be re-turned.

The propellers were 17 feet 10 inches in diameter and 16-foot pitch. The pair which you saw in the house are of the same diameter with a mean increasing pitch of 24 feet. These will give a much higher speed.

You might have observed that the engines were only supported by light tubes and wires; still they were so well balanced, not only in weight, but the force of one cylinder is balanced against the other, that they ran very smoothy notwithstanding their high speed and the enormous quantity of power developed.

The steam pressure was 275 pounds to the square inch. The bursting pressure of the tubes of which the boiler is formed is about 2,000 pounds per square inch while cold, and by actual experiment were burst by generating steam in them, at a pressure of 1,750 pounds per square inch. Therefore you will see that the factor of safety is very high. So far the highest amount of power developed has been at the rate of one horse-power to every 7.14 pounds of motor complete, that is, including engines, pumps, casing about the boiler, propellers, smoke-stack, etc., etc. I think this is six or seven times as high as has ever been accomplished before.

I think I shall succeed unless there is some new factor which we do not understand, as Prof. Langley expresses it. Another question is the cost. If every step in these experiments takes as long as the development of the power did, it may be that my friends and myself may not be able to furnish the necessary cash to follow up the experiments to finality.

Yours very truly,
Hiram S. Maxim.

These letters are contained in a Research Narrative just issued by the Engineering Foundation, New York.

Preliminary Notice

of Applications for Admission and for Transfer

September 18th, 1931

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 1931.

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

COWIE—NORMAN CLAUDE, of Sault Ste Marie, Ont., Born at Espanola, Ont., Oct. 2nd, 1907; Educ., B.A.Sc., Univ. of Toronto, 1931; 1929 (summer), Algoma Steel Corpn., Sault Ste Marie, Ont.; 1930 (summer), elect'l. dfting, Algoma District Power Company, Sault Ste Marie; May 1931 to date, elect'l. engrg., design, dfting, estimating, constrn., etc., Algoma District Power Company and the Great Lakes Power Company, Sault Ste Marie, Ont.

References: A. E. Pickering, R. A. Campbell, C. J. Russell, F. H. Barnes, A. A. Rose.

SCHWING—HANS, J., of Montreal, Que., Born at Zurich, Switzerland, Dec. 3rd, 1903; Educ., Diploma of Civil Engineer, Swiss Federal Technical University, Zurich, 1926; Special course in hydraulics and design of water power plants during one semester; 1923-24-25 (vacations), practical training with Waggital Power Corporation and Furka-Oberalp Railway; June 1927 to Nov. 1928, Pennsylvania Rld. Co., Pittsburgh, asst. on divn. engr.'s corps. Design of rld. structures, studies of yard and station layouts, supervision of constrn. contracts, surveys, office and field work; 1929 (Jan.-July), with Lonza Power Corporation, Brique, Switzerland, supt. in charge of constrn. for extension to sand deposit plant at central electric station; Aug. 1929-May 1930, surveys, field and office work, Montreal terminal development, C.N.R.; 1930 (May-Aug.), struct'l. detail work in field office for constrn. of copper refining plant at Copper Cliff, Ont., for Fraser Brace Engrg. Co.; 1930 (Aug.-Oct.), asst. inspr. for constrn. of sub-station, Montreal East, Montreal Light Heat & Power Cons.; at present, engr., Beauharnois Light Heat & Power Company, Montreal, Que.

References: J. W. McCammon, K. M. Perry, H. L. Currie, R. N. Coke, R. A. C. Henry.

FOR TRANSFER FROM THE CLASS OF JUNIOR TO A HIGHER CLASS

JOY—CLYDE BARBER, of 124 High Park Ave., Toronto, Ont., Born at Hamilton, No. Dakota, U.S.A., March 6th, 1896; Educ., B.A.Sc., Univ. of Toronto, 1924; Summers: 1920 and 1922, asst. to H. H. Gibson, O.L.S.; 1921, concrete inspr., James, Proctor & Redfern Ltd.; 1923, struct'l. dftsman., Sarnia Bridge Co.; 1924, dftsman., Can. National Elec. Rlys., Toronto; 1924-25, struct'l. dftsman., American Bridge Co., Pencoyd, Pa.; 1925-27, arch'l. and struct'l. dftsman., and 1927-30, struct'l. designer and estimator, The Austin Company, Philadelphia, Pa.; Aug. 1930 to May 1931, struct'l. designer and estimator, London Structural Steel Co. Ltd., London, Ont. (*S. 1920, Jr. 1925.*)

References: S. B. Wass, C. R. Young, H. A. McKay, P. J. Duff, W. D. Proctor, A. M. Reid, F. C. Ball, H. B. R. Craig.

McLEISH—ROBERT GRAHAM HAMILTON, of 122-34th Ave., Lachine, Que. Born at Glasgow, Scotland, Aug. 8th, 1898; Educ., 2 years, Khaki College, overseas. Six months D.S.C.R. course in mech'l. engrg., Queen's Univ.; 1916-19, overseas, Can. Art'ly.; 1914-16 and 1919-20, junior mech. engr., Can. Gen. Elec., Company; 1920-24, with H.E.P.C. of Ontario, as follows: 1920-22, on constrn. plant design; 1922, cost studies and reports on Niagara Development for Gregory Commn.; 1922-24, asst. chief right-of-way engr.; 1924, plant and production engr., and 1924-26, plant supt., Imperial Radiator Co.; 1926-28, estimating engr., and from 1928 to date, chief estimating engr., Dominion Engineering Works, Ltd., Lachine, Que. (*S. 1921, Jr. 1925.*)

References: R. P. Johnson, S. W. Johnston, H. G. Acres, H. A. Crombie, H. S. Van Patter, J. G. Notman.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

HALPENNY—MERLE B., of 4935 Connaught Ave., Montreal, Que., Born at Montreal, July 13th, 1904; Educ., B.Sc. (Mech.), McGill Univ., 1926; with Dominion Bridge Company, Lachine, as follows: 1923-24 (summers) and 1925-26, struct'l. and mech'l. detailing; 1927-28, elect'l. layouts and designing crane and gate work; 1929, gen. mech'l. estimating; 1930 to date, checking mech'l. estimates. (*S. 1923.*)

References: F. P. Shearwood, F. Newell, R. H. Findlay, D. C. Tennant, R. S. Eadie, R. M. Herbison, K. O. Whyte.

MORGAN—JAMES CLARENCE, of 540 Bathurst St., Toronto 4, Ont., Born at Simcoe, Ont., May 18th, 1904; Educ., B.A.Sc., 1930, M.A., 1931, Univ. of Toronto; 1929 (summer), traveller for Canada Colors and Chemicals, Toronto; 1930-31, grad. work at Univ. of Toronto, development of apparatus and method for micro silica analysis; at present, demonstrator in electro-chemistry, Univ. of Toronto, and working towards degree of Ph.D. in electro-chemistry. (*S. 1929.*)

References: C. R. Young, E. A. Allcut, W. B. Dunbar, J. J. Spence, J. R. Cockburn, T. R. Loudon, C. H. Mitchell.

NORMAN—DOUGLAS, of Toronto, Ont., Born at Toronto, July 21st, 1904; Educ., B.Sc. (E.E.), Univ. of Man., 1925; 1922-25 (summers), chainman and rodman, C.N.R.; 1925-27, test dept., and 1927 to date, engr., transformer eng. dept., Can. Gen. Elec. Co. Ltd., Toronto, Ont. (*S. 1926.*)

References: A. L. Sutherland, C. E. Sisson, E. P. Fetherstonhaugh, N. D. Seaton, W. Burns, L. DeW. Magie.

RACEY—HERBERT JOHN, of 1310 Montrose Ave., Westmount, Que., Born at Chicoutimi, Que., March 29th, 1904; Educ., B.Sc. (Civil), Queen's Univ., 1928; Summers: 1923, chainman, C.P.R., constrn. dept.; 1925, levelman, topog'l. survey, Ottawa-Montreal Power Co.; 1926, field dftsman., transmission line constrn., 1927, field engr., constrn. of Quebec terminal station, Shawinigan Engineering Co. Ltd., and from 1928 to date, with same company as follows: 1928-29, chief of party on survey of hydro-electric power projects, Upper St. Maurice River; 1929-30, res. engr. on transmission line constrn., La Tuque, Que.; 1930-31, res. engr. on constrn., Mattawin River storage dam, Toro Rapids; at present, concrete mixing plant inspr., Rapide Blanc development, Rapide Blanc, Que. (*S. 1928.*)

References: C. R. Lindsey, C. S. Saunders, J. A. McCrory, J. W. H. Ford, C. Luscombe A. Macphail, W. P. Wilgar, D. S. Ellis.

In a booklet received from the Ohio Brass Co., entitled, "Insulation of Some of the Higher Voltage Lines," the advantages of increased insulation and methods for obtaining transmission line reliability are discussed, and the author covers, among other things, conductor heights, the effect of polarity and height upon direct lightning strokes, increasing flashover by the efficient use of tower clearances, the use of high ground wires, span lengths, station insulation, radio interference and high ultimate porcelain insulators.

EMPLOYMENT SERVICE BUREAU

This Service is operated for the benefit of members of the Engineering Profession and Industrial and other organizations employing technically trained men—without charge to either party

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Capital to Invest

A.M.E.I.C., with ten years industrial, engineering, manufacturing and executive experience in Canada, England and the United States, is interested in investing both time and capital in a suitable venture. Located in Montreal. Apply to Box No. 675-W.

Situations Wanted

ELECTRICAL AND RADIO ENGINEER, B.Sc. '28. Experience in the design and testing of broadcast radio receivers, including latest superheterodyne practice, and capable of constructing apparatus for testing same. Also familiar with telephone and telephone repeater engineering. Thorough experience in design, construction and inspection of municipal conduits. Apply to Box No. 12-W.

TECHNICALLY TRAINED INDUSTRIAL EXECUTIVE, open for employment. Canadian, age 40, with extensive Canadian and American industrial experience, particularly in metal manufacturing industries, including grey iron and steel foundries, machine and steel fabricating shops—arrangement and equipment of plant and mechanical handling systems to improve manufacturing methods, cut costs, step up production and quality of product—wants connection with progressive company in Canada preparing for business expansion. Apply to Box No. 35-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E. (Ont.), 15 years experience, available on short notice. Experienced surveys, draughting, reinforced concrete design, municipal engineering, construction work, inspection, estimating. Apply to Box No. 107-W.

CIVIL ENGINEER, university graduate 1926, desires employment as junior engineer or instrumentman on construction work. Experience, resident engineer on railway construction, miscellaneous surveys. References. Available any time. Apply to Box No. 149-W.

CIVIL ENGINEER, B.Sc., age 34, is open for a position as construction engineer in charge of construction of hydro-electric plants or paper mills; designing engineer of hydro-electric developments or paper mills. Willing to make small investment. Apply to Box No. 157-W.

ELECTRICAL ENGINEER, B.Sc., McGill 1926. Five years experience in the design of switchboards, layouts and wiring diagrams. Considerable experience in high and low tension switchgear design. Fifteen months experience in switchboard estimating. Available at once. Apply to Box No. 247-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.

MECHANICAL ENGINEER, B.Sc. McGill 1919, A.M.E.I.C., married. Eleven years experience, including structural, reinforced concrete, piping and high pressure boiler and furnace design, heating and ventilating, hydraulic and boiler plant operating problems. Apply to Box No. 265-W.

Situations Wanted

DESIGNING DRAUGHTSMAN, experience in layout of steam power house equipment and piping. Wide experience in mechanical drive and details of machinery, gearing and hoists. Also some experience in ventilating and heating work and calculators. Accustomed to structural design and details. Good references. Present location Montreal. For interview apply to Box No. 329-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., R.P.E., Ont., with twenty-four years experience, embracing dams, wharves, grain elevators, foundations, pile driving, highways, municipal engineering, water power surveys, road locations, inspections and estimating, is open for engagement as engineer or superintendent in construction, operation or maintenance. Location immaterial. Apply to Box No. 358-W.

STRUCTURAL AND CIVIL ENGINEER, Jr.E.I.C., age 31, married. Was instrumentman and structural engineer on erection of Royal York hotel, and asst. resident engineer on James Bay Extension, T. & N.O. Rly. Experience includes structural, civil and mechanical draughting and all kinds of instrument work and special work. Qualified as captain in military engineering, R.M.C., Kingston. Available anywhere in Canada, preferably Toronto, for any kind of work. Apply to Box No. 377-W.

STRUCTURAL AND CIVIL ENGINEER, B.Sc., age 35, married. Thoroughly experienced in design, shop work and erection of steel bridges, buildings and movable structures. Seeks position as designing engineer or engineer on construction. Available on short notice. Will go anywhere. Apply to Box No. 399-W.

CIVIL ENGINEER, B.A.Sc., C.E., A.M.E.I.C., age 29, married. Experience over nine years includes railway location and construction as resident engineer. Hydro-electric report on estimates and investigation, also design, construction and teaching on hydraulic structures, bridge foundations and caissons. Location immaterial. Apply to Box No. 447-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

DESIGNING ENGINEER, A.M.E.I.C., P.E.Q., with extensive experience in design and construction of power plants, industrial buildings and hydraulic structures, desires position as designing engineer or resident engineer on construction. Apply to Box No. 492-W.

MECHANICAL ENGINEER, Jr.E.I.C., B.Sc., '26. Ten months experience in pulp and paper steam control. Four years experience in detail and design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

Situations Wanted

CIVIL ENGINEER, B.A.Sc., '29, with experience in supervision of construction and general office engineering, desires permanent position with contractor or engineer. Available at once. Apply to Box No. 524-W.

MECHANICAL GRADUATE, 1927, age 26. One year with specialized piping contractor on design and cost estimates. Three years on hydro-electric power plant design, proportioned 25 per cent electrical, 25 per cent civil and 50 per cent mechanical. Five months field engineering on hydro-electric power house construction. Pre-graduate experience on power plant operation and general construction. Canadian, married. Available at once. Apply to Box 528-W.

ELECTRICAL ENGINEER, married, graduate of McGill University, desires position in Ottawa, Montreal or Toronto. Experience includes four summers with a building concern as instrumentman and assistant engineer, two and one-half years with the Canadian Westinghouse Co., this time being distributed between tests, design and sales. At present employed but available on short notice. Apply to Box No. 533-W.

UNDERGRADUATE ENGINEER, S.E.I.C., junior year standing (Sask.), desires work to complete course. Electrical or mechanical work preferred. Apply to Box No. 553-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, B.Sc. McGill Univ., Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

MECHANICAL ENGINEER, A.M.E.I.C., experience in the design and maintenance of steel mills, zinc and sulphuric acid plants, cement plants; power house layouts; familiar with shop practices and costs, desires connection. Apply to Box No. 571-W.

YOUNG ENGINEER, Jr.E.I.C., experienced in design, details and erection of steel and concrete structures. Also a good theoretical and practical knowledge of steam, hydraulic and I.C. engine power plant. Good practical mechanical and electrical engineer, able to operate and maintain any type of machinery or power plant. Location immaterial. Apply to Box No. 572-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., (Univ. of B.C., '30), Undergraduate experience in pulp mill. One year's experience, Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

PARTNER. Full time engineering partner to establish welding firm. Must have business and structural steel experience, and be able to invest substantial amount in firm. Apply to Box No. 589-W.

ELECTRICAL ENGINEER, graduate Univ. of Alberta, '31, with excellent record, desires connection with electrical manufacturing firm, power or communication company. Good general experience includes one summer railway construction, two summers geological surveys in oil fields of Alberta, planetable topographer and asst. geologist. Available immediately. Apply to Box No. 596-W.

Situations Wanted

MECHANICAL ENGINEER, S.E.I.C., age 21, four years mechanical engineering, Queen's University, desires permanent employment. Experience in wood work, machine shop work, draughting and surveying. Location immaterial. Available at once. Apply to Box No. 600-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building, desires change. Location immaterial. Available on one month's notice. Apply to Box No. 601-W.

ELECTRICAL OR MECHANICAL ENGINEER, B.Sc. '31, S.E.I.C., desires employment which will give experience and lead to advancement. Two summers in a large communication company, including draughting, switchboard and surveying. Available on short notice. Will go anywhere. Apply to Box No. 606-W.

CHEMICAL ENGINEER, S.E.I.C., University of Alberta '30, desires a position in any industry with chemical control. Experience includes three summer vacation periods of five months each as assistant chemist, and ten months as chief chemist with a cement company. Age 29. Single. Available at short notice. Apply to Box No. 609-W.

MECHANICAL ENGINEER, Jr.E.I.C., 5 years apprenticeship on general mechanical engineering; 10 years experience on heating and ventilating and mechanical equipment of buildings. Design, draughting and production. Desires change. Capable of taking charge of engineering department. Further particulars if required. Apply to Box No. 616-W.

POWER ENGINEER, M.E.I.C., age 42. Married. Thoroughly conversant with electrical, steam, mechanical and industrial engineering, desires executive position with large industrial, power or financial corporation. Best of references as to ability and positions held. Apply to Box No. 617-W.

CIVIL ENGINEER, Jr.E.I.C., B.A.Sc. '24, age 35, married. Five years designer and estimator with well-known firm of industrial builders; two years detailing, designing and estimating structural steel for bridges and buildings, also survey and municipal experience. Open for position immediately, will go anywhere. Apply to Box No. 618-W.

CIVIL ENGINEER, A.M.E.I.C., graduate '23, married, eight years municipal engineering experience. Sewerage and sewage disposal, water works, street pavement, etc. Also some experience highway construction. For the past three years engaged by firm of consulting municipal engineers. Desires permanent position. Location immaterial. Available immediately. References. Apply to Box No. 624-W.

ELECTRICAL ENGINEER, B.Sc., N.S. Tech. Coll. '31. Experience in design and construction of rural distribution lines, trouble shooting, inventories and general office work, desires position with public utility or industrial plant. Location immaterial. Available at once. Apply to Box No. 628-W.

Situations Wanted

CIVIL AND MECHANICAL ENGINEER, experienced in design, layout, installation and selling. Sixteen years association with largest Canadian industries manufacturing equipment particularly relating to pulp, paper and lumber and five years design and construction of sulphite mill, including electrolytic bleachmaking from salt. Apply to Box No. 633-W.

ELECTRICAL ENGINEER, B.Sc., N. S. Tech. Coll., '31. Experience includes geological survey work in Rouyn mining area and hydroelectric power plant construction both civil and electrical work. Available at once. Apply to Box No. 639-W.

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Canadian Pacific Railway Company's Wolfe's Cove Branch and Tunnel at Quebec

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, October 1st, 1931.

SUMMARY.—The tunnel which forms the subject of this paper was rendered necessary to give access to the first unit of the new Quebec harbour development above Cape Diamond. The paper describes the equipment and method used for driving the tunnel, and also gives the requirements as regards lining, drainage and ventilation during construction.

The Wolfe's Cove branch of the Canadian Pacific Railway Company was built during the past year to provide the company with a means of access to the new Wolfe's Cove terminal at the Quebec harbour.

The older part of Quebec harbour at the confluence of the St. Charles and the St. Lawrence rivers could accommodate, in the Princess Louise basin, boats drawing 25 feet and because of the ever increasing size of vessels, deeper water for berths became necessary if Quebec wished to retain her position as an ocean port. Quebec has always occupied an important place in the shipping trade of Canada. In the days of sailing ships, Quebec turned out some of the finest vessels in the world and at Quebec was built the "Royal William," first vessel to cross the Atlantic entirely by steam.

Extensive studies carried out over a period of years led the Harbour Commissioners of Quebec to decide that the future improvements and extensions of the harbour facilities should be carried out along the shore of the St. Lawrence upstream from the citadel and a scheme has been worked out for a harbour development extending from a point about two miles above Cape Diamond to Sillery. At the location selected there will be better shelter than at the old docks and only a small amount of dredging is necessary to give deep water alongside the quay walls.

The first unit of the harbour development called the "Wolfe's Cove Terminal" was completed in June this year and consists of a quay wall 4,300 feet long with 40 feet of water alongside at low tide, a two-storey steel and brick shed 1,380 feet long by 100 feet wide with railway tracks and roadway to permit of the proper handling of traffic to and from steamers.

The first vessel to use the New Wolfe's Cove terminal was the new Canadian Pacific steamship "Empress of Britain" which docked there June 1st, this year.

The Wolfe's Cove branch was constructed on the location finally selected after extensive studies of various routes covering the territory from Cape Diamond to the Rouge river and extends from a point on the main line of the Canadian Pacific Railway about 2½ miles west of the

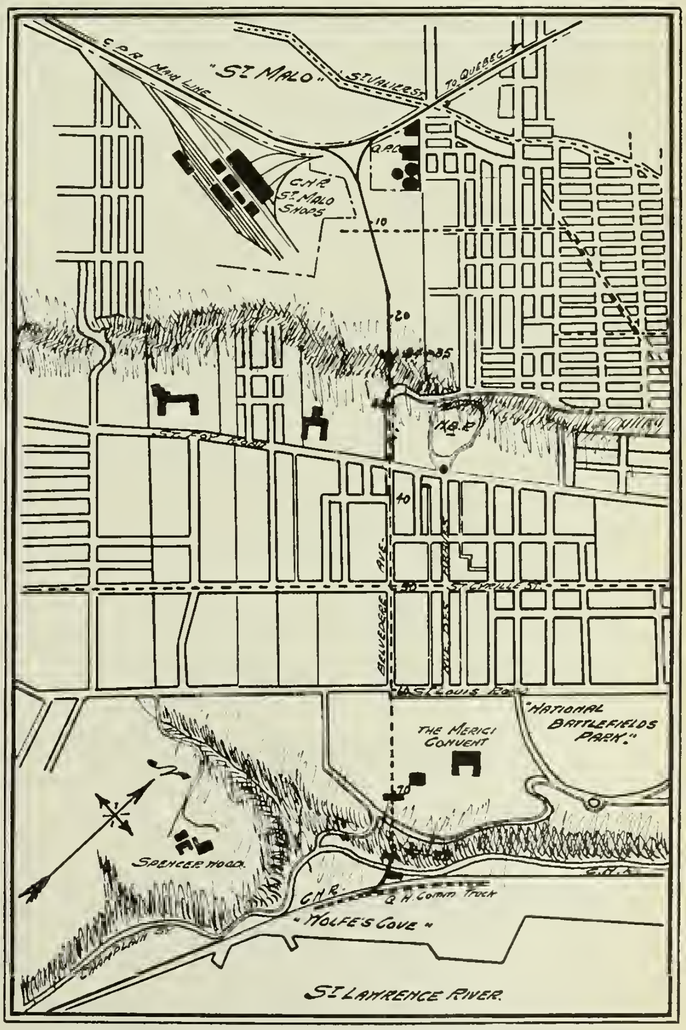

Fig. 1—Location of Tunnel under Quebec City.

Fig. 2—South Portal of Tunnel.

Palais station at Quebec, to the Wolfe's Cove terminal of the Harbour Commissioners. The new line is 1½ miles long, one mile being in tunnel through the ridge which lies between the valley of the St. Charles river and the St. Lawrence. This ridge rises to a height of 250 feet to 350 feet above the St. Lawrence. The railway where the branch takes off is 60 feet above the St. Lawrence. The Harbour Commissioners' railway is about 20 feet above river level. The tunnel passes through the ridge slightly west of the Plains of Abraham and comes out on the St. Lawrence a little to the east of the historic site of Wolfe's Landing, the centre line being directly under Belvedere avenue. Grade on the branch is carried out about level from the existing main line to the north portal of the tunnel and drops through the tunnel on an 0.8 per cent grade.

There are no grade crossings of streets on this branch line. Champlain street alongside the St. Lawrence was the only street which would be crossed at grade level and grade separation for this street was provided by constructing a diversion and carrying it over the tunnel lining extended past the face of the cliff a sufficient distance to accommodate the roadway.

The selection of this location was influenced by the topographical features, the expected geological formation and the desire to avoid interference with the existing appearance and conditions of the terrain at the historic site of Wolfe's Landing. Published data of the geological formation were studied and a further examination of the geological structure was carried out by means of trenching from the surface to the rock at a number of locations. The overburden on the plateau is generally from five to twelve feet deep. From the information obtained it was expected that most of the tunnel would run through Quebec City limestone and that possibly one hundred yards or so would be in shale formation at the north end of the tunnel. Considerably more of the shale formation than expected was encountered. Both these rocks are quite soft and weather on exposure. The limestone is self-supporting for tunnel such as was built but had to be protected to prevent weathering. The shale had to be supported immediately with timbers to hold it in position until concrete lining could be placed.

In establishing the centre line care was taken to insure accurate chainage and levels. A 500-foot steel band tape was used and measurements were taken with the tape held at a uniform tension, approximately parallel to the surface and between fixed points. The angle between the tape and a horizontal line was read and the horizontal and vertical

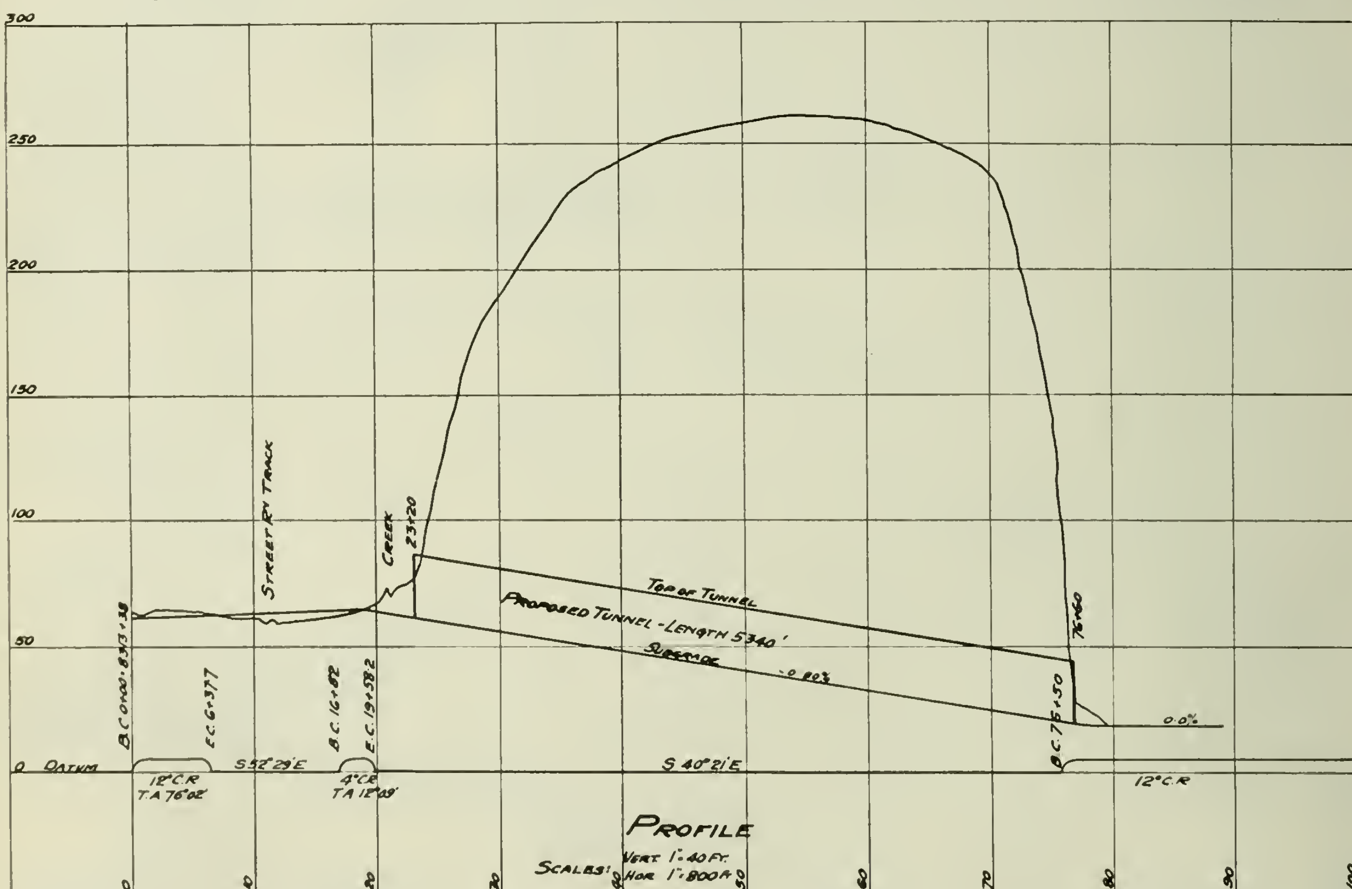

Fig. 3—Profile of Tunnel.

Fig. 4—Timber Lining, North Portal.

distance between such points calculated. The horizontal distance was also calculated by using the measured distance on the slope and the difference in elevation between points as established by level. These operations were carried out several times until similar results were obtained and the accuracy of the work established, after which a number of fixed points were made permanent by constructing concrete monuments, each carrying a metal plate on which the point was fixed. The foundations for these monuments were carried below frost level. Where ground level would be disturbed along the centre line during construction, points were referenced out and the reference points were established in permanent form. Location of the line outside the tunnel portion was fixed and handled in the same manner as the tunnel portion. At the north end there is about 2,300 feet of such line between the main line and the north portal, and at the south end about 300 feet between the portal and the junction with the Harbour Commissioners' railway.

The location plan, profile and book of reference were approved by the Board of Railway Commissioners July 2nd, 1930, and the contractor was advised at once to proceed with the work. Prior to this date, competitive bids had been received from several of the leading contracting firms and the Dominion Construction Company having the low tender, was selected to do the work. The spread in price between three low bids on this job was less than 10 per cent. The time for completion of the work was specified as June 1st, 1931, that is, eleven months only were allowed for the construction of this 1½ mile branch line with one mile of it in tunnel. Within three days after approval of the plan the contractor had men on the work, having moved a small force in boarding cars so as to get an early start.

The tunnel is constructed for single track. The clear width inside is 16 feet and the clear height above base of rail at the centre line is 22 feet 6 inches, the side walls being vertical and the top being formed by a semi-circular arch with a radius of 8 feet.

Grading of the approaches or sections of the line outside the tunnel entailed the moving of about 9,000 cubic yards of material. This grading was completed and the tunnel excavation started early in August. The north end went under August 5th and the south end August 9th. In the meantime, the contractor had supplied and assembled the plant and equipment required for tunnel work. The plant was arranged in two complete units, one at each end of the tunnel, each unit consisting of a battery of two air compressors with a capacity of 1,650 cubic feet, a 200-h.p. generating set, one compressor air blower 5,000 cubic feet capacity at 2½ pounds pressure with direct connected 50-h.p. motor, one blacksmith shop with drill sharpening machine, drill steel furnace and complete blacksmith outfit. At each end there was also a complete set of drills, drifting machines, piping, cars, locomotive, etc. At the north end only, there was a saw-mill completely equipped for the sawing and framing of the timber required for lining the tunnel, or for breakdown timbers. Most of the employees were housed in boarding cars but separate buildings were supplied for use as wash rooms and drying rooms where the men changed when going on and off duty. Electric power for all the plant and equipment on this job, as well as for lighting, was supplied by the Quebec Power Company.

For excavating the tunnel the bottom heading method was adopted because it was thought that by this method it would be possible to keep closer to the true section than by any other method, and with the class of rock expected here, it was thought that excessive overbreak might occur if the top heading or the full section method were used.

The heading driven from each end was taken out about 12 feet high by 14 feet wide. The drilling for this heading consisted of about twenty-four holes eight to ten feet deep. The work was carried on in two shifts over the twenty-four hours and each shift generally drilled and shot one round. The shot was arranged in seven delayed actions, the central holes being fired first. About three pounds of powder per cubic yard was used. The advance in each heading averaged 16.1 feet per day. Work was carried on for one hundred and sixty-six days in the north end and one hundred and sixty-two days in the south end and the heading was holed through February 16th at 7.45 o'clock a.m. The bores met almost exactly. In firing the last shot, the wires from the caps in the charges in the Wolfe's Cove end were passed through a drill hole to the St. Malo face and all wires were

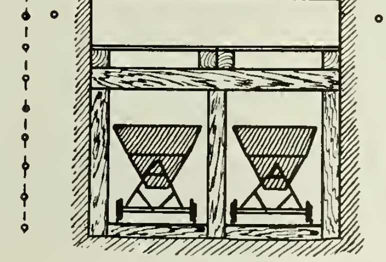

Fig. 5—Layout of Drill Holes in Heading.

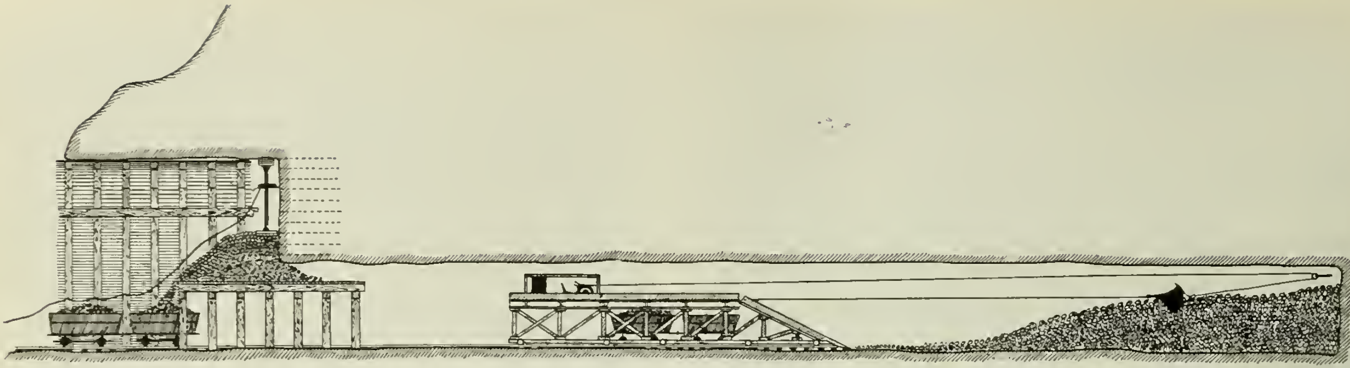

Fig. 6—Mucking Machine.

attached to the one firing switch. There were eighty holes, forty in each end, fired in the last shot. The muck from this shot filled the headings except for two small holes about three feet high at each of the upper corners. On the breakdown the drilling was arranged according to quality of rock and other conditions and blasting required about one and a half pounds of dynamite per cubic yard.

The muck from the heading was first handled back from the face to clear a space for the drillers to work and then loaded on 2½-yard cars run on a 36-inch gauge track. A five-ton electric mine locomotive handled the muck trains, consisting of five or six cars, out of the tunnel. For the handling and loading of the muck in the heading, a mucking machine was used. This mucking machine consisting of a steel platform with a steel plate ramp on the front end was carried on steel bents, mounted on wheels running on rails. The platform and bents were so constructed that the muck cars could be placed under traps in the platform for loading. On the platform was mounted a 50-h.p. double drum hoist with motor and from this hoist a drag was operated which pulled back the muck from the face or pulled it up the ramp and through the traps into the cars, as desired. The drag was shaped like a Gillette razor with on one side a plate and on the other side teeth like steam shovel dipper teeth. When returning empty to the front, the drag slid along on its rounded back. This drag was attached to and operated on an endless cable fixed to the hoist and passing through a pulley on the front end, the pulley being attached to eyebolts or to a timber attached to eyebolts set in the rock.

The whole machine was very efficient and it ran very low in maintenance cost as well as having a low first cost. It handled up to twenty 2½-yard cars per hour for several consecutive hours.

Behind the mucking machine distant probably 300 or 400 feet from the face, breakdown timbers were erected in the heading at a height of about seven feet. On these timbers the drilling and blasting for the breakdown to the full section of the tunnel were carried out. The muck from this operation landed on the breakdown timbers and was then shovelled into muck cars either over the end or through traps. The muck from both the breakdown and the heading was disposed of at the north end by loading into standard gauge cars for delivery and use on the main line of the Canadian Pacific. At the south end muck was used for filling in alongside the waterfront in accordance with instructions from the Harbour Commissioners.

It was necessary to use the blower for clearing the gases from the tunnel after the heading had advanced about 1,500 feet. Until then the drillers were able to get back to the face in about twenty minutes after a shot was fired without suffering any ill effects from gas or dust. A spray was turned on the muck heaps after each shot and this tended to expel the gases and permit of earlier reoccupation of the heading. The man using the spray would go up for this purpose and stay only 20 to 25 minutes, after which he was free for other duties not in the heading.

At the south end where the tunnel is in Quebec City limestone, the only timber required for supporting the rock

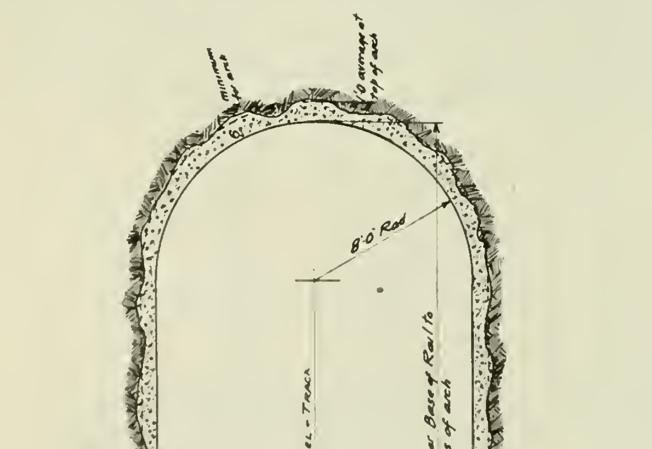

Fig. 7A—Typical Section of Interior Where Rock is Self-Supporting.

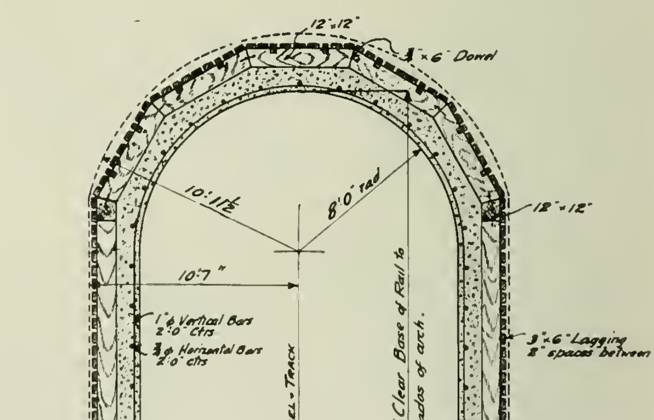

Fig. 7B—Typical Section in Loose Shale Where Timbering is Required.

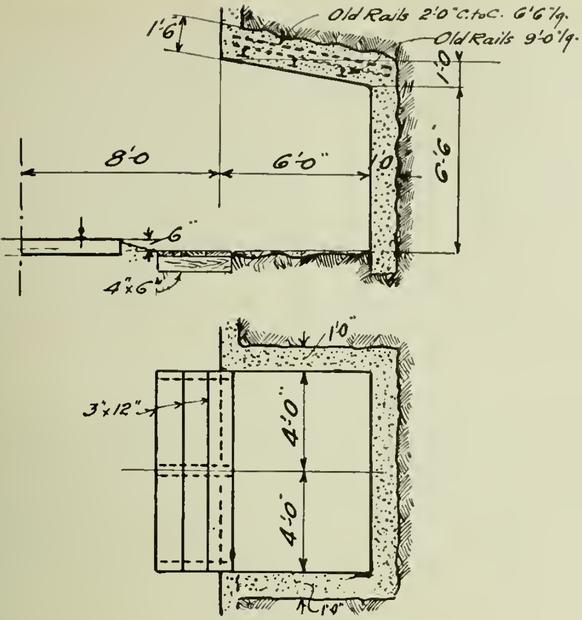

Fig. 8—Refuge Bays.

was three square sets at the portal. In the north end where the tunnel passed through shale it was necessary to place complete timber lining to prevent further falls of rock outside the section required. The timber lining consists of a five-segment arch and plumb posts of 12-inch by 12-inch timber at 4-foot centres with 3 inches by 6 inches lagging. The wall plate and foot plate are also of 12-inch by 12-inch timber. The lagging was placed with 3-inch opening between planks so that if swelling of shale occurred, pressure could be relieved by picking out material from behind the lagging. Such spacing also permitted the free flow of concrete to fill the interstices in the dry packing and make solid the space between the lagging and the undisturbed rock. The swelling of shale is sometimes a very serious matter but did not cause serious trouble here.

In placing the timber, the wall plates and arch timbers were placed first, the lagging was next placed on this portion of the lining and the whole dry-packed with timber to give solid bearing between the timbers and the undisturbed rock. The plumb posts were placed in position later and lagging as required placed behind same. Two gangs were employed on timber lining in the north end, each making an average advance of about ten feet per day. Full timbering extends from the north portal for a distance of 2,500 feet. It was started September 12th, 1930, and completed April 3rd, 1931, and about 1,000,000 f.b.m. of timber was used.

The rock in the tunnel drilled easily and shot small. Many falls of rock occurred, fortunately without serious results. The falls occurred in the shale only and generally where boulders of foreign rock were embedded in the shale. No warning, such as small pieces of rock dropping off, occurred prior to such falls, and it was due to careful inspection and prompt placing of timbers that serious accidents were avoided. Wherever there was any indication of foreign boulders in the shale, breakdown timbers were placed at once. Breakdown was started September 12th, 1930, and completed March 25th, 1931. Total tunnel excavation amounted to 100,000 cu. yds.

The tunnel is lined with concrete throughout and the type and quantity of concrete used varies according to the class of material through which the bore passes.

The lining used where an open cut was excavated and backfilled, is 2 feet 6 inches of reinforced concrete. Where timber supports had to be used in soft rock, the lining is 2 feet 3 inches of reinforced concrete. Where the rock is self-supporting and where concrete is placed simply to prevent weathering of the rock, plain concrete 12 inches thick is used. Where the rock is self-supporting but where slight stresses might result from frost action or from any other cause, reinforced concrete lining 1 foot 3 inches thick is used. At three places located at equal distances in the tunnel, refuge bays are constructed to provide a place for the section gang to get clear of trains. Two refuge bays are located in the west wall of the tunnel and one in the east wall. In the east wall are also located three 3-inch wood fibre conduits for carrying signal and telegraph cables.

At the south end of the tunnel where the lining was carried out beyond the face of the rock cliff a sufficient distance to permit the rerouting of a street over the tunnel to preclude a crossing of the tunnel track at grade, the lining was made 2 feet 6 inches thick and was heavily reinforced. All of the concrete used in the lining was 1-2-4 mix, with the water content carefully controlled.

Construction of the lining progressed from both ends of the tunnel at the same time and was put under way even before the breakdown work was completed. In placing the concrete lining, bench walls about four feet high were placed by hand. The forming for such walls was of timber. Materials were handled to location in muck cars and deposited in the ordinary way. Above these bench walls the concrete was placed and flowed into position by air. Steel forms were used. Two sections of such forms 40 feet long being used, one at each end. These were mounted on wheels and carried on rails adjacent to the bench walls. They were so designed that they could be drawn away from the concrete when it was desired to move them ahead. For the placing of concrete, the plant at each end consisted of a one-yard mixer with pneumatic placer and necessary pipe. The concrete was mixed in the ordinary way and deposited in a hopper, and thence in the pneumatic placer, after which a plate was set over it, and when the air was turned on, it was caused to flow through a 6-inch pipe, and delivered behind the form at the top of the tunnel lining, the pipe extending along the floor of the tunnel and then being carried up to the top of the form bulkhead in each case. Bends in the pipe line consisted of 24-inch sections of pipe

Fig. 9—Concrete Plant in Tunnel.

with 22½ degrees of curvature, these sections being made up with an upper and a lower half bolted together through flanges. The lower half of each section was constructed of manganese steel to increase its resistance to wear, but even this material wore down and had to be built up electrically with Stelite. Placing of concrete was carried out from the north end and from the south end or from two of the three intermediate stations which were established. Two of the points within the tunnel were about 1,200 feet and 2,500 feet from the north portal respectively, and the third point was about 1,400 feet from the south portal. From these locations the concrete was delivered by the pneumatic placers. At the three stations inside the tunnel, 8-inch well drill holes were drilled from the surface and concrete materials were delivered to the mixer from these holes. The set-up of the plants at the three inside mixing points was both effective and interesting. At each of these points, the equipment was mounted on a tower of heavy timber construction with two main platforms, the lowest of which was of sufficient height above the tunnel floor to permit the free movement of muck trains beneath it. The lower platform carried the concrete mixer, while the upper platform was used for the storage of cement and supported an aggregate hopper which discharged through a chute directly into the mixer beneath. The concrete placer was located on the floor of the tunnel to one side and received the concrete shots, of predetermined size, directly from the mixer.

Cement was delivered to the inside mixing stations in cars, but the sand and rock which were premixed in the proper proportions, were shot directly into the aggregate hoppers, in batch quantities, through well drill holes with 6-inch metal liners, put down from 185 feet to 215 feet through the rock ledge, from a roadway above. This method of delivering the aggregate to the mixers not only facilitated its handling, but also reduced to a minimum interference with the muck trains by the concreting operations. Daily progress of concrete lining was about twenty feet per day at each end.

Ground water caused some trouble, particularly in the placing of concrete. The major difficulty encountered was with the seepage of water through the rock, which, throughout a considerable length of the tunnel, was sufficiently severe to cause apprehension concerning the ability of the green concrete to set up without becoming over-watered and porous. At these points, sheet tin was applied in the arch back of the timbering, and in some cases back of the plumb posts, to shed the water and to give the concrete a chance to set up. Approximately 10,000 square feet of tin was used for this purpose. All of the seepage water in the finished tunnel is brought from behind the lining through weep holes at the bases of the side walls, and is readily carried to the south end of the tunnel in the sloping side ditches.

At a few points where leakage occurred through the lining in spite of the precautions taken, Sika waterproofing was applied to the inside face of the lining and proved effective in stopping the flow of water. Concreting was started October 10th, 1930, and completed April 29th, 1931 Total concrete in portals and tunnel lining is 27,000 cubic yards.

No ventilating equipment has been installed although housing for such equipment is provided for in the south portal. The tunnel clears within ten minutes after the passage of a train and no inconvenience or ill effects are felt by persons on a train passing through the tunnel.

Traffic on the branch line is controlled by signal indication only, the signals being controlled from a centralized traffic control machine in a signal tower located on the main line at St. Valier. In addition this machine also controls the signal protection at two street railway level crossings, one steam railway level crossing, the junctions between the branch line and the Canadian Pacific main line, the junction between the Canadian Pacific and Canadian National main lines, and the junction between the branch line and the Harbour Commissioners Railway, all the switches being electrically operated.

Riveted Tension Members

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SUMMARY.—This paper describes a research carried out by the photo-elastic method to determine if possible a reasonable reduction formula for use with riveted tension members. Stress lines were ascertained both for tension plates with rivet holes in them and for tension plates actually riveted together; both types of specimen being tested to destruction. The results were further studied by tests on steel plates, and as a result a deduction formula is proposed taking account of the stagger and gauge distance.

Considerable attention has been given from time to time to the problem of arriving at a rational deduction formula for use with riveted tension members. Some of the attempts that have been made to derive a formula from a strictly analytical basis had an apparent amount of success; but the writer showed in the results of a research published in the Canadian Engineer of August 26, 1924, that certain assumptions that had been made in these investigations were not correct. These results were obtained by using the photo elastic method; and while they served to disprove the assumptions in question, there was no clear indication from them as to an easy method of determining the actual stress distribution in riveted tension members.

The research was continued, using the photo elastic method, with a view to determining whether or not there were certain simple factors governing the stress distribution from which a reasonable deduction formula could be put together.

There are two avenues of approach to the problem. The first, and apparently the more popular of the two, is to use tension plates with rivet holes in them and to observe their behaviour when tested to destruction. The second method is to observe what happens when tension plates which are actually riveted together are treated in a similar manner. Both kinds of models were investigated; as it was felt at first that there might be some fundamental difference in stress distribution between these two types which would affect the general workability of a formula drawn up from observations on only one type of plate.

Some idea of the general difference in stress distribution in the two types of plates may be had from Figs. 1 and 2. Fig. 1 shows one set of principal stress lines for a plate with merely a rivet hole in it; Fig. 2 shows the corresponding set of principal stress lines for a plate into which the load is transferred by means of a rivet. The type of variation of stress intensity on a right section through these holes in both Figs. 1 and 2 is illustrated in Fig. 3. There is a region of high stress concentration close to the rivet or rivet hole depending upon which plate is used; and the highest unit stress in either case may be three or four times the average unit stress on the uncut right section of the plate. This means, of course, that the ordinary elastic limit may be

*Assisted by Messrs. K. B. Jackson, G. W. Smart, W. Turner and H. St. P. Butler.

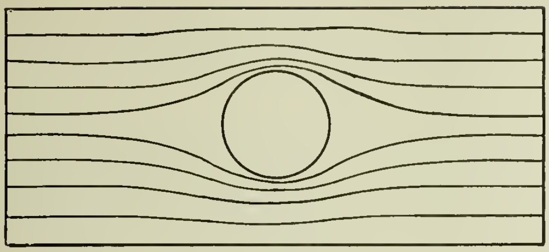

Fig. 1

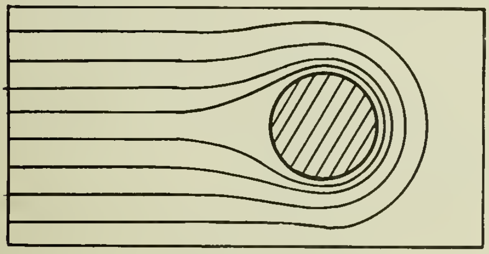

Fig. 2

Fig. 3

exceeded in these areas around the holes even when the average stress on the gross sections is well below this limit.

It was intended originally to explore the stress distribution for both types of models; but it was seen, as will be shown, that a certain factor common to both types was the governing effect, so that merely plates with holes in them were used finally.

The photo elastic method gives on a screen properly placed, a colour variation scheme from which the values of the algebraic differences between the two principal stresses in the main plane of the specimen may be obtained. As the load is placed on a specimen, there appear in succession the colours yellow, red and blue followed by the repeated sequence of the same colours as the stress becomes greater and greater. The outlines shown on Figs. 4 and 5 may be called isochromes as they give roughly the central lines of the various colours for a given load. These colour bands may be taken as representing the lines along which the principal stress differences have certain values. The principal stress differences shown on these isochromes are in pounds per square inch, and if one of the principal stresses is small, as is the case in this problem, it is not very far from the truth to say that the isochromes show the regions along which the other principal stress has a given value. The celluloid tension models used in making Figs. 4 and 5 were 1½ inches wide and approximately 3/16-inch thick with ¼-inch rivet holes. The edge distances were ⅜-inch and the gauge lines ¾-inch apart. The rivet stagger is ¾-inch in Fig. 4, and 2 inches for Fig. 5.

The average unit stress on the uncut right section in Figs. 4 and 5 is below the elastic limit of the material; but in the areas around the edges of the rivet holes the elastic limit is exceeded. This was done in order to give a more striking stress picture; although it is realized that the elastic limit having been exceeded, the specimens could not have been used for accurate stress determination. These diagrams are merely used here to illustrate a point that is not so convincingly seen from isochromes in which low stress values are used; although it must be clearly understood that almost the same configuration of results obtains for loads which keep the stresses below the elastic limit.

Many sections such as those illustrated in Figs. 4 and 5 were examined. Various stagger ratios were used and it was found that the salient features in all of these, conformed to the same type of stress distribution as shown in these figures.

It was while investigating the stress along various sections of these models that a certain persistent fact was noticed; namely: that there is a region of very high stress around the rivet holes which is so much higher than anywhere else that one would naturally expect first failure always to take place in or about that locality. *This is not new evidence; but it is doubtful whether its full significance has ever been taken into account as far as the present problem is concerned.*

When this was noticed, an attempt was made by the photo elastic method to deduce the effect of varying the stagger and gauge on these maximum stresses at the edges of the rivet holes; but it can be seen from Figs. 4 and 5 that there is not a very great decrease in stress value at the rivet holes for an increase of stagger from ¾-inch to 2 inches. Fig. 6 shows the stress variations on the edge distances of right cross sections through rivets for three specimens of the same dimensions given for Figs. 4 and 5, the staggers being varied as shown and only one half the load applied as in Figs. 4 and 5. It is evident that the failures of the specimens would most likely be in the order of No. 1 to No. 3; but the actual variation of maximum stress at the edge of the rivet hole is not very great as we go from No. 1 to No. 3. The reason why No. 1 would fail first follows, of course, from the fact that there is a greater average stress on the section. But the difference between any two of these cases is not such as to give rise to the conviction that it would require considerable variation of material on the right section to look after it. Indeed, one would almost form the conclusion that having allowed for the worst case, the remaining cases require very little variation of material. *The condition at the edge of the rivet holes is startling enough in all cases.*

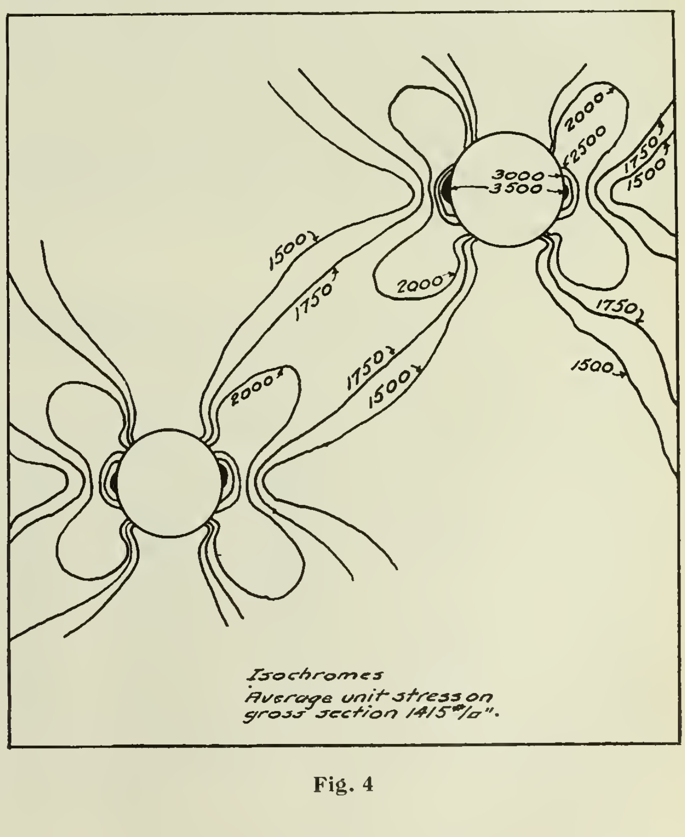

Fig. 4

Table I

Specimens 24″ × 4″ × ¼″ ; ½″ holes; gauge lines 2″ apart

Specimen	Stagger	First Failure
A	0	47300
B	¼ in.	46800
C	½ in.	47850
D	¾ in.	47500
E	1 in.	48600

The variation of stress on a right cross section on the other side of the rivet hole is of the same nature in all cases as shown in Fig. 3. The average stress in this case is very much lower than for the edge distance side; and, therefore, one would not expect first failure to begin on that side.

The supposition that the dangerous area was located at the edge of the rivet hole *on the edge distance side* was borne out in a few preliminary tests of steel plates. *In every case, failure commenced at that locality;* that is, with practical edge distances and rivet spacing values.

It was decided then to find out by means of a series of such tests on perforated steel plates whether or not any more pronounced law could be determined than was evident from the photo elastic method. The results of two of a series of ten tests is given in Table I. The plates used were 24 inches by 4 inches by ¼ inch with ½-inch holes in them on gauge lines 2 inches apart. These results are typical of the series. Certainly there is nothing convincing in these figures. They are the variations one might expect as being due either to the slight variations of the internal steel structure itself or to the errors in placing the specimens in the testing machine even with the greatest of care being taken.

Another series of tests is given in Table II. These are the results from using steel plates 15 inches by 3 inches by ⅛-inch. The edge distances in all cases were the same on each side for a given test, two holes ⅜-inch diameter being used for all specimens.

The variation of figures in both Table I and Table II may be taken as typical of the results obtained in all the tests. Altogether, a total of two hundred and ninety-two plates were tested, with more or less the same type of results.

There is one very curious fact that seems to be persistent although it has not any great bearing on the present problem. It will be noticed that the plates seem to be weakest not when the two rivet holes are on the same right section, but when the holes are slightly staggered. This

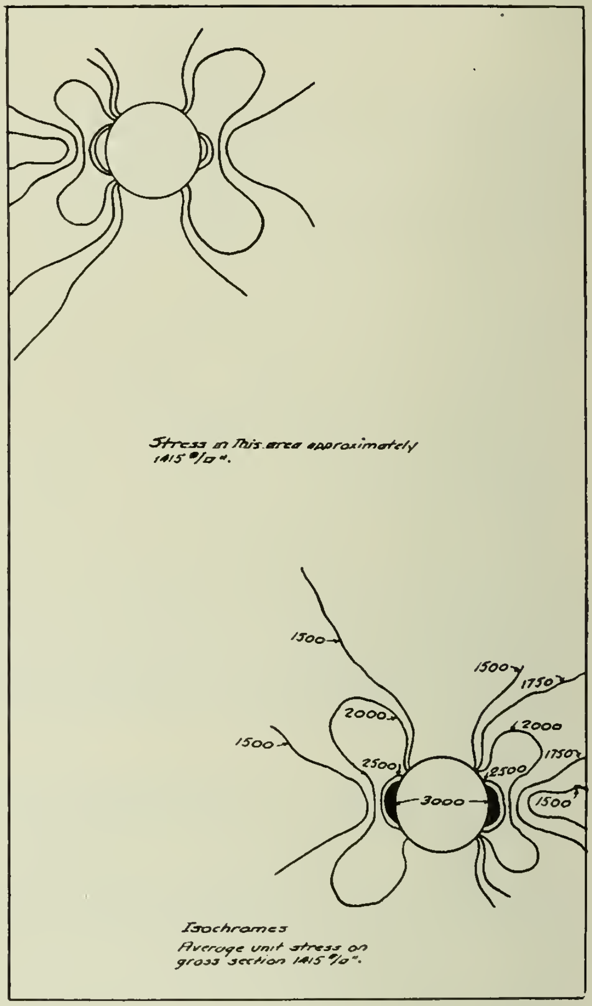

Fig. 5

Table II

Specimens 15″ × 3″ × ⅛″; ⅜″ holes

Stagger	Gauge Distance								
	1⅜	1⅛	1⅛	⅞	⅞	⅞	⅝	⅝	⅝
0	16540	16350	16160	16560	16340	16500	15070	16300	16440
⅛		16250	15870	15800	16290	16020		16220	16700
¼	16550	16150	16070	16240	16250	16150	15550	16360	16590
⅜		16160	16520	16100	16700	15910		16470	16550
½	16340	16480	16510	16550	16300	15780	15740	16370	15920
⅝		16080	16350	16040	16340	15640		16380	
¾	16360	16550	16460	16360	16720	16320	16380	16640	16330
1	16830	16630	16500	17130	16630	16450	16440	16860	
1½	16410	16690	16570	16880	16650	16880	16240	16770	16450
2	16690	17330	16410	16500	16880	16200	16250	16650	16810

Loads in Table are First Failure loads.

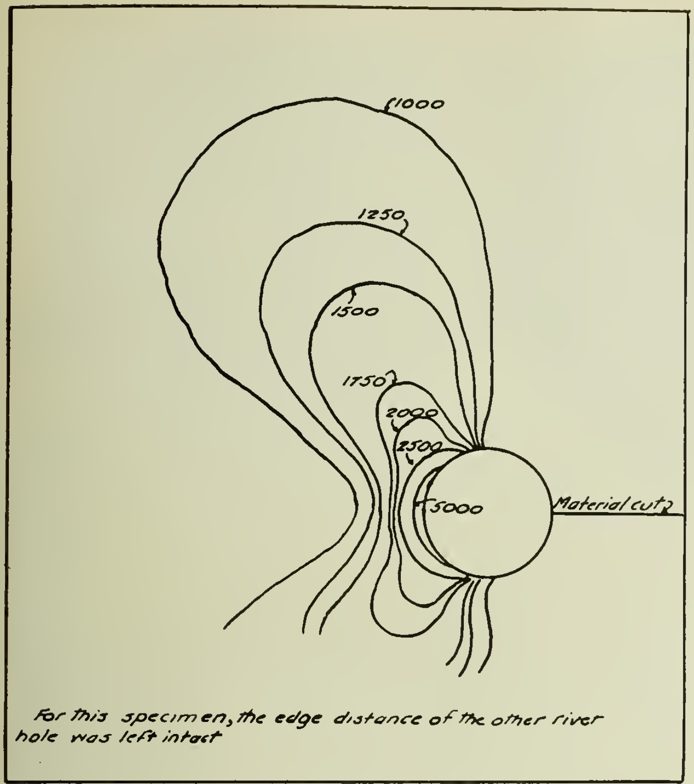

Fig. 6

same fact was suspected during the photo elastic investigations.

It is obvious that if the basis of considering first failure as the governing factor in the problem is admitted, that there is no necessity for a very complicated deduction formula. And what other basis of argument is required? It is this first failure which must be prevented. What happens after first failure is of no practical importance. It might be thought, of course, that the method of failure of the material after this first failure takes place would give some clue to the conditions before first failure. But the writer cannot hold with this idea. The stress distribution after first failure is so different that it is not possible to correlate the after effects with those before first failure. Fig. 7 shows the isochrome lines around one hole for a specimen of the same dimensions as that used in Fig. 5 with only one half of the load placed upon it and the edge distance cut through to the boundary of the plate. It is obvious that the failure on the edge distance side has increased the stress at the rivet hole beyond all proportion and the stress distribution in the remaining material bears no similarity to that in Fig. 5.

Before the tests in Table II were made, several plates of the same material with no holes in them were tested to determine their strengths. The average of these tests gave the ultimate strength as 57,000 pounds per square inch. If two ⅜-inch rivet holes be deducted from a given right cross section and the ultimate strength calculated in the customary manner assuming an average strength of 57,000 pounds per square inch, a figure of 16,100 pounds is obtained which is sufficiently close to the results of Table II for zero stagger to pass without comment. On the other hand, if merely one rivet is deducted, an ultimate strength of 18,700 pounds is given which is considerably higher than

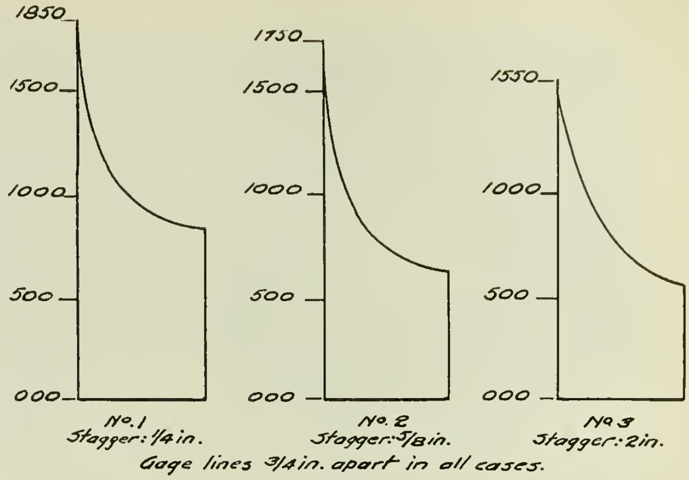

Fig. 7

any of the tests show for first failure. This can be explained by the high stress concentration at the rivet holes which is not very much affected by increased stagger as has been shown by the photo elastic results; and also by the fact that the ultimate failure of the riveted tension plates would be a higher value than first failure, in the neighbourhood of the holes.

One might almost feel safer after looking at these results in always deducting two rivets in order to allow for the effect of damage done to rivet holes in the shop. Certainly the practice of adding ⅛-inch to the rivet diameter in figuring deductions is a factor of safety in the right direction when the high stress in the neighbourhood of the rivet is remembered. Edge distances certainly should not be made too small.

Examining the results in Table II and other results of a similar character, the writer makes the following arbitrary observations:

(*a*) As the stagger ratio, $\frac{s}{g}$, increases in value from zero to about $\frac{6}{10}$ there is very little increase in strength of the tension member. The first failure values in Table II above the double lines lie between these limits of stagger ratio.

(*b*) There seems to be very little increase in strength of the tension member for increase of stagger ratio beyond a value of 1.6.

Based upon these opinions, the writer at first thought of proposing the following deduction formula:

$$x = 1.6 - \frac{s}{g}$$

where x is the deduction to be added to one rivet deduction, x in no case to exceed a value of unity.

s = the stagger in inches

g = the gauge distance in inches.

This formula, of course, gives a deduction for two rivet holes up to a considerable stagger ratio which will appear excessive to many structural designers. The fact that ⅛-inch is usually added to the rivet diameter in calculating net areas lends weight to the objection; and in view of this practice, the writer feels that a concession should be made and proposes the following formula:

$$x = 1.5 - \frac{s}{g}$$

The Practical Application of the Microscope in Railway Service

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, October 29th, 1931.

SUMMARY.—Microscopic examination of the material involved in the fracture of machine and structural parts has been found of very great value, and this paper gives illustrations of a number of typical failures, principally in locomotive work, and discusses their probable causes, with special reference to the occurrence of failure from fatigue cracks.

To the engineer, if he happens to be working on a railway, his line of work appears to be the most important; to the civil engineer, the material that is used in the making of tracks, bridges, or buildings, seems to be of supreme importance; to the chemist, the use of the microscope in determining the quality of paints, oils, chemicals and various other materials used by him will seem of very great value. So on through the many branches of engineering and railway work.

However, this paper only attempts to cover the practical application of the microscope to that particular branch of the service in which the writer is most interested, namely, the locomotive.

The locomotive of the present day that hauls passengers and freight between distant points tends to give a feeling of security and a knowledge that both human lives and possessions are well protected in transportation.

The microscope has a great deal to do with that safety. It is also most useful in the interesting study of the parts of the locomotive.

The part that the microscope plays is to inform the observer whether or not the laws of nature are being followed and whether the best results are being obtained from the materials used, such as iron and steel. It shows the structure that results from any treatment which has been given the part under observation.

The illustrations reproduced in this paper are made from photographs of fractures and microscopic structures and have been selected from over five hundred reports and three thousand photographs.

The use of iron in its pure form is not generally practicable. Iron with alloying elements, which make it into steel, is the material used in making the greater part of a locomotive, and the following will, therefore, refer to steel with particular reference to the application of the microscope to failures.

It would save some expense if the average engineer could learn more of the nature of a failure from its fracture. This knowledge would be the result of a study of the failed materials by tests, chemical analyses and microscopic examination.

Everything is not known regarding microscopic examination, but that is the most interesting part of the work. New features appear and new values are attained which help to reduce the number of failures and in the case of railroads to make travelling safe.

What does the observer expect to see in a microscopic examination of a piece of steel? Very often, what experience teaches him to look for. The structure can be observed, whether coarse or fine grained, the impurities, etc. Also the structure of the steel can be compared with standard structures to find if it conforms to what is desired.

It is well, before cutting specimens for examination under the microscope, to examine the defective or broken part to see what can be learned from it. A typical case where such an examination is of assistance, is the following case of a broken steel axle on a self-propelled passenger car that failed in service.

The axle is fractured at the end of the keyway. The ends of the fractured axle show that the failure is, without doubt, a fatigue failure, starting at both sides of the keyway. A view of the key and keyway, as seen in Fig. 1, show at once that the fault and cause of this failure are mechanical. The square-ended key in a round-ended keyway is not good practice. Fig. 1 also shows the ends of the fractured axle. The square end of the key to the left of the notches in the end of the key-way should be noted, also that the crack creeps across the section. The two original cracks join and meet one another when nearly across. The final break can be detected from the coarse grain. Further examination shows that the key is made of steel that has been carburized

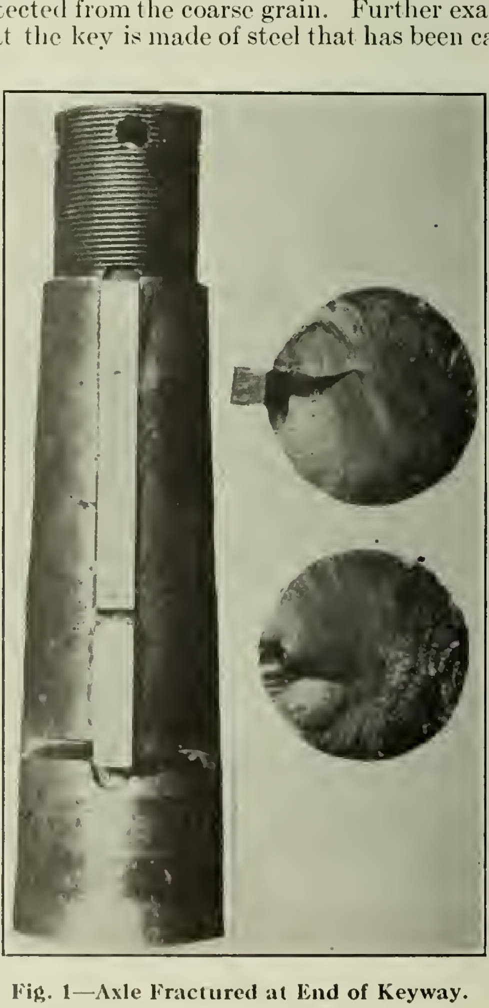


Fig. 1—Axle Fractured at End of Keyway.

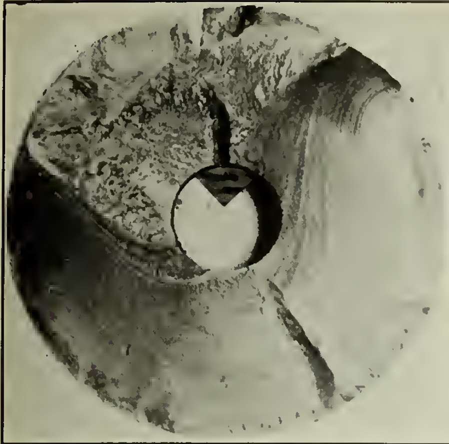


Fig. 2—Section Carbon Steel Axle that Failed in Service.

Fig. 3—Fractured end of Nickel Steel Driving Axle.

Fig. 4—Fracture due to Tool Marks and Poor Material.

and hardened. The result is that a hardened key is driven into a comparatively soft steel keyway, and the nicks made on each side develop into a crack and ends in failure of the axle. This is one of the first main causes of failure of steel parts of a locomotive, or, in fact, any machine, and this fault cannot be too clearly impressed upon anyone who desires to reduce the preventable failures to a minimum.

Scratches, tool-marks, sharp corners and any similar unfinished surface, no matter how small, if located where there are stresses at work, will result in fatigue cracks and failure. This statement is, perhaps, too critical, but one cannot be too careful where life is concerned.

Had it been necessary to substantiate any of the facts observed by this examination, a microscopic study of the structure would have shown that the steel axle was of the best, that the key had been case-hardened and the failure could be from one cause only, namely, the improper shape and structure of the key.

A carbon steel main driving axle that failed in service is seen in Fig. 2. This is something entirely different from the previously described failures. Here it should be noted that the fatigue cracks start at about ⅜-inch from the surface and that they commence at several points. This is peculiar and until an examination of the structure of that steel has been made at several places, the cause of this break can only be guessed at. The microscope, however, shows that overheating of the axle was the cause of the start of this crack.

This axle has been so hot that the structure of the material has been changed from a coarse structure of passable size, into a very fine structure. The change goes in to a depth of ⅜-inch. In failures of this type the copper in the bronze of the bearing actually penetrates into the steel and thus embrittles the steel and causes the crack to penetrate from the surface to the depth above mentioned. Fatigue cracks start at the root of these primary cracks. A failure is the result.

Fig. 3 illustrates a larger section of steel that failed in service. A nickel steel driving axle on one of the large locomotives. This failure is serious mainly in that it is expensive and results in delay of the train. Generally such a failure takes place as the locomotive starts up after stopping at a water tank or at some station. The locomotive when running does not exert stress sufficient to more than increase the crack, but with a sudden strain at the start, the crack completes the failure of the section and the locomotive has to go out of service for repairs.

This failure started in the keyway at both sides, and joined after passing the bottom of the keyway. As will be observed, the creeping crack extends across two thirds of the cross section; it is a question how much of the fracture is due to the fatigue or creeping crack and how much was final fracture. The fact that nearly three-quarters of the section was fatigue crack indicates good material. Possibly a poorly sharpened or damaged cutter tore the steel along the bottom of the keyway and cracks started from several of these tears, ending in failure through fatigue.

The grain of the steel in the final break is fine and uniform. The microscope would come in well in this case if one were wanting a satisfactory structure for further comparisons, otherwise it need scarcely be resorted to.

A clear case of poor material is shown in Fig. 4, and this can readily be seen from the fracture, also the fact that the fatigue crack extends but a short distance into the steel. The complete failure followed not long after the fatigue crack started. The microscope turned upon this steel showed a very coarse, dirty steel. The failure started in the poor material, through fatigue, and possibly began through some tool mark or tear in the axle and rapidly continued until the section gave away under the stress, when four-fifths or nearly the whole section was still holding.

The case shown in Fig. 5 is undoubtedly a freak failure, or rather fracture, of a steel axle. The cause of the strange fracture became plain when the microscope was brought into the case. It will be noted that there are three pockets where balls of steel rested when the axle was taken off the locomotive. There are also faint outlines of the

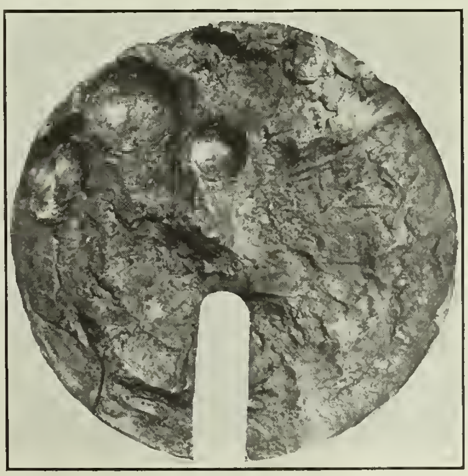


Fig. 5—Fracture in Steel Axle Caused by Overheating.

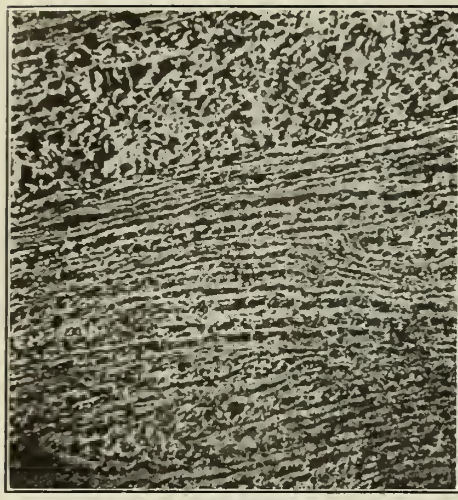


Fig 5A—Structure of the Steel of a Ball Near the Surface.

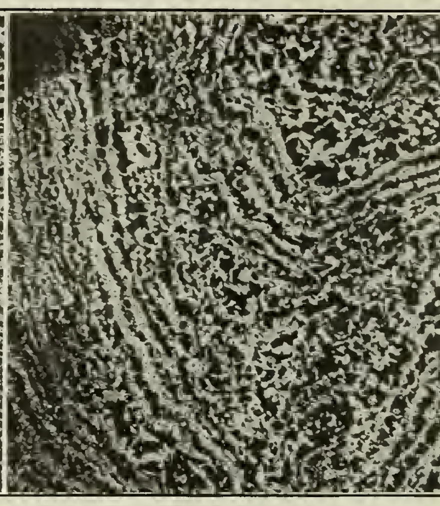


Fig. 5B—Structure of the Steel Near the Centre of the Ball.

Fig. 5C—Fine Grain Metal that has not received Rolling Stresses indicating Structure of the Metal at the Time of Fracture.

paths where the balls rolled before finally settling in the deep impressions or pockets. The steel of the included balls proved to be of the same material as the rest of the axle, and the structure as shown in accompanying pictures, shows that the steel of the balls was torn from the axle in service and rolled into the balls. The axle failed through overheating and twisted off at the last. Heat cracks extend in from the surface to considerable depth. The metal fractured at several places and chunks of hot metal rolled into the balls, also making pockets in the ends of the axle to mislead one in forming conclusions as to the cause of failure. The microscope clearly shows the details, as illustrated in Figs. 5A, 5B and 5C.

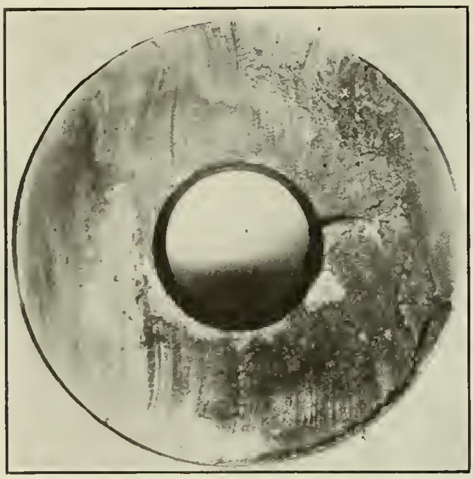


Fig. 6—Service Failure of Nickel Steel Crank Pin.

The chemical analysis of the balls found in this axle and the axle itself, give the following information: drillings were taken from the cross section of axle:—

Location	Car	Phos.	Sul.	Mang.	Si.
	per cent	per cent	per cent	per cent	per cent
Halfway from centre to surface	.436	.036	.025	.57	.060
Centre	.423	.036	.023	.57	.....
Wall of Spherical Cavity	.44	.....	.....	.58	.....
Spherical ball found in cavity	.42	.028	.....	.58	.....

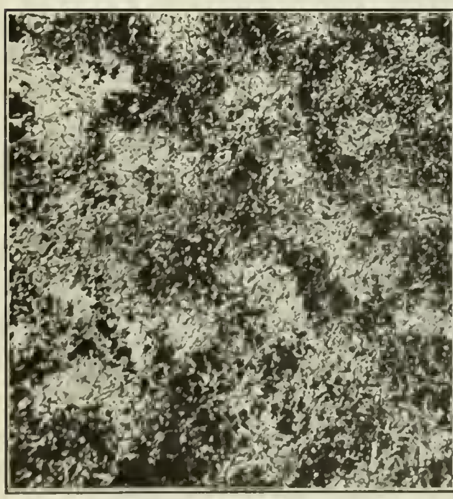


Fig. 6A—Structure of Cross Section of Crank Pin, Grain Fine.

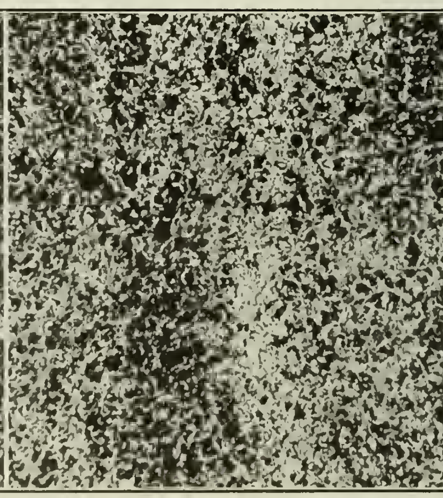


Fig. 6B—Structure of Steel in Longitudinal Section Near Surface of Pin.

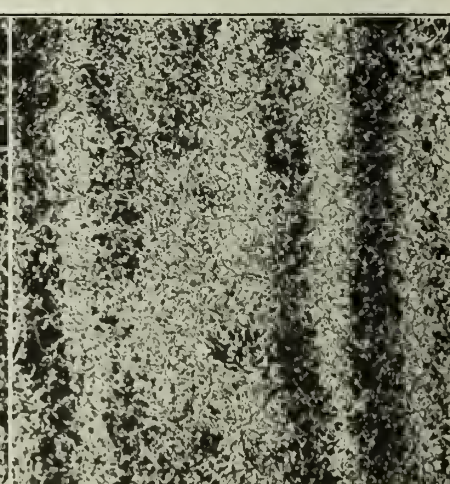


Fig. 6C—Structure of Steel in Longitudinal Section Near Centre of Pin.

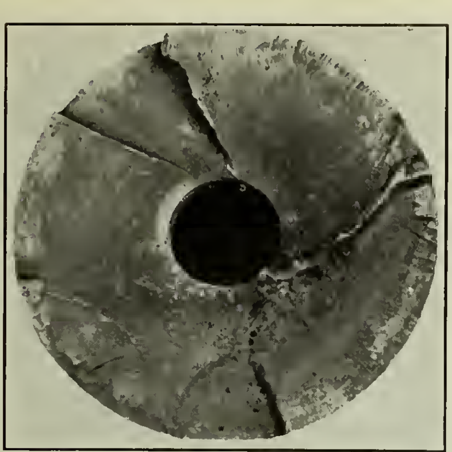


Fig. 7—Failure in Carbon Steel Axle.

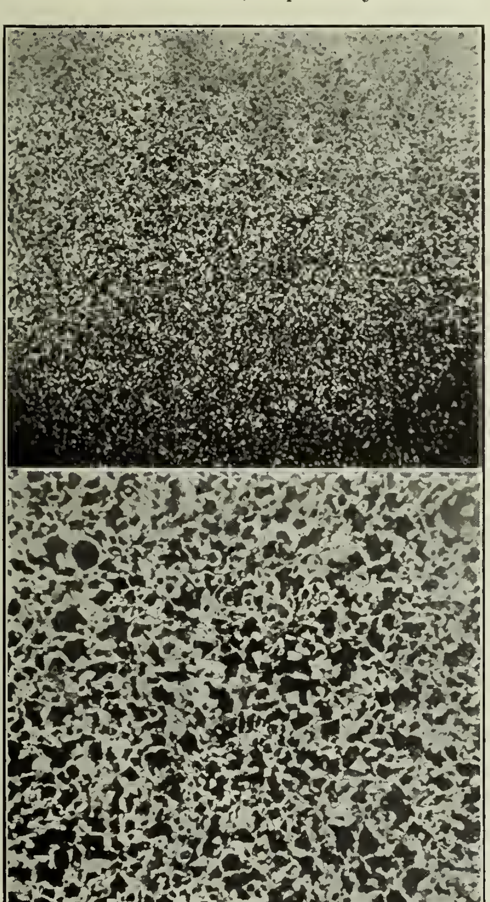
This table does not show any difference between included balls and the axle. The microscope, however, gives a clue and results in clearing the mystery.

A crank pin failure as illustrated in Fig. 6 will next be considered. The steel is nickel and of good quality, as judged from the fracture. It will be noted that the fatigue crack covers nearly the whole section, showing that there was resistance to the final break until the last. This is typical of nickel steel. Carbon steel, unless of the very best, fails before half the section is covered with the fatigue crack.

The crack started in the fillet near the wheelfit and, judging from the microscopic structure of the steel, the crack started in either a banded structure or a scratch in the steel as there were very fine tool marks that gave rise to the crack. A mark of less than one-sixty-fourth of an inch will be sufficient to cause failure, especially in fillets. Fillets should be made free from the least tool mark or cut, and should be finished of ample dimensions and polished. The grain of the steel is very fine with banded areas. Fig. 6A illustrates a somewhat non-uniform distribution of pearlite and ferrite.

A

B



Figs. 7A and 7B

Another case of an overheated carbon steel main driving axle that failed in service is shown in Fig. 7. This axle has been overheated and developed primary cracks, and from fatigue the axle failed completely, when only a small portion of the section held. This is an example of the resisting qualities of good steel. The structure at the surface of the journal was refined to a depth of ⅜-inch, readily noted under the microscope.

Fig. 7A illustrates the structure of the steel near the surface of the axle. It is very fine and uniform to a depth of ⅜-inch. This is due to the axle becoming very hot with a temperature in the neighbourhood of 1,400 degrees F., which is sufficiently hot to refine the grain.

Fig. 7B shows the structure of the steel about one inch in from the surface. The difference between this structure and that in Fig. 7A on the surface should be noted.

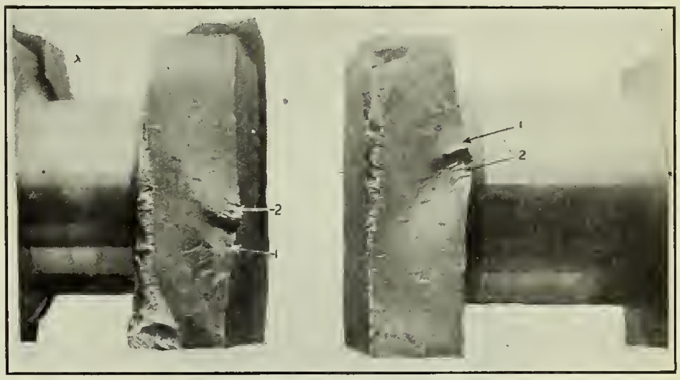


Fig. 8—Fractured Ends of Crank Shaft.

Fig. 8 illustrates a crank shaft for a 6-cylinder engine that failed in early life due to improper manufacture. The shaft was forged into a slab and cut out to form, twisted to give the right angles between arms and turned up to sizes. The section to the left shows the fractured end of the crank

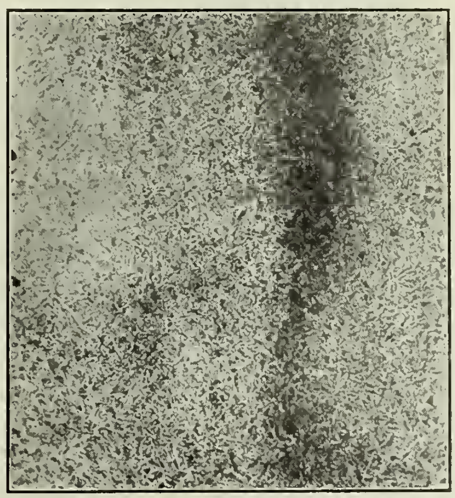


Fig. 8A—Structure of Steel in Section of Crank Shaft near Fillet—Note Dark Horizontal Band with Non-Metallic Inclusion.

shaft; the bearings turned on this, allowing the grain of the steel to be cut at the fillets. The shaft failed from fatigue starting at several places in the fillet, as indicated by the arrows. The defects were minute ends of non-metallic inclusions. It will be noted that the combined fatigue cracks continued over nearly seven-eighths of the section. Excellent steel but poor forging practice. The section to the right shows the opposite fractured end. Here the finish on the fillet was free from tool marks and scratches.

There is another type of failure, or rather a start of failure. A weld on a steel forging sometimes is the cause, and great care should be used in the welding operations on parts that are subjected to heavy stresses. Fig. 9 shows a view of a locomotive crosshead-end (right section cut off

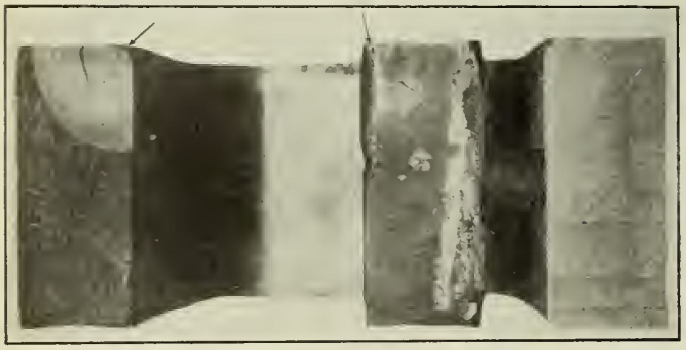


Fig. 9—Failure Caused by Weld.

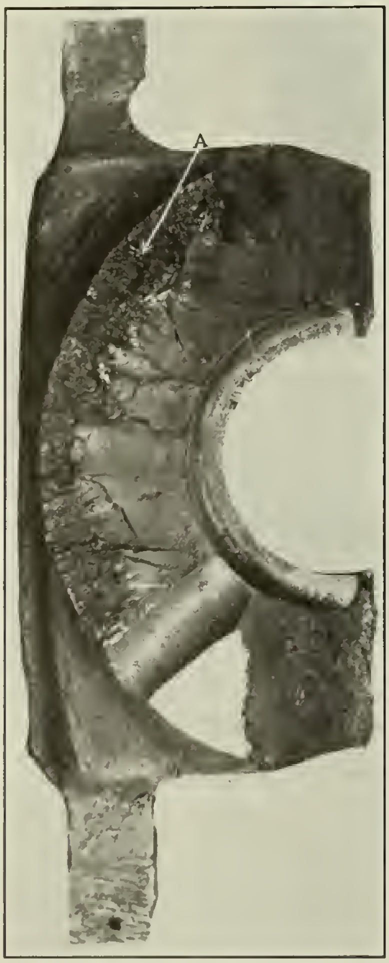


Fig. 10—Failure due to Flaws in Casting.

and moved towards the centre) which failed from a fatigue crack that severed one section and started another fatigue crack on the opposite section. The start of the failure is readily seen, the cracks in the right-hand section being the older of the two, both were progressive, starting from deposited metal.

Fig. 10 illustrates a failure of a casting, a steel crosshead. This shows that the metal in that portion of the casting

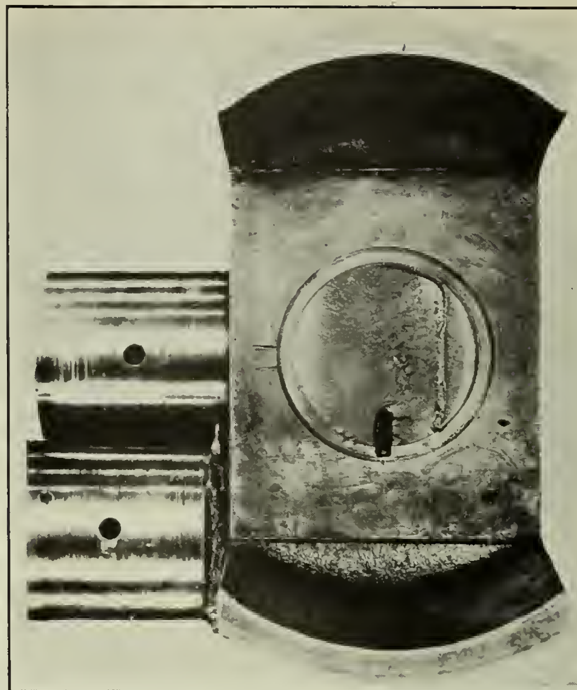


Fig. 11—Score Marks Causing Failure in Stationary Engine Crosshead.

near the riser or gate was poor and cracked due to flaws. The microscope reveals the fact that the impurities weaken the material, so that on cooling, the casting either cracks or is so weakened by stresses that it fails when subjected to heavy strains in service, as occurred in this case. Note flaw to the left of the fracture at A.

Fig. 11 explains a most interesting failure in the crosshead of a stationary engine. This failed in service and is a

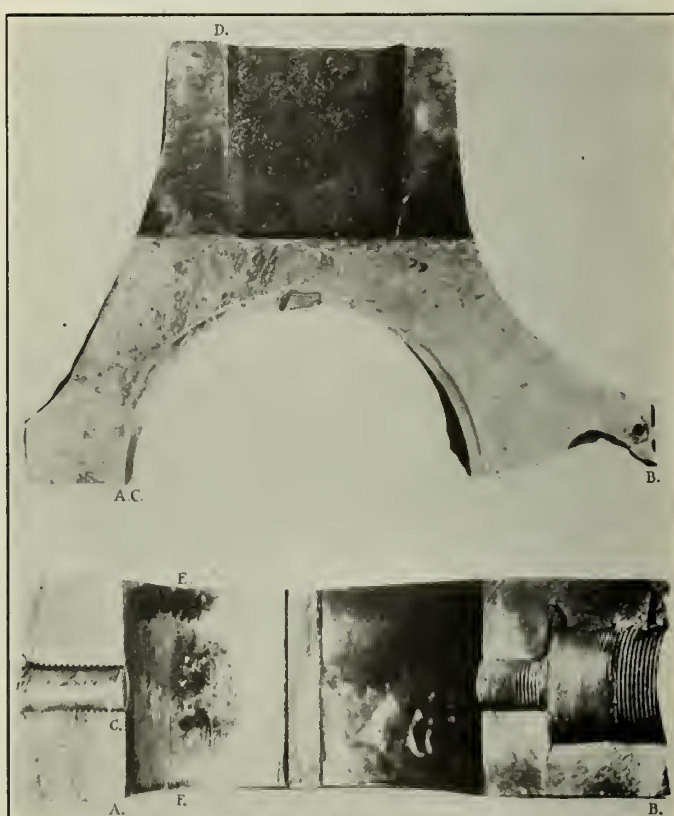


Fig. 12—Side and End View of Broken Leading Locomotive Side Rod.

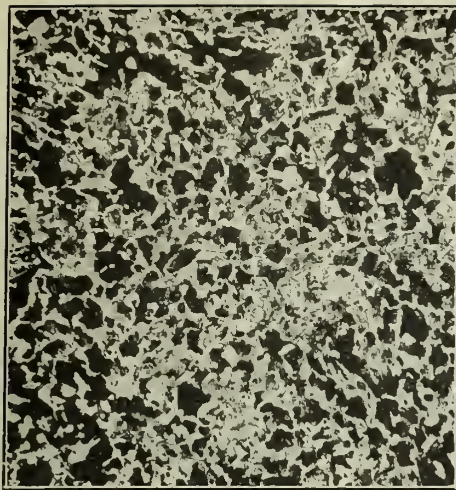


Fig. 12A

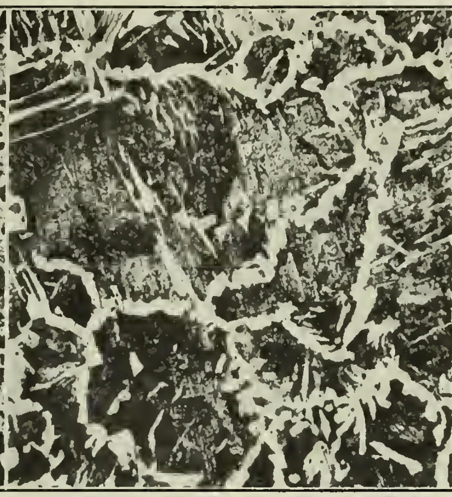


Fig. 12B

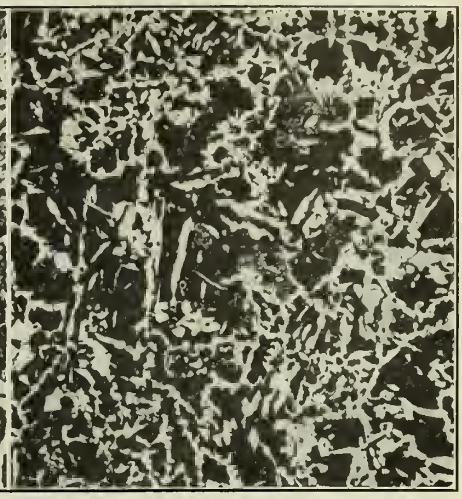


Fig. 12C

typical example of fatigue cracks starting from score marks due to wear. These were not removed when under repair and failure was the result. The usual fatigue crack with its ending in failure is as sure as if the material was broken up deliberately. In this case the fillets on both pins were slightly cut in service and the fatigue cracks started from these small marks.

Fig. 12 shows a side and end view of a broken leading left side rod from a locomotive. At *A* is the location of the specimen for the microscope, the structure of which is illustrated in Fig. 12B. The grain is very coarse, giving indication of the high temperature to which the rod has been subject in service. The fracture started in material with this structure. At *B* is the location of another specimen for the microscope whose structure appears in Fig. 12A. The grain here is fine and uniform, giving indication of heat which changed the structure from the original. For that at *C* see Fig. 12C, indicating the fine structure throughout the rod when put in service. The grain is fine and uniform over the greater portion; some areas have a coarse grain with traces of forging structure. *C* is the location of the start of the crack and the dark bands at *E* and *F* are where the fit of the bushing is at least 1/32-inch slack, tapering towards the centre, leaving for bearing a strip scarcely two inches wide of fit, the rest being slack.

Examination of fractured steel forgings throws considerable light on the subject of failures of steel parts, and the importance of lubrication in service.

When a steel forging, in contact with bronze, heats up, some of the copper, or content of that bronze, enters the steel resulting in hot short, causing a number of cracks which start fatigue failures, if not the failure itself.

Fig. 13 illustrates the outer surface of a piece of boiler plate. The depression shown has the appearance of a crack; however it is a corrosion crack and often causes failure. It is due to the combination of corrosive action, a question of electrolysis, and strain in the metal.

The structure of steel in boiler plate is shown in Fig. 14 where the rolling lines are quite pronounced. This is taken near the centre of a piece of plate, and the microscope here shows that the plate has been finished at a proper temperature and that the metal is clean with carbon evenly distributed.

A decarbonized surface of a section of a spring leaf is illustrated in Fig. 15. Spring leaf failures are a study in themselves and though failures are known to occur from this structure just what the limits are is now under observation by a number of companies using and manufacturing carbon steel.

This subject is one of great interest to all engineers whether from an operation, maintenance or safety point of view. The microscope is a very valuable instrument in caring for the safety of the travelling public, more valuable, perhaps, than anyone realizes. It tells by vision the paths that should be followed if safety is to be fully achieved.

Fig. 13—Corrosion Crack in Boiler Plate.

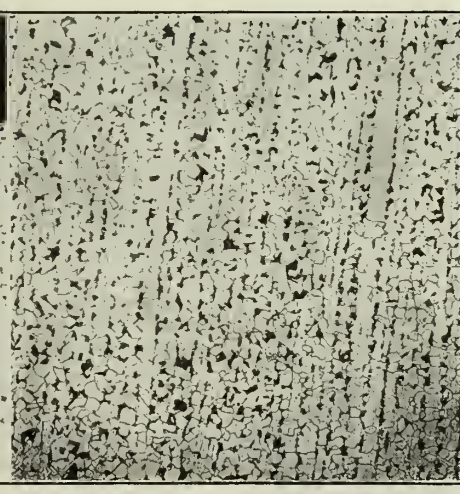


Fig. 14—Structure of Steel in Boiler Plate.

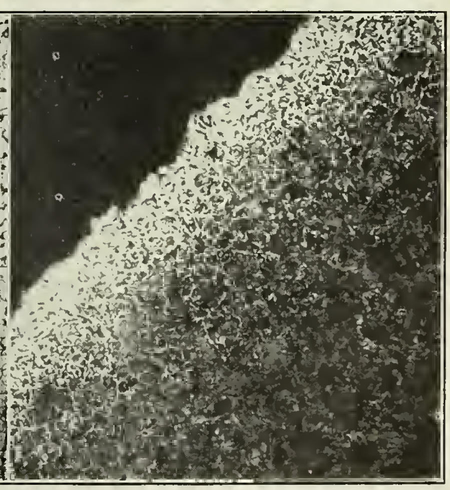


Fig. 15—Section of Spring Leaf, showing Decarbonized Surface.

Aviation in Canada and the National Research Laboratories

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Paper presented on October 15th, 1931, before the Aeronautical Section of the Montreal Branch of The Engineering Institute of Canada (Montreal Section, Royal Aeronautical Society).

SUMMARY.—After a brief account of the progress in aviation in Canada during the past ten years, the author points out the necessity for research facilities in Canada to provide for the development of aircraft types specially suited for Canadian use. He then describes the wind-tunnel, the tank for testing seaplane floats and the equipment for making endurance and economy tests on aircraft engines, which have been established in the National Research Laboratories at Ottawa, Ont.

The development of a country is dependent upon transportation and communication and can only proceed as fast as these facilities permit. This fact is particularly true of Canada, and is of great significance at the present stage in the development of the Dominion.

In Canada, like most other countries, transportation was at first confined to the natural waterways of the country. The early explorers and traders penetrated the country along the chains of rivers and lakes. As settlement proceeded roads and railways were constructed and settlement and development followed these arteries. With increase in population and traffic, improvements in these systems of transportation were demanded—single track railroads were double tracked, locomotive power was increased and trains were operated on faster and faster schedules. Waterways were improved and provided with better safeguards, canals were enlarged and the capacity of harbour facilities was increased. Highway systems were extended and road construction was bettered.

Examination of a map will disclose the fact that at the present time some three-quarters of the area of the Dominion are still unserved by roads or railways. Most of this area has been but little explored owing to its relative inaccessibility by surface transportation. Aircraft, however, requiring no prepared surface track between point of departure and destination, and, when of the boat or float type requiring only the natural landing facilities provided in the numerous lakes and rivers, are well able to give access and transportation to such regions. Once this fact was properly appreciated the exploration and a certain amount of development of these territories began by means of aircraft and has been proceeding rapidly during recent years. As a result, it is learned that much of this country is rich in natural resources.

The mobility and range of vision provided by aircraft enable the topography of country to be readily and rapidly determined and air transportation of personnel and supplies of ground parties greatly facilitates detailed geological, water power and other investigations in promising locations, as disclosed by aerial reconnaissance. Aircraft have thus, in the past few years, been the means of greatly extending our knowledge of the natural resources of the northern regions. But knowledge of the vast potential wealth locked in these regions will be of little use unless the key, in the form of transportation, is provided.

Provision of rail transportation in the near future to much of this territory is impracticable and water transport, even when feasible, is limited to a short period of the year. Air transportation, on the other hand, is practicable with adequate frequency and regularity throughout the year with the exception of relatively short periods during the fall freeze-up and spring break-up. While air transportation is not likely in the near future to be able to handle bulk freight, such as grain, it has already been demonstrated to be quite feasible, even with existing types of aircraft, for the transportation of construction supplies, mining equipment and machinery into this country and products, such as furs and gold, out of it.

It is, therefore, considered that, until the development in any particular locality is sufficient to justify the building of a railroad, aircraft must be largely depended upon to provide the necessary transportation. It is not improbable that in certain regions the requirements and conditions may be such that aircraft can continue to provide all the facilities needed. It thus appears that the key to the development of these regions for many years to come exists in aircraft. This being the case, the production of suitable freight aircraft for such services in the Dominion is an urgent necessity. That aircraft of adequate capacity can be produced is evidenced by the freight carriers already built and in operation, notably the Junker and Vickers freight aircraft.

While in perhaps no other country are aircraft being used in a greater variety of ways or to a greater extent in relation to the population, the most effective uses to which aircraft have been put in Canada have been those in connection with the investigation, development and protection of the natural resources of the country. Aerial surveying and the preparation of maps from aerial surveys have been brought to a very high state of perfection in the Dominion. Each year, large areas are photographed and mapped. Aircraft are performing valuable services in the protection and development of our timber resources through the detection and suppression of fires, combating insect pests and in the preparation of plans for the most economical utilization of the timber. Fishery patrol by aircraft has been demonstrated to be the most effective and economical method yet employed. The possibility of combating the wheat stem rust by dusting from aircraft has been indicated from preliminary trials. The surveyor, geologist and engineer are finding aircraft invaluable aids in the location of railroads, highways, and transmission lines and in connection with river improvements, harbour, terminal and water power developments.

While Canada is undoubtedly well adapted to exploit air travel, the sparse population and excellence of existing railroad facilities in the more settled sections has militated against the successful operation of air routes for the transportation of passengers, mail and express, except in the more remote regions. In spite of these and other handicaps, the air mail traffic in the Dominion has, since its inception, shown a continual increase in volume. The air lines operating in the north country and those serving isolated communities fill a very definite need and have been generally successful. Some of the first self-supporting air lines in the Empire were those serving mining centres in the north.

It is believed that air lines for mail and express in the older sections of the country can be made to pay well if divorced from passenger carrying, if suitably designed aircraft are operated and if public patronage is solicited by a well directed policy of education. Regular passenger air lines, covering territory served by railroads, are, for a number of reasons, unlikely to be self-supporting for some years.

The accompanying diagrams (Figs. 1 to 3), prepared from information published in the Reports on Civil Aviation, indicate the present situation in Canadian aviation

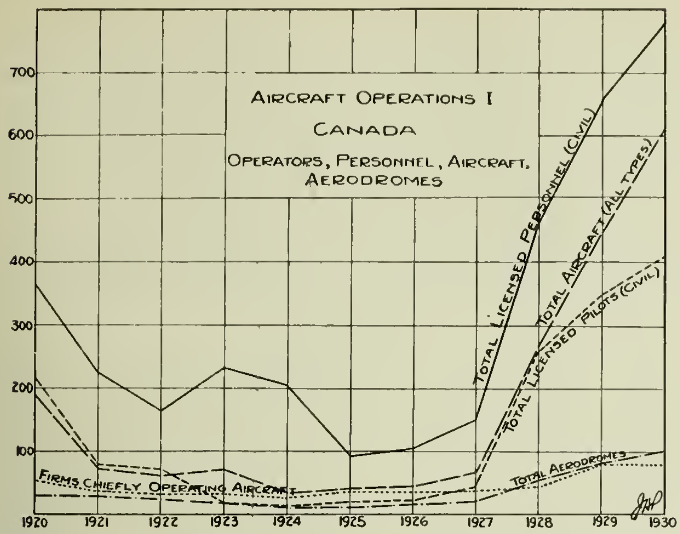

Fig. 1—Number of Aircraft, Personnel and Aerodromes in Canada, 1920-1930.

and the development during the past ten years. The rate of expansion of civil aviation in Canada in recent years has been exceeded in only one other country. They show a remarkable extension during the years 1927-1929, and while progress has naturally been less rapid during 1930-1931, there is no doubt that the upward trend will be resumed when more favourable economic conditions obtain.

Just as the extensive sea-borne commerce of the great maritime nations gives rise to and supports the thriving ship-building industries of those nations and their prosperous maritime commerce at the same time depends upon an up-to-date and efficient industry, so is successful aviation dependent upon a healthy industry. The sound development of national aviation depends upon the building up of an industry capable of constructing and servicing the aircraft required and a flourishing industry depends upon successful aviation. The two are mutually interdependent.

If Canadian aviation is to be enabled to assist, as it is capable of doing, in the development of the country and to be independent of foreign builders and aircraft, every effort must be made to build up a strong aircraft industry in the Dominion. Otherwise, as in the case of most countries which are backward industrially, Canada must purchase from other countries, and, in so doing, pay these countries for their expenditures and efforts in developing their aircraft. Not only will the cost then be greater than if a strong Canadian industry had been developed but the Dominion will be rendered dependent upon foreign builders for her aircraft, which, however unsatisfactory it may be in ordinary times, may be disastrous in times of emergency.

Up to the present, aircraft builders in Canada have been seriously handicapped in their efforts to develop improved aircraft suited to Canadian requirements through lack of adequate research and testing facilities. They are also placed at a distinct disadvantage in competing with builders in foreign countries having at their disposal extensive government research laboratories.

Research facilities are most needed and can do most useful work during the early stages of the establishment of the industry and yet it is precisely during this period that the industry is itself least able to provide such facilities. Well-equipped aeronautical laboratories such as have been provided by the governments of most other countries, would make possible the securing of information essential in the production of improved aircraft and motors suited to the needs of the country, place at the service of the aircraft builders of Canada means for the solution of their technical problems and enable the Dominion to do her share in adding to the scientific and technical knowledge so necessary in the successful development of commercial air routes within the British Empire.

The accompanying diagram (Fig. 4) prepared from information published in the Reports on Civil Aviation and supplied by the Census of Industry Division, Dominion Bureau of Statistics and Customs Division, Department of National Revenue, indicates the relation between the aircraft industry in Canada, foreign imports and Canadian production.

Scientific knowledge and research are playing today a more important part in industrial progress than ever before and, while most industries are indebted to these, none are more so than aviation. The rapid development in all branches of aviation during the past twenty years has been very largely the result of valuable painstaking research in the science of aeronautics. Further progress in air transportation and the aviation industry is dependent

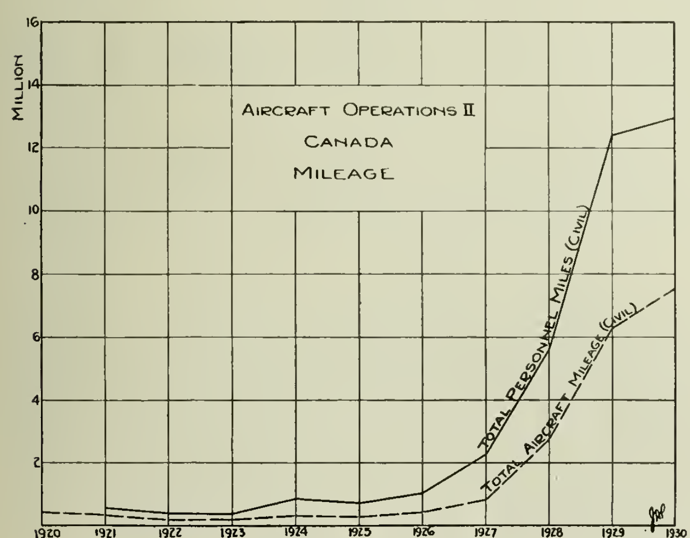

Fig. 2—Aircraft Mileage in Canada, 1920-1930.

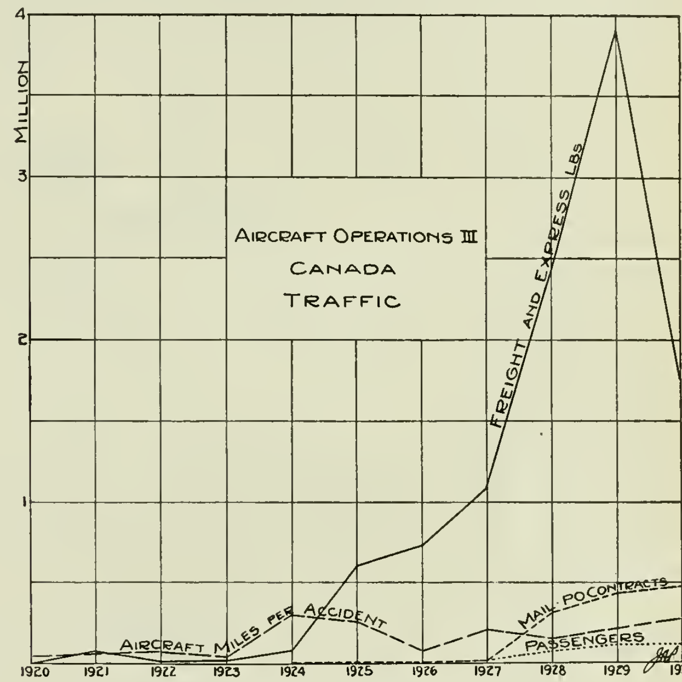

Fig. 3—Traffic Statistics in 1920-1930.

on continued research effort. Advances greater than any yet made may well result from future research in aeronautics.

Research work may, in a general way, be divided into three types, which are adapted to three different classes of organization. So-called "fundamental" research, contributing to basic theory or pure science, is generally carried on in educational institutions and private research laboratories and occasionally in laboratories of far sighted industries. "Practical" research on the other hand, directed to the invention of a particular method or device, or the solution of a special problem of manufacture, is the work of the industrial laboratory. The principal function of a government laboratory is the conducting of researches of general and immediate application and primarily national in character. Studies for the solution of problems or improvement of methods or products of a whole industry for the general good of the industry and the country are properly the work of a government laboratory.

Thus, the great mass of general information accumulated from work in government aeronautical laboratories is largely the basis for the design and construction of aircraft and engines, for government regulations for the construction and operation of aircraft and engines and for improvements in the efficiency, safety and comfort of aircraft.

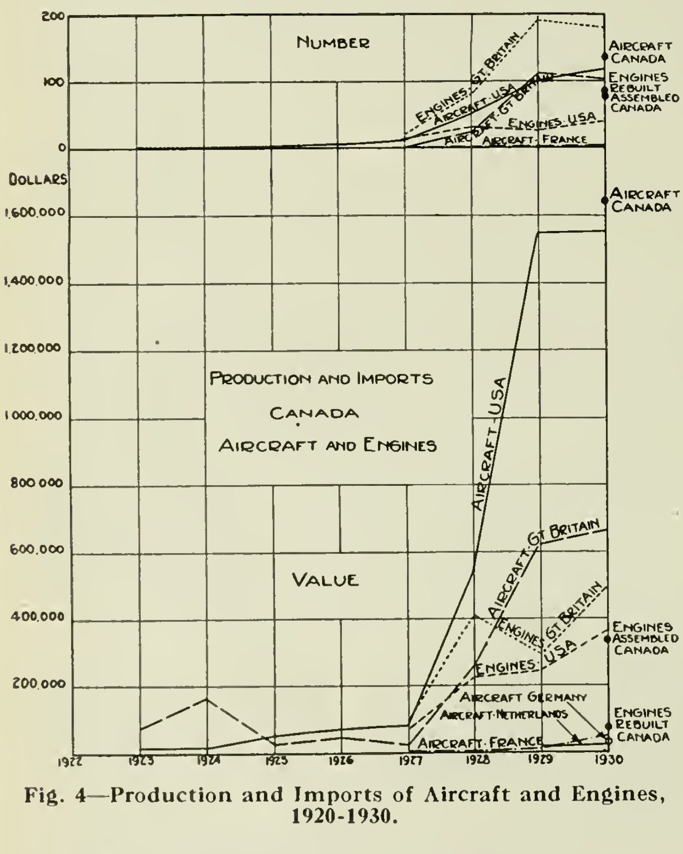

Fig. 4—Production and Imports of Aircraft and Engines, 1920-1930.

If the most effective use is to be made of aircraft in Canada in the future, adequate research facilities must be provided to assist designers and the industry to develop improved aircraft, suited to the conditions and requirements of the country and to solve the problems arising in Canadian aviation. The National Research Council has, therefore, with the approval of the Sub-Committee of the Privy Council for Scientific and Industrial Research, undertaken to provide, in the National Research Laboratories now being established at Ottawa, facilities for aeronautical research.

While aeronautics embraces most branches of engineering, the special equipment being installed for aeronautical research at Ottawa includes a wind tunnel for aerodynamic investigations, a test tank for hydrodynamic studies and tests and an engine dynamometer for aircraft engine work. Aeronautical investigations in other branches of engineering, such as in strength of materials, metallurgy, radio, sound, illumination and photography, will be made in the laboratories of the Physical, Chemical, Engineering and other divisions of the National Research Laboratories.

As design, construction and installation of the equipment for aeronautical research is still proceeding, it is not possible at this time to do more than describe the equipment in a general way, without giving specific information as to its operation.

Wind Tunnel

The wind tunnel is now recognized as the most important element of an aeronautical laboratory. As its general use, construction, theory and requirements are well known, it is not proposed to deal with them in detail in this paper.

Tunnels now in use, with the exception of variable density tunnels, are of the atmospheric type, in which the pressure in the air stream is substantially atmospheric. Such tunnels may be classified as follows:

(*a*) Open return, closed air stream (N.P.L. and R.A.E. types).
(*b*) Open return open air stream (Eiffel type).
(*c*) Closed return, closed air stream (modified Göttingen type).
(*d*) Closed return, open air stream (Göttingen type).

An important requirement in a wind tunnel is a steady uniform current of air and, from this standpoint, open and closed return tunnels are equally satisfactory. The closed return tunnel, however, possesses certain important advantages compared with the open return, namely:

1. Compactness, requiring a smaller building to house the tunnel and consequently lower initial cost.
2. Low power consumption, due to conservation of the energy in the return air stream.
3. Greater accessibility and convenience of operation.

The first advantage is strikingly demonstrated by the fact that it is possible to build two closed return tunnels in the space occupied by one open return tunnel.

The measure of the efficiency or power economy of wind tunnels is the ratio of the brake horse power of the driving motor to the kinetic energy per second of the air passing the working section. This ratio, termed the power factor, may be expressed

$$\frac{550P}{\frac{1}{2}\rho A V^3}$$

Some typical values of the power factor for atmospheric wind tunnels are as follows:

Open return tunnels—N.P.L. type	1.60
Open return tunnels—R.A.E. type	0.89
Closed return—open jet—single return Göttingen tunnel	0.68
New 5-ft. tunnel—Farnborough	0.38
10-ft. tunnel—California Institute of Technology—open jet	0.28
closed jet	0.192
20-ft. tunnel—Langley Field—double return	0.62

The very low power factors reported for the California tunnel are attributable principally to, first, the extremely short length of the open air jet, namely 0.8 diameters* as compared with 1.5 and 1.83 diameters for the Göttingen and Farnborough tunnels, respectively, and, second, to the fact that the cross section is circular throughout the circuit.

There appears to be some slight sacrifice in economy if, in closed return tunnels, a double return duct is used

*Measured from nozzle exit to collector throat.

(as in Ottawa), instead of the single duct. Based on model tests, a figure of 0.48 has been estimated for the double return as compared with the figure above, 0.38, for the single return. Preliminary tests of the Ottawa tunnel have yielded results indicating a power factor of 0.38 without honeycomb or propeller screen, the length of jet being 2.1 diameters. The maximum air speed so far attained is about 150 miles per hour.

The greater freedom and accessibility permitted by the closed return arrangement with open air stream is not the least advantage of this type of tunnel. Free access to the model not only makes the setting up and adjustment much simpler and more convenient, but makes it possible to assemble the model complete with balances outside the air stream. In addition, while the corrections to be applied to allow for the influence of the stream boundaries in the open and closed stream tunnels differ but little on tests of aerofoil and streamline models, in the case of propeller tests, the corrections are much smaller for the open air stream.

There were two features in which the original Göttingen tunnel differed from other tunnels and which contributed largely to its low power consumption. These were the rapidly converging nozzle at the entrance to the experimental section of the air stream, and the cascades of guide vanes at the corners of the air passages. In the nozzle, the contraction in area, usually about 4:1, results in a corresponding increase in velocity of the air stream thereby reducing the effect of velocity fluctuations existing at the entrance to the nozzle. At the same time, it permits the honeycomb to be placed in a region of low velocity with consequent reduction in the power loss due to the honeycomb.

The guide vanes direct the air around the corners of the air passages in such a way as to maintain a uniform distribution of velocity across the air stream and with a minimum of turbulence.

Because of these advantages, the closed return, open air stream type was adopted for the Ottawa tunnel. The actual arrangement of the tunnel was governed by certain local conditions.

The building in which the tunnel was to be housed was already in existence and was of such form that a double return tunnel, with the plane of the circuits horizontal, could be housed to better advantage than a single return. Previous to making this decision comparatively few double return tunnels of this type had been built. It has been since learned that the construction of two such tunnels is under consideration in England and one in Germany.

The dimensions of the building were sufficient to permit the construction of a tunnel having an air stream not larger than 9 feet in diameter.

A small hydraulic power plant was available on the property, having a minimum continuous generating capacity of 600-h.p. at low water. It was originally proposed to employ the whole output of the plant for the wind tunnel.

Accordingly the decision was made to construct a 9-foot diameter, 600 h.p. open jet, double return wind tunnel. Design was started in September, 1929, and construction in November, 1929. The tunnel was first operated at full power early in June, 1931.

The general arrangement of the tunnel will be apparent from Fig. 5. The principal dimensions are tabulated below:

Building (inside) length		140′ 4½″
width		50′ 6″
height—side		17′ 6″
centre		25′ 0″
Tunnel—overall inside dimensions—length		107′ 6″
width		50′ 6″
Nozzle—17 ft. square at entrance, 9 ft. diameter at exit.		25′ 0″ long overall
Free air stream	9′ 0″ diameter	13′ 0″ long
Collecting bell	14′ 0″ diameter at entrance. 10′ 0″ diameter at exit.	6′ 0″ long
Expanding cone	13′ 0″ diameter at exit	25′ 0″ long
Transition section	13′ 0″ diameter at entrance. 13′ 0″ square at exit.	14′ 0″ long
Return passages (two)	6′ 6″ × 13′ 0″ high at entrance, 125′ 0″ long (approx.) on centre line. 8′ 6″ × 17′ 0″ high at exit.	

The tunnel, with the exception of part of the nozzle, collecting bell and expanding cone, is constructed of reinforced concrete, resting directly on bed rock. The tunnel is self-supporting and is quite independent of the building.

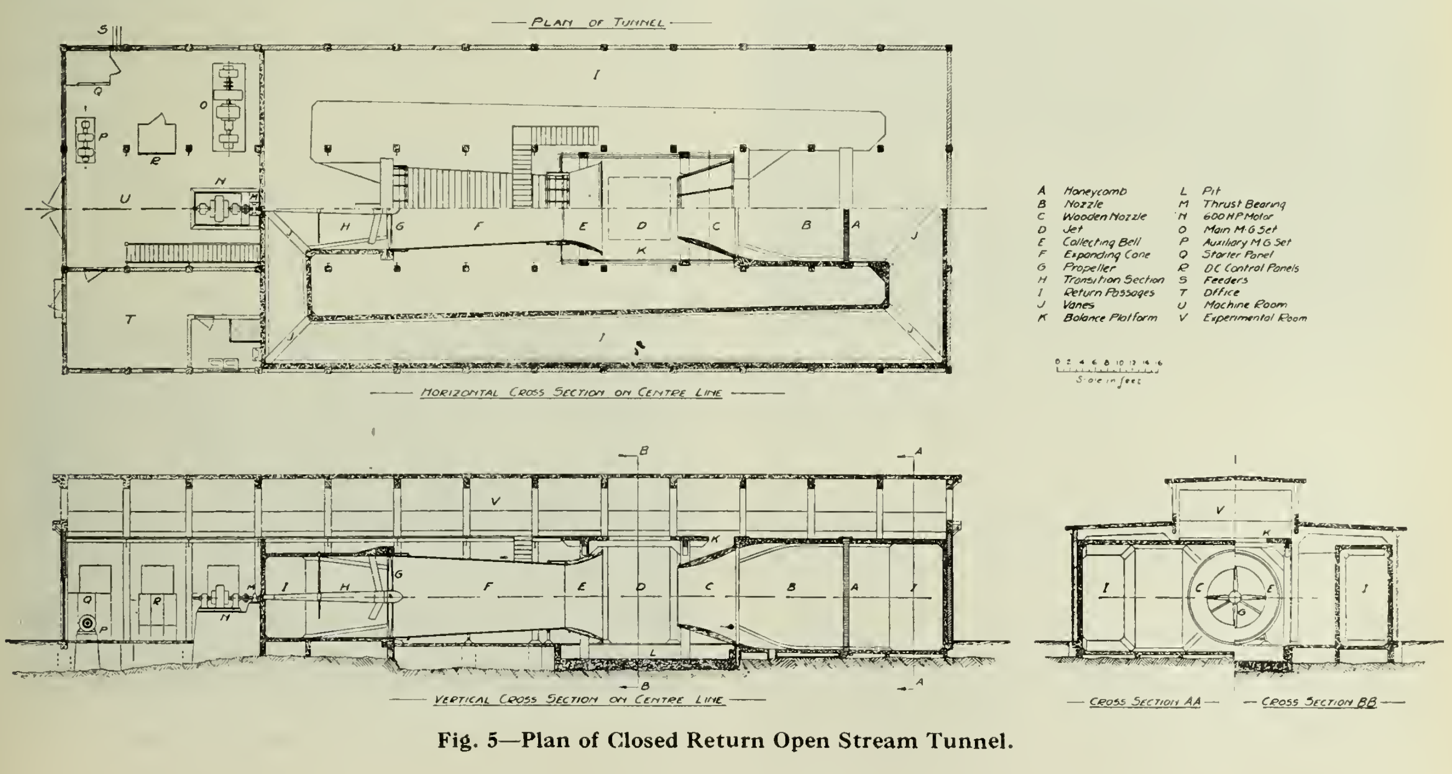

Fig. 5—Plan of Closed Return Open Stream Tunnel.

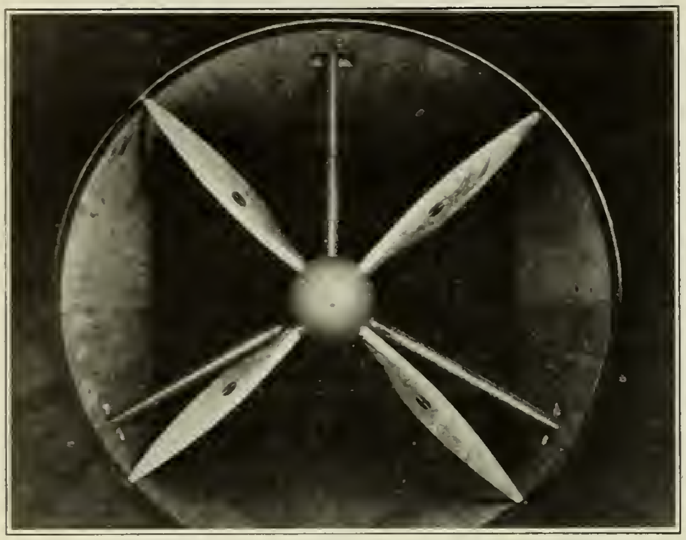

Fig. 6—Propeller.

All foundations of machines rest directly on bed rock.

The nozzle is constructed partly of reinforced concrete and partly of wood.

The contraction in area in the nozzle is over 4½ to 1, and the bursting pressure on the walls of the square section is about 55 pounds per square foot at maximum air speeds. In the concrete portion of the nozzle the section changes from 17 feet square to 14 feet 9 inches diameter circular.

The remainder of the nozzle is constructed of staves of B.C. cedar with steel hoops and is held by means of eight tie rods to a heavy steel ring anchored on the face of the concrete portion of the nozzle. The attachment is so arranged that adjustment of the nozzle is possible in order to align the jet.

The honey comb is composed of straight and crimped strips, spot welded together in units which are suspended from above and compressed from the two sides. To permit this, the honeycomb is located within a structural steel frame set in the concrete of the tunnel. The material of the honeycomb is 26 gauge (.018 inches thick) non-corrosive alloy. The cells are trapezoidal in cross section, averaging 2 inches to a side and are 9 inches long.

The collecting bell and expanding cone are constructed of B.C. cedar staves, those of the bell being shaped to the required curvature. The cone is of usual wood stave pipe construction. The bell and cone are supported on structural steel cradles. The large end of the cone fits in a recess turned in a cast iron ring embedded in the concrete of the transition section and is held thereto by means of a series of bolts.

Provision has been made for the insertion of a cylindrical section between nozzle and collecting bell, should it be desired to enclose the jet for high speed work.

The propeller is of the usual aircraft type, with four adjustable dural blades held in an alloy steel hub. The diameter is 13 feet. Its maximum speed when absorbing 600 h.p. is 1,000 r.p.m., at which speed the tip velocity is about 680 f.p.s.

The propeller (shown in Fig. 6) is carried on a steel shaft, some 25 feet long, which is coupled directly to the shaft of the driving motor. The propeller shaft is carried on roller bearings at motor and propeller ends with a roller steady bearing midway between.

The propeller bearing is supported on three radial cast iron arms of streamline cross section, bolted to the cast iron ring previously mentioned. The propeller turns inside this ring which is bored out to permit a small clearance (about ¼ inch) between blade tip and ring. Three radial arms are employed to avoid synchronization with the propeller blades and the arms, from the shaft outward, are inclined downstream in order to support the shaft close to the propeller hub, while keeping the arms as far as possible from the tips of the propeller blades.

The shaft extends in front of the propeller to carry a wooden spinner and is enclosed back of the propeller in a tapering sheet metal casing. The shaft passes through a sealing plate in the tunnel wall to the motor coupling.

In the original Göttingen tunnels and in later tunnels of the same type built elsewhere, the vanes are roughly of aerofoil section, relatively thick and of large chord. As little published information was available concerning the proper shape and arrangement of the vanes, before designing those for the Ottawa tunnel, an experimental investigation of the subject was undertaken.

The study was made using a wind tunnel 18 inches by 36 inches in cross section, arranged with a right angled bend in which the vanes were placed for testing. Vanes of a number of different cross sections were tested and the effect of profile, chord, spacing, incidence, and other factors studied. Based on the information derived from this research* the vanes employed in the Ottawa tunnel are made of sheet steel, rolled to a 90-degree circular arc. The gap between vanes measured at right angles to the air-stream approaching the vanes is ⅓ chord or roughly ½ chord measured along the diagonal of the corner. The vanes are supported at the ends only, any spacers or stiffeners between vanes having been found to have a detrimental effect on the velocity distribution behind the vanes. The incidence of the vanes will not be finally fixed until tests have been made of the tunnel, although a variation of incidence from 0 to 6 degrees was found to have a relatively small influence on the pressure drop across the vanes in the model tests.

As there is a probability, particularly if the tunnel is run with the air stream enclosed, of the air temperature rising excessively, provision is being made for cooling the air by arranging two of the cascades at the propeller end of the tunnel for water cooling. These vanes are hollow and constructed of welded steel plate.

Power for the wind tunnel is supplied from a hydraulic turbine-driven, 1,000-kv.a., 2,200-volt, 3-phase alternator in a power plant on the property. The plant contains two alternators, either of which can be isolated to supply the wind tunnel only, thus avoiding any mutual interferences between the wind tunnel and other laboratory loads being supplied from the plant.

An electrical machine room is provided at the propeller end of the wind tunnel building.

The 2,200-volt current entering the building passes to a 2,200-volt panel and thence to the main m.g. set. This

*The Design of Corners in Fluid Channels. Klein, Tupper and Green. Canadian Journal of Research, Vol. 3, September 1930.

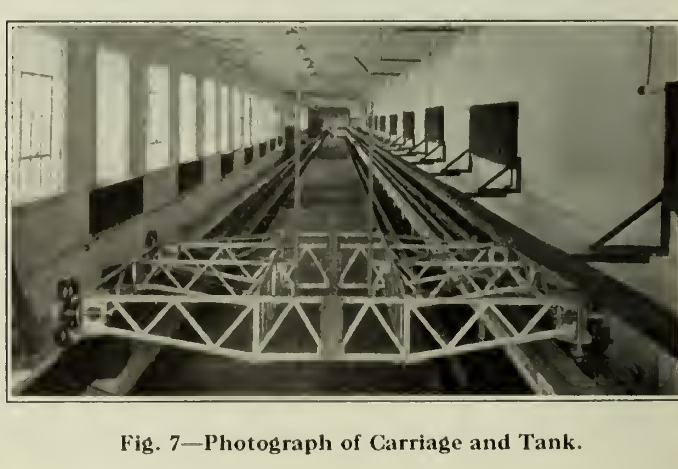

Fig. 7—Photograph of Carriage and Tank.

set comprises a 760-h.p., 2,200-volt, 3-phase, 60-cycle, synchronous motor and a 2,000-amp., 250-volt variable voltage d.c. generator together with necessary exciters. The set is started by semi-automatic starter and may be stopped by push button from any one of a number of stations. Between generator and propeller motor the current passes through the d.c. control panel. The propeller motor is of the shunt type with commutating poles, a continuous rating of 600 h.p. at 1,000 r.p.m. with 40 degrees C. rise of temperature and a two-hour 25 per cent overload at about 1,075 r.p.m. A speed range from under 100 r.p.m. to the overload maximum is provided.

Speed control of the propeller motor initially will be manual from any one of three control stations, one on either side of the air stream below and one on the balance platform above. An automatic control, actuated directly by the air, is under construction.

Complete protective devices and meter equipment are provided.

In addition a 50-h.p. induction motor, variable voltage, d.c. generator set, complete with control equipment is provided for supplying current for testing model propellers in the tunnel.

Balances of the wire suspension type are now being designed and constructed. They are to be mounted on a heavy steel and concrete platform above the experimental section of the air stream. The platform is quite independent of tunnel and building. A large mass of concrete is placed in the floor of the platform to reduce the period of vibration.

Above the tunnel, extending the whole length of the building, is a well lighted room to be employed as an observation room, computation room and shop in which minor adjustments of models and instruments may be made.

In addition to purely aeronautical work, much other work may be conveniently done in the wind tunnel, including the determination of wind pressures on buildings, towers and other structures, design of windmills and ventilators, wind effects on transmission cables, air resistance of motor cars and locomotives and the calibration of instruments.

Test Tank

Flying boats and aircraft fitted with floats are extensively used in Canada, particularly in the north country where the numerous lakes and rivers provide landing places for such craft in country lacking other landing facilities. Improvement of floats and hulls and of the performance of aircraft fitted with them is therefore of considerable importance in the Dominion. For this work a testing tank is essential.

Test tanks are fewer in number than wind tunnels and the greater number of existing tanks are designed and used for ship work. Until quite recently, there was only one tank, that of Messrs. Short Bros., of Rochester, Kent, England, designed for aircraft work. While ship tanks have been used for many years for testing aircraft models, the conditions in aeronautical and in marine work differ materially and ship tanks are not altogether satisfactory for aircraft work. In spite of handicaps, however, much valuable information pertaining to aircraft floats and hulls has been accumulated from work in ship tanks.

High speed is the principal requirement in a tank for aeronautical work. No existing ship tank is able to test a model of usual scale up to flying speed. Although the model speed is the square root of the scale times full scale speed and hence the smaller the model the lower the speed, it is not possible to reduce the scale indefinitely without sacrifice of accuracy in construction of model and in observations.

To attain high speeds, without excessive accelerations and deceleration, a long tank is required. In northern climates a long tank necessitates large capital expenditure for a building to house and heat the tank. The cross section of the tank, however, may be smaller than for marine work, since beam and depth of tank are dependent on model size and aircraft models may be smaller than ship models without sacrifice of accuracy.

There are now under construction in England, Germany and the United States, test tanks designed for aeronautical work only. These are in every case longer and smaller in cross section than existing ship tanks and provision is being made for much higher carriage speeds.

A German ship tank is being provided with a new high speed carriage for aeronautical work.

In fixing on the dimensions of the Ottawa tank, in addition to the foregoing general considerations local factors had to be considered. As in the case of the tunnel, a building was available some 410 feet by 18 feet by 16 feet high. In this building a tank 394 feet 2 inches long by 9 feet 0 inches wide by 6 feet 0 inches deep has been built.

The general arrangement of tank and building are shown in Fig. 8.

The tank is constructed of reinforced concrete and rests on solid rock for about 100 feet of its length at one end, the remainder resting on well tamped rock fill, varying in depth from zero to 6 feet. The bottom of the tank is about 4 feet below the floor of the building.

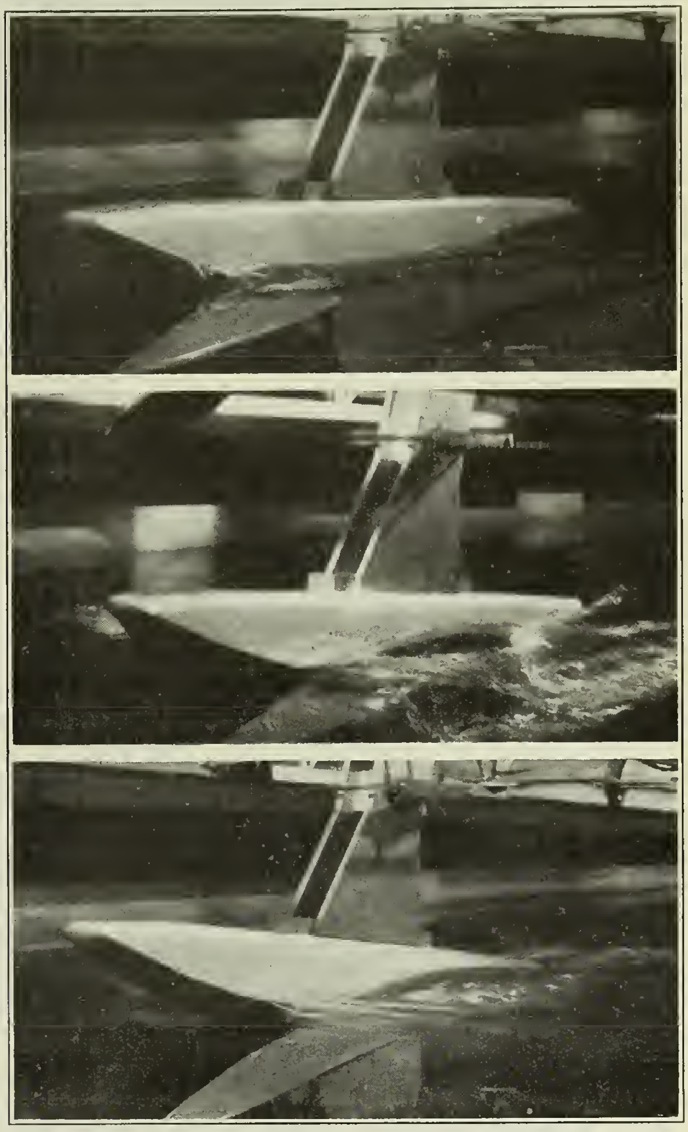

Fig. 8A—Test of Seaplane Float—Speed Three Feet per Second.
Fig. 8B—Speed Seven Feet per Second.
Fig. 8C—Speed Ten Feet per Second.

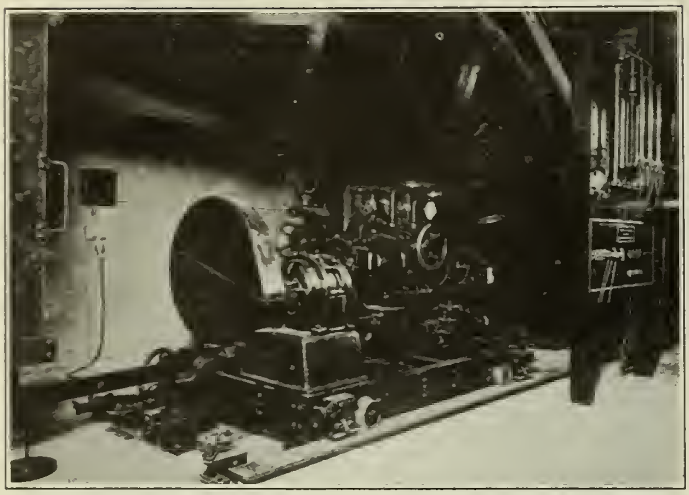

Fig. 9—Dynamometer and Air Duct as Arranged for Test of Tractor Type Air-Cooled Engine.

The rails (80-pound railroad rails) on which the carriage runs are carried on H-beams which in turn rest on the cast iron caps on concrete piers extending above the tank sides. The ends of the rails are planed square and are joined by carefully fitted fish plates. The rails are accurately aligned and levelled.

The carriage (see Fig. 7), is constructed of light structural steel and runs on four light steel disc wheels with narrow flat steel treads (without flanges). The wheels turn on roller bearings on fixed axles. At each end of the carriage on one side is a pair of guide rollers running in contact with the sides of the rail head. The rollers on the inside of the rail are fixed. Those on the outside are maintained in contact with the rail head by spring pressure.

As the speeds being provided for in the design are too high to permit of securing the necessary acceleration by traction between steel wheels and steel rails (probably wet) the carriage is to be drawn along the tank by steel cables. The arrangement will in general be similar to that in a traction elevator, using an endless steel cable passing around a driving sheave at one end and an idler sheave at the opposite end of the tank. Wooden troughs at one side of the tank support the cable and eliminate catenary sag between the sheaves.

The driving sheave is driven through a speed reducer and variable speed gear from an induction motor. An automatic control has been designed for the driving system which will control the car during acceleration, constant speed run and deceleration. As the balance is also to be automatic, it will not be necessary to carry an observer on the carriage.

Owing to the very short time available for measurement and observation during the constant speed portion of the run, the towing balance must necessarily record automatically. The actual design of the balance embodies a number of new features as compared with existing towing balances. It is being constructed throughout of metal.

The tank may also be used for work on surface vessels, calibration of current meters and certain hydraulic work in addition to the purely aeronautical work.

The tank is now being prepared for regular work and Figs. 8A, 8B and 8C show the wave formation at various speeds, exhibited during a preliminary run with a model of a seaplane float.

Power Plant Equipment

There are now three firms in Canada assembling aircraft engines and Canadian assembled engines have been exported. The Dominion government, under Air Regulations 1920, is required to test aircraft engines for export to establish their airworthiness. Up to the present the government has not possessed facilities for making such tests. As the testing of engines for this purpose is very properly a function of the National Research Council, an engine testing laboratory is being equipped in the National Research Laboratories.

The equipment, the installation of which is now practically completed, includes an hydraulic type dynamometer of British manufacture capable of accommodating aircraft engines of any type, air or water cooled, tractor or pusher, right or left hand rotation, and of absorbing power up to 1,000 h.p. at speeds up to 2,500 r.p.m.

For cooling air-cooled motors under test, a large motor driven centrifugal fan is arranged to discharge a blast of air through a cylindrical duct and adjustable nozzle past the engine cylinders. Air speeds up to 130 m.p.h. are obtainable.

The equipment is unique in that provision is made for the application of thrusts to the engine crankshafts corresponding to propeller thrusts up to 6,000 pounds.

Fig. 9 shows the dynamometer and air duct as arranged for testing an air-cooled tractor type engine. The lever and apparatus for the application of end thrust is seen at the left.

All necessary accessories and instruments such as flow meters, tachometers, thermometers and oil temperature control are included.

As the equipment is being installed in the city of Ottawa, the question of noise suppression is a serious one. The dynamometer is being placed below grade level in a room excavated out of the rock. The exhaust and cooling air pass from the room into a large exhaust silencing chamber, also below grade, from which they escape to the open air through small openings in a wall facing across a river.

Again, while installed primarily for aircraft engine work the equipment because of its flexibility and range will enable much general research and testing of internal combustion engines to be done and, being the only equipment of its kind in the country, permits investigations not otherwise possible to be made.

Shops

Well-equipped machine and wood working shops have been fitted up on the property to serve all divisions of the National Research Laboratories. In these shops much of the equipment of the aeronautical laboratories has been and is now being made, including the tank carriage, wind tunnel and towing balances. The models for wind tunnel and test tank will be made in these shops.

In addition to the central shops, small shops equipped with bench lathe, drill and grinder and the necessary hand tools are located in the different laboratories. In these small jobs incidental to the arranging of experimental apparatus may be done by the researchers, more satisfactorily and economically than in the main shops.

While the aeronautical laboratories are being equipped primarily for aeronautical investigations and testing, they will be found useful for a great variety of work of a non-aeronautical character. The equipment, because of its type and capacity, enables investigations, not otherwise possible, to be made in the Dominion. From an aeronautical standpoint, the laboratories provide the government with urgently needed testing facilities and relieve the Canadian aircraft industry of serious handicaps under which it has previously laboured.

By courtesy of Canadian National Railways.

A View of Downtown Toronto Looking Toward the Waterfront

FORTY-SIXTH ANNUAL GENERAL MEETING IN TORONTO

ON

FEBRUARY 3rd, 4th and 5th, 1932

The forty-sixth Annual General Meeting of The Engineering Institute of Canada is scheduled to convene at Headquarters, 2050 Mansfield street, Montreal, during the third week in January, 1932, for the reading of the minutes of the last Annual General Meeting and the appointment of scrutineers and auditors, after which the meeting will be adjourned and reconvened at Toronto, Ont., on Wednesday, Thursday and Friday, February 3rd, 4th and 5th, 1932.

The reconvened meeting and other functions will be held at the Royal York Hotel, Toronto, Ont., and arrangements have been made to accommodate a large number of guests.

The programme of the functions is now being arranged, and a most interesting and enjoyable three days are in prospect.

The Annual General Meeting was last held in Toronto in 1926 at which time the members of that Branch amply demonstrated their capacity for organization, and their enviable record is sure to be equalled, if not bettered, in February, 1932.

THE

ENGINEERING JOURNAL

THE JOURNAL OF
THE ENGINEERING INSTITUTE
OF CANADA

VOLUME XIV NOVEMBER 1931 No. 11

Our Branches and Their Activities

One of the most active discussions which took place at the Plenary Meeting of Council centred around the report of the Papers committee. It will be remembered that this committee was reorganized last year, and its membership considerably extended, for it was felt that heretofore this important standing committee of The Institute had not been able to function as originally intended. Committee reports are, as a rule, somewhat dry reading, but in this case the report contained information gathered by the committee as to the doings of practically all of The Institute branches, large and small, which afforded a notable cross-section of their activities. The data collected on this subject were accompanied by interesting comments and suggestions from the chairman, R. B. Young, M.E.I.C., and the information presented was so striking that the Council has directed its transmission for the information of all branches.

It cannot be too strongly urged that the accomplishment of The Institute's task of facilitating "the acquirement and interchange of professional knowledge among its members," and enhancing "the usefulness of the profession to the public," depends primarily upon the work of the branches. Our general professional meetings and our publications are sponsored by The Institute as a body, but the educational work of The Institute, the stimulation of the interest of its members in professional and technical questions, and the dissemination of professional information, should be, and are, very largely the objects of our branch meetings. These meetings afford the needed opportunities for our members to express themselves regarding engineering affairs, and, particularly in the larger branches, give scope for making and maintaining those personal contacts between members of different divisions of the profession, which are often so valuable.

There is another aspect to which attention was drawn during the discussion on the report, namely, the fact that, particularly in our smaller branches, local resources are apt to be limited, and it was shown that there certainly exists a need for some effective agency which will assist such branches to obtain their due share of papers, technical communications, and lectures.

Mr. Young's committee rightly laid stress on the social side of The Institute's work, and showed how successful some branches have been—and these not necessarily the largest—in securing public recognition of the place held in their community by The Institute and its members. This has been accomplished in many cases in spite of many obstacles, and there are a number of instances where functions sponsored by our branches really hold a leading place among local social events. In the committee's opinion, branch activities should not be exclusively directed towards professional ends. Entertainment and hospitality should have their place along with engineering, and branch programmes should be selected to suit local needs in these respects.

The Papers committee, as reorganized, if it fulfils the aims outlined in the report, will be performing a task of considerably greater importance and wider scope than that defined in the by-law which now governs its activities. The additional duties which it is now proposed that the committee should undertake form a legitimate extension of its activities, and cannot fail to be of great assistance to our branch executive committees and branch secretaries.

During the discussion the hope was expressed that members of Council, on their return from the Plenary Meeting, will take an early opportunity of laying before their constituents some of the salient points brought out in the report of the Papers committee, and in the discussion which followed its presentation.

List of Nominees for Officers

EXTRACT FROM BY-LAWS

Section 68—Not later than the seventh day of November, the Secretary shall mail to each corporate member of The Institute the list of nominees for officers, as prepared by the Nominating committee and the Council.

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. The words "Special Nomination" shall be printed conspicuously near such names, and the names of the members making such nominations shall be printed on some part of the officers' ballot.

Section 74—Notices shall be deemed to have been mailed to members as prescribed by the By-laws if such notices are printed in The Journal of The Institute and mailed by the dates prescribed in the By-laws.

NOMINATIONS

The report of the Nominating Committee was presented to and approved by Council at the meeting held on October 16th, 1931. The following is a list of the nominees for officers as prepared by the Nominating Committee and now 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 1932 as Proposed by Nominating Committee

PRESIDENT:	Charles Camsell, M.E.I.C.	Ottawa.
VICE-PRESIDENTS:		
**Zone "B"*	A. H. Harkness, M.E.I.C. R. S. McCormick, M.E.I.C.	Toronto. Sault Ste. Marie.
**Zone "C"*	A. B. Normandin, A.M.E.I.C.	Quebec.
**Zone "D"*	Sydney C. Mifflen, M.E.I.C.	Glace Bay.
COUNCILLORS:		
‡*Cape Breton Branch*	J. R. Morrison, A.M.E.I.C.	Sydney.
‡*Moncton Branch*	J. G. Mackinnon, A.M.E.I.C. L. H. Robinson, M.E.I.C.	Moncton. Moncton.
‡*Quebec Branch*	Hector Cimon, M.E.I.C.	Quebec.
††*Montreal Branch*	A. Duperron, M.E.I.C. D. Hillman, M.E.I.C. F. Newell, M.E.I.C. P. L. Pratley, M.E.I.C.	Montreal. Montreal. Montreal. Montreal.
‡*Ottawa Branch*	G. J. Desbarats, M.E.I.C. John McLeish, M.E.I.C.	Ottawa. Ottawa.
‡*Peterborough Branch*	R. L. Dobbin, M.E.I.C.	Peterborough.
‡‡*Toronto Branch*	J. J. Traill, M.E.I.C.	Toronto.
‡*Hamilton Branch*	F. W. Paulin, M.E.I.C.	Hamilton.
‡*Niagara Peninsula Branch*	E. G. Cameron, A.M.E.I.C.	St. Catharines.
‡*Sault Ste. Marie Branch*	A. E. Pickering, M.E.I.C.	Sault Ste. Marie.
‡*Winnipeg Branch*	J. N. Finlayson, M.E.I.C. J. W. Porter, M.E.I.C.	Winnipeg. Winnipeg.
‡*Lethbridge Branch*	J. B. deHart, M.E.I.C.	Lethbridge.
‡*Calgary Branch*	B. Russell, M.E.I.C.	Calgary.
‡*Victoria Branch*	F. C. Green, M.E.I.C.	Victoria.

In accordance with the directions of Council and in order to provide for the representation of the Saskatchewan Branch for one year to complete the term for which the late Mr. R. W. E. Loucks had been elected, the following nomination has been made by Council on the recommendation of the Branch Executive Committee:

†*Saskatchewan Branch* C. J. Mackenzie, M.E.I.C. Saskatoon.

It will be noted that councillors are being elected this year by only fifteen branches. This is in accordance with the recent change in the By-laws, making the term of office for councillor two years instead of one year, thus insuring a measure of continuity for Council membership.

*One Vice-President to be elected for two years.
†One Councillor to be elected for one year.
††Two Councillors, to be elected for three years each.
‡One Councillor to be elected for two years.
‡‡One Councillor to be elected for three years.

The Fifth Plenary Meeting of Council

The Fifth Plenary Meeting of the Council of The Institute was held on Monday, Tuesday and Wednesday, September 21st, 22nd and 23rd, 1931, the following members being present:

President S. G. Porter, M.E.I.C., in the chair; Past-Presidents R. A. Ross, D.Sc., M.E.I.C., and H. H. Vaughan, M.E.I.C.; Vice-Presidents O. O. Lefebvre, D.Sc., M.E.I.C., (Province of Quebec), T. R. Loudon, M.E.I.C., (Province of Ontario), W. G. Mitchell, M.E.I.C., (Province of Quebec), and H. B. Muckleston, M.E.I.C., (Western Provinces); Councillors P. H. Buchan, A.M.E.I.C., (Vancouver), G. H. Burbidge, M.E.I.C., (Lakehead), J. L. Busfield, M.E.I.C., (Montreal), K. M. Chadwick, M.E.I.C., (Victoria), C. V. Christie, M.E.I.C., (Montreal), H. Cimon, M.E.I.C., (Quebec), F. A. Combe, M.E.I.C., (Montreal), W. P. Copp, M.E.I.C., (Halifax), A. R. Crookshank, M.E.I.C., (Saint John), E. H. Darling, M.E.I.C., (Hamilton), R. L. Dobbin, M.E.I.C., (Peterborough), B. Grandmont, A.M.E.I.C., (St. Maurice Valley), N. M. Hall, M.E.I.C., (Winnipeg), G. N. Houston, M.E.I.C., (Lethbridge), G. E. LaMothe, A.M.E.I.C., (Saguenay), J. A. McCrory, M.E.I.C., (Montreal), P. B. Motley, M.E.I.C., (Montreal), W. P. Near, M.E.I.C., (London), F. H. Peters, M.E.I.C., (Ottawa), R. W. Ross, A.M.E.I.C., (Edmonton), T. Taylor, M.E.I.C., (Toronto), D. C. Tennant, M.E.I.C., (Montreal), G. C. Torrens, A.M.E.I.C., (Moncton), R. S. Trowsdale, A.M.E.I.C., (Calgary), A. E. West, M.E.I.C., (Border Cities), L. W. Wynne-Roberts, A.M.E.I.C., (Toronto), R. B. Young, M.E.I.C., (Toronto), and Treasurer W. C. Adams, M.E.I.C., (Montreal).

Expressions of regret at being unable to attend the meeting were received from Past-Presidents M. J. Butler, M.E.I.C., C. H. Mitchell, C.B., C.M.G., D.Eng., M.E.I.C., and George A. Walkem, M.E.I.C.; Vice-President F. R. Faulkner, M.E.I.C., (Maritime Provinces) and Councillor E. G. Cameron, A.M.E.I.C., (Niagara Peninsula).

MONDAY, SEPTEMBER 21ST

Following the President's introductory remarks of welcome the first item of business taken up was the confirmation of the proceedings of the meeting held on September 8th, 1931, together with other routine business.

The report of the Finance Committee was next presented, including the financial statement for the first eight months of the year, which, considering the present adverse economic conditions, was considered satisfactory.

The Finance Committee having presented a list of members of all classes in arrears for three years or more, discussion followed as to the manner in which these should be dealt with, and in this connection the chairman of the Finance Committee submitted a recommendation which had already been communicated to Council proposing a change in The Institute's By-laws regarding arrears of annual fees. If approved by the membership, this would involve the adoption of procedure similar to that of the American Society of Civil Engineers, whereby a member in arrears for twelve months would automatically forfeit his connection with The Institute and would be so notified by the Secretary. Reinstatement would, of course, be possible on payment of arrears and at the discretion of Council. Prolonged discussion followed, during which the present method of dealing with members in arrears was considered in detail, and ultimately the matter was referred to the Legislation Committee for the drafting of a suitable amendment to Section 37 of the By-laws and other sections affected, for submission to the membership at the Annual General Meeting, and for ballot thereafter, this amendment to follow the lines recommended by the Finance Committee.

The List of Nominees for Officers, prepared by the Nominating Committee, was received, but as acceptances had not yet been sent in from all nominees its consideration was postponed until the October meeting of Council.

After adjournment for lunch, applications for admission and for transfer were considered, together with a number of special cases, and the following elections and transfers were effected.

Elections		*Transfers*	
Assoc. Members	11	Assoc. Member to Member	2
Juniors	7	Junior to Assoc. Member	9
Affiliates	4	Student to Assoc. Member	6
Students admitted	4	Student to Junior	7
		Student to Affiliate	1

The tentative programme for the Annual Meeting at Toronto in February 1932 was approved, and discussion followed as to the necessary action to be taken by The Institute in connection with the meeting which is to be held in Canada at the Bigwin Inn, Ontario, by the American Society of Mechanical Engineers in June 1932. On the invitation of that Society it was decided that The Institute should take part in this meeting, and that the cordial co-operation of The Institute should be offered to the Board of Direction of the society.

Discussion followed on the general question of the extent to which The Institute can helpfully participate in meetings of this kind, and consideration was next given to the proposed visit to Canada in September 1932 of the Institution of Mechanical Engineers (Great Britain). The Secretary reported that he had been in correspondence with the Institution and with Canadian members of the Institution in this connection, and that he had been able to furnish to them information as to the projected Canadian tour, which had been found helpful. His action was approved, and he was directed to give any assistance possible, and, at a later date, when the itinerary is known, to request our branches to do what is possible in receiving and entertaining the Institution party.

The report of the Committee on Membership was next presented, and from this it was noted that while the figures for admissions to The Institute show an increase for the first half of 1931 as compared with 1930, the efforts of the Committee on Membership to promote effective action by the branches regarding this matter have not been so successful as had been hoped. The committee, however, considered that in view of the existing economic situation the results should be regarded as satisfactory, and in their report recommended that the effort to increase membership through the medium of the branches be continued and encouraged, detailed suggestions being proposed with this end in view.

During the discussion several speakers commented on the difficulty arising from the fact that membership in the Professional Associations was compulsory in most provinces, and that particularly in times of financial stringency members were unwilling to pay fees to more than one engineering organization. Further discussion was held over until the following day.

Tuesday, September 22nd

Continuing the discussion on the report of the Committee on Membership it was pointed out that this subject was intimately connected with the service given by The Institute to its members, and with the requirements of the Professional Associations. In the opinion of some Councillors The Institute had not devoted enough study to one of its principal objects, the acquirement and interchange of professional knowledge among its members, and the time had come for a change in The Institute's policy, which would be reflected in a more effective appeal to prospective members. It was felt that special efforts should be made to interest and bring in the younger men, which can most effectively be done by the branches themselves.

The President pointed out that this discussion was covering some of the items which would come up later in connection with the report of the Papers Committee, after which it was resolved that the report be received and that the chairman be asked to present a further report at the Annual Meeting.

The next item of business was the report of the Committee on the Relations of The Institute with the Provincial Associations of Professional Engineers. H. H. Vaughan, M.E.I.C., the chairman of this committee, stated that while his committee had succeeded in securing from nearly all of the Provincial Associations co-operation in nominating members on the proposed National Committee, this proposal had not become effective owing to certain difficulties, the Council of one of the Provincial Associations having maintained that co-ordination of all activities of engineering associations throughout Canada might be obtained more readily by developing a plan which would at first apply only to the Provincial Associations. The Council of that Association in fact declined to approve of the formation of a Dominion-wide committee unless its members were accredited by the Associations alone, the Engineering Institute of Canada taking no further active part for the time being. Under the circumstances his committee had acquiesced, and as a result a committee of four had been convened, the members of which were accredited by the Professional Associations as follows:

C. C. Kirby, M.E.I.C., New Brunswick and Nova Scotia Associations.

J. M. Robertson, M.E.I.C., Quebec and Ontario Associations.

C. J. Mackenzie, M.E.I.C., Manitoba, Alberta and Saskatchewan Associations.

A. S. Gentles, M.E.I.C., British Columbia Association.

The Engineering Institute of Canada had no representation on this committee, whose purpose was, to advise as to the best means for obtaining co-ordination of the activities of the various Provincial Associations.

At the date of the first meeting of the Committee of Four Dean Mackenzie was unfortunately unable to attend, and his place was therefore taken by Dean R. S. L. Wilson, M.E.I.C., of the University of Alberta. Mr. Vaughan announced that a copy of the report of the above committee of four had been sent to him for the information of the Council of The Institute, and he now submitted it for that purpose. As an introduction to the discussion which ensued the members of Council from British Columbia gave a detailed explanation of the policy of the Professional Association of British Columbia in regard to this matter, and pointed out that they had been invited to the Council meetings of that Association in order that they might be able to interpret to The Institute Council the feelings of that body. They believed that the policy adopted would work out eventually to the benefit of The Institute.

After further discussion it was suggested that the matter might perhaps be discussed more freely if Council sat as a committee of the whole, and it was unanimously resolved to do this. While in committee, letters were presented from several absent members of Council regarding the problem of co-ordination, and the general opinion was expressed that The Institute was under great obligation to Mr. Vaughan and his committee for the work which they had accomplished, which had resulted at last on definite action on the part of the Councils of the Provincial Associations. It was felt that further development must necessarily be slow, and that while The Institute was now taking no part in the negotiations it would be desirable to maintain The Institute's committee so as to keep in touch with the Committee of the Associations, and render any assistance which might be requested.

The President felt that definite progress had now been made, and while he still thought it would have been wiser to have had The Engineering Institute recognized as a party to the work of co-ordinating the requirements of the Provincial Associations, he had not insisted on this personal view. He felt also that The Institute should, for the present, withdraw from active participation in the movement, and should continue its own committee as a means of contact and for the consideration of any matters which might arise affecting the interests of The Institute. He thought that as far as the Associations were concerned the provisions of the British North America Act did not form such a barrier to Dominion-wide legislation as some had supposed, and he believed that it would ultimately be possible for the Association Councils to enter into joint agreements with each other and possibly with The Institute.

After adjournment for lunch the discussion was continued, and further suggestions were made, several members being of the opinion that membership in the Associations should be recognized as a qualification for admission to The Institute, and that as the co-ordination of their work was now to be considered by the Associations alone, the way was left clear for The Institute to develop its own policy along constructive lines to take care of the changed conditions of to-day.

Some members felt that the time had come for a really active committee on the policy and development of The Institute, which should report at the next Plenary Meeting of Council, and believed that such changes in the constitution of The Institute should be made as would increase its usefulness to all members of the profession, and prepare for a future change in its relations with the Provincial Associations. After further discussion a small committee was appointed to draft a resolution for the consideration of Council, and on receiving their report the committee rose and reported to Council.

The Council having reconvened with the President in the chair, it was unanimously resolved that The Institute's Committee on the Relations of The Institute with the Provincial Associations of Professional Engineers, including Mr. Vaughan's sub-committee, be discharged; that the thanks and appreciation of Council be extended to Mr. Vaughan for the work his sub-committee has done during the past year, and that a new committee be appointed to keep in touch with and assist the committee of the Associations.

It was also resolved that the Council of The Engineering Institute of Canada wishes to record its appreciation of the efforts of the Committee of Four appointed by the Provincial Associations to consider ways and means of co-operation between them, and to express the hope that these efforts will be continued to a successful conclusion. The Council of The Institute will continue to co-operate with the Associations to the fullest possible extent, and gladly offers to the committee all the facilities at its disposal. A copy of this resolution to be sent to the Council of each Provincial Association.

Council then passed on to the report of the Committee on the Relations of The Institute with other Technical Societies, presented by the chairman, J. A. McCrory, M.E.I.C. This report stated that the arrangement entered into last year with the Council of The Royal Aeronautical Society, London, was working satisfactorily and that negotiations are proceeding for a somewhat similar arrangement with the Institution of Electrical Engineers (Wireless Section), but that in view of the experimental nature of these arrangements, it would be desirable to wait until their operation had been proved before entering into similar agreements with other bodies. In the committee's view action as regards such affiliation should be limited for the time being to the interchange of publications on some equitable basis. Discussion followed, and the report of the committee was accepted, after some criticism as to the indefinite nature of its recommendations. Eventually the latter portion of the report was referred back to the committee with the suggestion that after further study more definite recommendations should be made if possible.

R. B. Young, M.E.I.C., chairman of the Papers Committee, next presented a detailed report on its work, and pointed out that on undertaking the chairmanship of this committee he had felt that its usefulness could be greatly extended if its constitution were changed. This had been done, with the permission of Council, and during the past year he had gathered a good deal of information as to the existing nature of branch activities, particularly as regards the preparation and presentation of papers, and the effective organization of branch meetings. He pointed out that his committee now consisted of a chairman and five members, one from each vice-presidential zone, except Zone A, from which two representatives had been appointed. Each zone member of this committee is, in turn, chairman of a zone committee, whose members are appointed by the branches in that zone, and this arrangement is intended to provide close touch with the problems of the individual branches. In Mr. Young's opinion the most useful function which the Papers Committee could perform was the promotion of branch activity as regards papers and meetings. He presented a tabulated statement as to the number of members in each branch; the frequency and character of the meetings held, and comments and suggestions received from the branches as to how a Papers Committee could best render service. Mr. Young pointed out that the great variation in the size of branches, from 34 to 1,193 members, and their scattered geographical situation, led to great diversity in the problems faced by different branches in providing the desired instruction and entertainment for their members. In general, meetings that are both instructive and social seem to be best adapted to the smaller branches, while in the larger branches regular evening technical meetings seem to be the most popular. He felt that the Papers Committee could perform the following functions with great advantage to the progress of The Institute. First, it can act as a clearing house of information as to the methods adopted by the branches, so that each branch may benefit by the experience of the others. Next, the committee can offer suggestions for the improvement of their meetings for the consideration of branches. Thirdly, joint activities can be organized, and, finally, the committee could collect and distribute information as to subjects and speakers that might be available to the branches. He would ask Council to consider this problem in detail, as the branch activities were really the life of The Institute.

Members present expressed general appreciation of the committee's report, and were particularly impressed by the work which had been accomplished, and the definite nature of the suggestions made. Prolonged discussion followed, during which other valuable suggestions were brought forward, and on the conclusion of the discussion it was unanimously resolved that the report of the Papers Committee be accepted; that the thanks of the Council be extended to it for its report; that the committee be asked to continue its efforts in regard to collecting information from the branches, and that the completed information, together with a summary of the discussion, be printed and distributed to the branches.

In order to provide, as far as possible, for continuity in the functioning of this important committee, it was suggested that while the committee, as a standing committee of The Institute, has to be appointed in February of each year at the Annual Meeting, it would be desirable, each year, for the chairman to continue his activities by retaining office as vice-chairman of the committee after the new committee is appointed, and also that every effort should be made to secure as much continuity as possible in the membership of the committee.

The report on the Committee on Biographies was presented by Mr. F. H. Peters, M.E.I.C., the chairman, and outlined a system of procedure which would result in providing for The Journal biographical sketches of deceased engineers born in Canada or who have worked in Canada. Mr. Peters stated that the Committee on Biographies had been in existence for some considerable time but for various reasons had not been able to undertake a systematic programme, although a number of biographies had been prepared and some of them published. The procedure recommended included the systematic collection of information by questionnaire and otherwise so as to insure that material for the biographies of prominent engineers would always be available when required. After brief discussion the Council adjourned at six thirty p.m., to reconvene at nine thirty a.m. on Wednesday.

Wednesday, September 23rd

After further discussion on the report of the Committee on Biographies it was unanimously adopted, and appreciation was expressed of the service rendered by the committee.

The President stated that Past-President H. H. Vaughan had kindly consented to accept the chairmanship of the new committee whose duty would be to keep in touch with and assist the committee of the Professional Associations which is dealing with the co-ordination of the activities of those bodies. This intimation was warmly welcomed.

The Council next proceeded to the consideration of the proposal of R. L. Dobbin, M.E.I.C., as to the desirability of revising the constitution and By-laws of The Institute, and it was pointed out that this matter would be greatly influenced by any action taken by the Committee of Four representing the Professional Associations. Several members felt that it would be unwise to take any definite action until some progress had been made by that committee. Other members were of the opinion that it would be of great advantage to appoint a Committee on Development to which could be referred not only questions regarding desirable changes in the constitution of The Institute, but also questions of internal policy regarding the relations between Headquarters and the branches, or the method for obtaining increased activity in the educational work of The Institute. The desirability of changing the present classes of membership and methods of admission of new members might also be taken up. The view was taken that it would be some time before the activities of the Professional Associations would be co-ordinated, and in the meantime The Institute should get its own affairs in order, and should not stand still. On the President's suggestion it was agreed to postpone further action on this matter and pass on to the next item on the agenda, this being a suggestion from Professor Copp that means should be adopted for obtaining closer contact between Headquarters and the branches. It was the feeling of the Council that the most important agency in this matter would be the councillors themselves, and that they should pass on, at their discretion, for the benefit of the branch executive committees and members, such information as to the activities of Council as they consider proper and desirable.

Another proposal affecting The Institute's policy came from Professor F. R. Faulkner, M.E.I.C., who advocated the appointment of paid regional secretaries. While it was felt that such an arrangement would probably work out to great advantage, the Treasurer pointed out that the proposal was not a new one; that the principle had indeed been approved by Council, but that for financial reasons it had so far been impossible to entertain it. It would also be very advantageous if Council could make a grant towards the onerous work of the branch secretaries, on whose activities so much depends.

Mr. Trowsdale drew attention to the provisions of Section 56 of the By-laws according to which the percentage of rebates paid to a branch depends on the number of corporate members of the branch He pointed out that in Calgary a change in the number of corporate members from slightly less to slightly more than one hundred had actually caused a material reduction in the branch revenues, and he suggested that an amendment to Section 56 of the By-laws would be proper, so that when the membership of a branch increases to a point where the rebate scale changes, the minimum amount payable under the new scale shall not be less than the maximum received under the old

After further discussion it was unanimously resolved that a payment should be made to the Calgary Branch which will bring their revenue from rebates this year up to an amount at least equal to the maximum paid to them before the increase in membership, and that the whole question of rebates be referred to the Legislation Committee for study

Vice-President Loudon drew attention to the desirability of The Institute undertaking some work which would indicate its interest in the economic side of engineering. He felt that in The Institute one of the greatest difficulties was to get engineers to take interest in their fellow men. In the hope of stimulating this interest, and in view of the present economic situation, Professor Loudon thought that The Institute should now undertake the investigation of one phase of the causes of unemployment, and make the resulting information available to the membership as a whole. He would move that a committee be appointed, possibly with one member from each branch, to (*a*) collect the published information on technological unemployment, and (*b*) to investigate the limits of the commodity requirements of Canada. It was explained that by "technological" unemployment was meant the unemployment resulting from the displacement of labour by machines.

An active discussion followed, from which it appeared to be the consensus of opinion that such an investigation was not within the province or power of The Institute and that such investigations seemed more properly the function of the government, or possibly the National Research Council, bodies which would have at their command funds, resources and information not available to a committee of The Institute. It was eventually decided that a committee be appointed to study the problem and report to Council as to whether The Institute can undertake the investigation suggested, and, if not, what steps should be taken to bring this valuable suggestion before the proper authorities.

Mr. Trowsdale drew the attention of Council to the cost of the E-I-C News, which, according to the financial statement, was approximately $1,600.00 per annum net, and questioned the value of this publication to the membership. He felt that this expenditure on the part of The Institute was not justified, particularly if, as he believed, the outlying branches found it of little value. He asked for discussion on this matter. The opinions of members of Council present were expressed and seemed about equally divided, but it was pointed out that during the inquiry of the Special Committee on Publications in 1929 and 1930, opinions received from the branches showed that a great majority appreciated the E-I-C News, and further that this publication had proved extremely useful in connection with the service of the Employment Bureau. After further discussion it was unanimously resolved that a small committee be appointed to investigate the question of continuing the E-I-C News and present a report on this matter to Council at an early date.

The President reminded the Council that a decision had not yet been reached as to the desirability of appointing a Committee on Development, as suggested by Mr. Busfield, and after some discussion, from which it appeared that the consensus of opinion was that it would be desirable to appoint such a committee, it was decided that this meeting should go on record as being in favour of the appointment of such a committee, and the matter was referred to the next meeting of Council for action.

The Plenary Meeting then adjourned.

OBITUARIES

Donald Allan Andrus, M.E.I.C.

Deep regret is expressed in recording the death of Donald Allan Andrus, M.E.I.C., which occurred recently in Roumania.

Mr. Andrus was born at Southfleet, Kent, England, on October 6th, 1870, and was educated at the Crystal Palace School of Practical Engineering, London, graduating in 1889.

In 1890-1894, Mr. Andrus was with the Ottoman Railway Company (Smyrna-Aidin) as instrumentman, draughtsman and on general railroad maintenance work; in 1894-1895, he was resident engineer on the construction of the Sokia branch, and during the years 1895-1890, he was in charge of surveys and location work in the field for the extension of the Ottoman Railway through Central Asia Minor to Konia on the line of the proposed Baghdad Railway. From 1901 to 1903, Mr. Andrus was engineer in charge for J. W. Williamson and Co., contractors, Cairo, Egypt, on their contract for widening the Suez canal between Ismailia and Suez, and from 1903 to 1911 he was continuously on contracts secured in his own name from the Egyptian government for the construction and maintenance of irrigation works in upper and lower Egypt. Mr. Andrus came to Canada in 1913 as chief engineer for Messrs. Baldry Yerburgh and Hutchinson Ltd., of London, England, on their contract with the Dominion government for the construction of Section No. 2, Welland Ship canal, until the work closed down in 1916. In 1918-1920 he was general manager and chief engineer of the St. Lawrence Dock and Shipbuilding Company at Levis, Que. In 1922 Mr. Andrus became superintendent for Sir Wm. Arrol and Co. Ltd., in the construction of Lock No. 7 of the Welland Ship canal, and the pit for Lock No. 4 at Thorold, Ont. Upon the completion of this section of the work his firm obtained the contract for the Hollinger dam at Island Falls, after which he returned to London, as agent in Europe for Quinlan, Robertson and Janin Ltd., and later became connected with the European Amiesite Ltd., also in London.

Members of the Niagara Peninsula Branch will remember Mr. Andrus describing to them a few years ago contracting and engineering conditions in Egypt about the time of the Assouan dam construction, the number of years spent by him in Asia Minor enabling him to speak with authority upon native life and characteristics in the Orient.

Mr. Andrus joined The Institute as a Member on April 29th, 1924.

William Jackson Fuller, A.M.E.I.C.

Members will learn with regret of the death at Fort William, Ont., on October 7th, 1931, of William Jackson Fuller, A.M.E.I.C.

Mr. Fuller was born at Leamington, Ont., on July 14th, 1877, and attended the School of Practical Science, University of Toronto, in 1897, 1898 and 1899.

In 1900 Mr. Fuller entered the employ of J. G. Sing, D.L.S., O.L.S., and was for two years in charge of a survey of the Georgian Bay Islands. This was an intricate triangulation survey for the Department of Indian Affairs, Ottawa. In 1902 Mr. Fuller entered the service of the Department of Public Works, with which he remained until the time of his death. He was for some sixteen years district engineer for the Department at Sault Ste. Marie, Ont., and last year was transferred to Fort William, where he occupied the same office.

Mr. Fuller joined The Institute (then the Canadian Society of Civil Engineers) on February 11th, 1908, as an Associate Member.

PERSONALS

John E. Macdonald, S.E.I.C., is with the West Kootenay Power Company at South Slocan, B.C.

C. E. Hogarth, A.M.E.I.C., is resident engineer at Klock, Ont., on the Trans-Canada Highway.

T. S. Armstrong, M.E.I.C., has been appointed assistant district engineer at Port Arthur, Ont., for the Department of Northern Development, Ontario. Mr. Armstrong was at one time with the Toronto Transportation Commission.

J. S. Kyle, Jr.E.I.C., is now located at Cartagena, Colombia, S.A., where he has taken over the duties of electrical engineer with the Tropical Oil Company. In 1930, Mr. Kyle was electrical inspector with the Canadian National Railways, at Toronto.

T. A. McGee, A.M.E.I.C., formerly advisory engineer with the Bishop Sales Corporation, Montreal, is now manager of the concealed heating division of the Gurney Foundry Company Ltd., Montreal. Mr. McGee was at one time vice-president and chief engineer of F. W. Pennock and Company, Montreal.

Dr. Arthur Surveyer, M.E.I.C., consulting engineer, Montreal has been appointed chairman of the Chignecto Canal Commission. Dr. Surveyer is a graduate of the Ecole Polytechnique and of the University of Montreal, and a Past-President of The Engineering Institute of Canada.

Martin F. O'Day, S.E.I.C., is now with the Northern Construction Company, at West Saint John, N.B. Following his graduation from the University of Manitoba in 1926, with the degree of B.Sc., Mr. O'Day joined the staff of Fraser-Brace Engineering Company, and was for several years located at Santiago, Colombia, S.A., later being sent to Island Falls, Sask. In 1930 he became connected with the Ontario Refining Company, Ltd., at Copper Cliff, Ont.

F. B. Goedike, A.M.E.I.C., who has for a number of years been Commissioner of Works, Township of York, Ont., has been appointed city engineer of Oshawa, Ont. Mr. Goedike is a graduate of Queen's University of the class of 1910, and since graduating has had a wide engineering experience in municipal work and other fields. Following graduation he was for a time with the Irrigation Department of the Canadian Pacific Railway, and in 1912 he took charge of a hydrographic survey of Toronto Bay for the Toronto Harbour Commission. In the latter part of the same year Mr. Goedike was appointed resident engineer with the sewer department of the city of Toronto, with which department he was engaged until the middle of 1915, when he was appointed locating and estimating engineer for a commission investigating radial railway entrances for the city of Toronto. In 1916 he became assistant engineer of the Toronto Harbour Commission, and in 1918 was associated with the firm of Barber and Wynne-Roberts, consulting engineers, Toronto. Towards the end of 1918, and for the following three and a half years, he was engaged on designing and estimating work of bridges, sub and superstructures, for the Hydro-Electric Power Commission of Ontario. For a short period in 1922 Mr. Goedike was engaged on the water works extensions for Toronto, and in the same year was appointed resident engineer on the tunnel sewer construction for the city of Hamilton.

ELECTIONS AND TRANSFERS

At the meeting of Council held on September 21st, 1931, the following elections and transfers were effected:

Associate Members

BATY, Edward, (Darlington Tech. Coll.), district plant engr., Bell Telephone Company of Canada, Montreal, Que.

BEMAN, Edwin Arthur, B.E. (Mech.), (Univ. of Sask.), res. engr., Dept. of Highways, Regina, Sask.

BLAKE, William Henry, Capt., R.C.E., (Sch. of Mil. Engrg., Chatham), District Engineer Officer, Mil. Dist. No. 7, Saint John, N.B.

CAMPBELL, Harold Montgomery, B.A.Sc., (Univ. of Toronto), 23 Bellevue Terrace, St. Catharines, Ont.

CARPENTER, Edward Stanley Cameron, B.E., (Univ. of Sask.), res. engr., Dept. of Highways, Regina, Sask.

FENNIS, Albert M., E.E., (Engrg. School, Zwickau, Saxony), 4510 Girouard Avenue, Montreal, Que.

HAGGAS, Ernest, (Tech. Coll., Bradford), senior dftsman., Canadian Westinghouse Company, Limited, Hamilton, Ont.

HAY, Charles Cecil, B.Sc., (Univ. of Sask.), mgr., Gibbs Bros. & Hay Ltd., Lumsden, Sask.

HOGG, Sidney, (Dundee Tech. Coll.), struct'l. engr., Saint John Dry Dock & Shipbuilding Co. Ltd., Saint John, N.B.

NOBLE, George, B.Sc. (Civil), (Univ. of Birmingham), dftsman., Imperial Oil Refineries, Ltd., Sarnia, Ont.

WILHJELM, Frits Erik, B.Sc. (Civil), (Royal Tech. Coll., Copenhagen), asst. engr., mtce., C.N.R., Moncton, N.B.

Juniors

ABRAMSON, Isaac Albert, B.Sc. (E.E.), (Univ. of Alta.), operator, Calgary Power Company, Seebe, Alta.

AVELING, Frederick Edward, (Royal Tech. Coll., Glasgow), 1929 Tupper St., Montreal, Que.

CAREY, Cyril Joseph, (Memorial Univ. Coll.), 142 Military Road, St. John's, Nfld.

KERRY, Armine John, Capt., R.C.E., (Grad., R.M.C.), B.Sc., (McGill Univ.), Works Officer, Mil. District No. 5, St. Louis Barracks, Quebec, Que.

MARLATT, Victor Egerton, B.Sc., (Univ. of Man.), instr'man., Dept. Railway and Canals, Fort Churchill, Man.

PICHE, Arthur, C.E., (Ecole Polytechnique), combustion engr., Anthracite Coal Service, 509 Dominion Square Bldg., Montreal, Que.

WHITE, Walter Edmund, B.A.Sc., (Univ. of Toronto), technical engr., Northern Electric Company, Ltd., Montreal, Que.

Affiliates

FOWLER, James, M.A., B.Sc., (Edinburgh Univ.), Vice-Principal, Institute of Technology and Art, Calgary, Alta.

INGRAM, Arthur Ferguson, operating manager, Canadian Airways Limited, 920 University Tower, Montreal, Que.

SAMUEL, Myron, (Diploma, Engrg., College of Dantzig), Canadian representative, J. I. Bernitz (Machy. Importers), of New York and Toronto, 118 Spadina Road, Toronto, Ont.

TODD, William L., (Purdue Univ.), Manager and President, Layne Canadian Water Supply Co. Ltd., 903 Kent Bldg., Toronto, Ont.

Transferred from the class of Associate Member to that of Member

SMYTH, Charles McDowall, (Polytech. Inst., London, Eng.), light and power supt., Cape Breton Electric Co. Ltd., Sydney, N.S.

THOMSON, Clarence, B.Sc., (McGill Univ.), manager, Fred Thomson Co. Ltd., 915 St. Genevieve Street, Montreal, Que.

Transferred from the class of Junior to that of Associate Member

BECKER, Fred Artland, B.A.Sc., (Univ. of Toronto), sales engr., Canadian General Electric Co. Ltd., Winnipeg, Man.

CLARK, George S., B.Sc., (McGill Univ.), mech'l. supt., Molson's Brewery, Limited, Montreal, Que.

GORDON, Charles Howard, (Grad., R.M.C.), B.Sc., (McGill Univ.), contracting engr., Atlas Construction Co. Ltd., 679 Belmont Street, Montreal, Que.

KELSEY, Ernest Starkey, B.Sc., (Univ. of Man.), asst. to director of technical service, Northern Electric Co. Ltd., Montreal, Que.

McDONALD, James A., B.Sc., (Univ. of Alta.), Bradley, Ont.

McLENNAN, Gordon Roderick, B.Sc., (McGill Univ.), elect'l. engr., C. D. Howe & Company, Port Arthur, Ont.

OS, Hartvik, C.E, (Univ. of Trondjhem), engr. and dftsman., C. D. Howe & Company, Port Arthur, Ont.

ROSS, Donald Grant, B.Sc., (Dalhousie Univ.), asst. engr., Saint John Harbour Commissioners, Saint John, N.B.

THOMPSON, Trevor Creighton, B.Sc., (McGill Univ.), divn. trans. engr., Quebec Divn., Bell Telephone Company of Canada, Montreal, Que.

Transferred from the class of Student to that of Associate Member

ANGUS, Frederic William, B.Sc., (McGill Univ.), dial engr., equipment engrg. dept., Bell Telephone Company of Canada, Montreal, Que.

ARCHAMBAULT, Joseph U., B.A.Sc., and C.E., (Ecole Polytechnique), engr., Quebec Public Service Commission, Quebec, Que.

HARDCASTLE, Sydney, B.A.Sc., (Univ. of Toronto), designer, Dominion Bridge Company, Ltd., Montreal, Que.

HOVEY, Lindsay Mansur, B.Sc., (McGill Univ.), asst. elect'l. engr., Winnipeg Electric Company, Winnipeg, Man.

MILLER, John James Hutchison, B.Sc., (McGill Univ.), plant engr., Northern Electric Company, Ltd., Montreal, Que.

O'DAY, Martin Frederich, B.Sc., (Univ. of Man.), Northern Construction Company, West Saint John, N.B.

Transferred from the class of Student to that of Junior

ABBOTT-SMITH, Henry Bancroft, B.Sc., (McGill Univ.), asst. meter engr., Shawinigan Water & Power Company, Montreal, Que.

EDWARDS, Hubert John, B.Sc., (Queen's Univ.), municipal dept., H.E.P.C. of Ontario, Toronto, Ont.

GATHERCOLE, John William, B.Sc., (Queen's Univ.), steam control and meter engr., Canada Sugar Refining Co. Ltd., Montreal, Que.

GREGORY, Hurd Anthony Forbes, B.Sc., (McGill Univ.), engr., Aluminum Company of Canada, Shawinigan Falls, Que.

HARGROVE, Paul, B.Sc., (Univ. of Alta.), transitman, Lethbridge Dvn., C.P.R., Lethbridge, Alta.

HUNT, Albert Brewer, B.A.Sc., (Univ. of Toronto), asst. operating supt., Northern Electric Company, Ltd., Montreal, Que.

SIMON, Robert Carleton, B.Sc., (McGill Univ.), designing, etc., Imperial Oil Refineries, Ltd., Montreal East, Que.

Transferred from the class of Student to that of Affiliate

COWAN, Lucien, engrg. sales dept., Crane Limited, 1170 Beaver Hall Square, Montreal, Que.

Students admitted

HANINGTON, Frederick Augustus, B.Sc. (E.E.), (Univ. of N.B.), meter supt., meter dept., New Brunswick Power Company, Saint John, N.B.

HULBERT, Edward, B.Sc. (E.E.), (Univ. of Man.), Lieut., R.C.C.S., Camp Borden, Ont.

PEREGO, Henry Anthony, (Undergrad., McGill Univ.), 3837 Old Orchard Avenue, Montreal, Que.

SMITH, Norman Janson Winder, (Grad., R.M.C.), Lieut., R.C.E., M.D. No. 4, 1254 Bishop St., Montreal, Que.

At the meeting of Council held on October 16th, 1931, the following elections and transfers were effected:

Associate Member

McQUEEN, Howard Renton, (Grad., R.M.C.), President and General Manager, Iron Fireman Limited, Montreal, Que.

Transferred from the class of Associate Member to that of Member

MACDONALD, Charles Beverley Robinson, Capt., R.E., (Grad., R.M.C.), chief engineer and agent, Macdonald, Gibbs & Co. (Engineers), Limited, Sao Paula, Brazil.

WELDON, Richard Laurence, B.Sc., M.Sc., (McGill Univ.), manager, International Power & Paper Co. of Nfld. Ltd., and chief engineer, International Paper Company, New York, N.Y.

Transferred from the class of Junior to that of Associate Member

BARRETT, Andrew Grant, B.Sc., (Queen's Univ.), chief engineer, Canadian Johns-Manville Co. Ltd., Asbestos, Que.

Transferred from the class of Student to that of Associate Member

BALLENY, James Lister, B.Sc., (McGill Univ.), asst. elect'l. engr., Dominion Bridge Company, Ltd., Montreal, Que.

ENNIS, Leo E., B.Sc., (Queen's Univ.), toll pole and wire engr., Quebec Division, Bell Telephone Company, of Canada, Montreal, Que.

FAIRBAIRN, John M., B.Sc., (McGill Univ.), general manager, Charles Warnock & Company, Montreal, Que.

Transferred from the class of Student to that of Junior

LOVETT, Percy Arthur, B.Sc., (N.S. Tech. Coll.), asst. equipment engr., Maritime Telephone & Telegraph Company, Halifax, N.S.

DesBRISAY, Aretas William Young, Lieut., R.C.C.S. (Grad., R.M.C.), B.Sc., (McGill Univ.), Officers' Mess, Camp Borden, Ont.

The Preparation of a Topographical Map from Aerial Surveys

The following account is abridged from material kindly furnished by Canadian Airways Limited, and is of interest as showing the manner in which aerial survey methods can be utilized for the rapid production of contoured maps.

A survey of the mouth of the Montreal river on Lake Superior, some 60 miles north of Sault Ste. Marie, was recently undertaken with a view to the preparation of a map suitable for the study of this area for the location and building of a hydro-electric plant and later to be used as the basis of a contour survey to be made by stereoscopic methods from the photographs. The scale of the map was to be 1/9600 or 800 feet to the inch, showing contours at 50-foot intervals over most of the area, and at 25-foot intervals along the river where possible engineering works were to be considered and where flood lines would be required.

The contract for the survey was made September 19th, 1930, and on September 22nd a seaplane arrived at the Soo to make the necessary photographs. Fortunately the weather was favourable, and in a two and a half hour flight on the morning of September 23rd, some two hundred vertical exposures were made and a number of stereo-obliques obtained. The films were developed and found satisfactory, and the machine was recalled on September 30th, no further flights being necessary.

On October 7th the preliminary layout of the mosaic of vertical prints was ready for preliminary inspection, and a rough model of the area had been made, which was sufficiently accurate to give the engineers a general idea of the formation and relief of the country.

Fortunately, some ground surveys had already been made in the district, the plans of which were available, and these were used for the necessary ground control. A comparatively small amount of ground survey work had to be done so as to complete a closed traverse, and some further information was obtained by altimeter readings of certain points adjacent to bench marks or other points of known elevation.

The finished mosaic, without contours, but on the proper scale, was ready on January 7th, 1931, and work on the contours was then proceeded with. The contours were located on the original overlapping photographs by the use of a Barr and Stroud topographical stereoscope and the actual contouring took about six weeks. The contours were then transferred by point to point inspection on to the original mosaic, which was copied in six sections, contact prints of which were mounted together to form a continuous map about 4 by 8 feet. The six negatives, each 22 by 24 inches, form the permanent record of the job. The finished mosaic was delivered on March 6th, 1931, and the whole map covered an area of about 60 square miles.

In order to derive full advantage from an aerial survey, it is advisable to have the area photographed immediately at the commencement of such work. A rapid study of the area in relief then indicates what ground work is required. It also gives camp locations, transportation routes, and provides a complete set of scalable prints for the use of the field party in recording data, checking angles and distances and planning work. Later these same pictures may be used, provided further investigation is warranted, in making reconnaissance or accurate maps and contoured plans.

For such an area as described, it would seem that a comprehensive reconnaissance report could normally be made available three to four weeks from the taking of the photographs.

A portion of the contoured map is reproduced above to show the result of this survey. So far the only check on the accuracy of the contours has been the comparison of the 1,000 feet contour along the river with a flood-line survey since made on the ground by engineers, on which very good agreement was obtained.

A map of the nature and extent of that described above could be furnished at a cost in the neighbourhood of $100 per square mile. On smaller areas the cost per square mile increases as the size of the area diminishes.

By Courtesy of Canadian Airways Limited

Section of Contoured Map of Montreal River.
Scale—1 inch = 3,290 feet.

CORRESPONDENCE

The Editor,
The Engineering Journal.
Sir:

In a previous letter it has been shown how necessary it is for the engineer to advertise his work, that this advertising must be placed where it will receive attention, and that "Inspection" is the key note to adequate response.

The three parties essential to a construction project are, the owner, the designer and the constructor. The owner is of prime importance, the designer projects the owner's ideas on to paper, and the constructor materializes these ideas after receiving the results of the designers work

At the beginning, the only two parties are, the owner and the designer, but after the contract is signed, the constructor enters in, and these three are represented in the field, by the inspector, the plans and specifications, and the superintendent; the first is the representative of the owner, the second is the work of the designer and the third is the representative of the contractor, and the same relative importance still holds; the interests of the owner are paramount.

In factory operation, quantity production has lowered the cost of the innumerable labour saving devices that contribute to our well being, and quantity production depends upon inspection, absolutely; save money reducing inspection costs and the result is total failure; whereas, on construction in the field, while the individual parts have undergone inspection at the place of origin; the assembling of these individual parts—steel, wood, concrete, etc. etc., seldom has adequate inspection.

In the building industry, where the vast majority of work is done under a lump sum contract, the tenderer frequently does not understand new processes or ideas, and makes a stab at the cost; hoping one of two things, either that he will get the contract in spite of the high price inserted for the unknown, or, that if he gets the contract, he will not be obliged to live up to specifications. Anyway he necessarily leaves all details to the foreman, whose main interest is the making of profits for the boss, and who has neither time nor inclination to do anything out of the ordinary, which is the very reason why, during their preparation, all plans and specifications should be gone over by the inspector in collaboration with the designer.

When the stonemason cut his stone on the job, and the carpenter framed the lumber, the architect had ample time to do the inspection himself, but with modern high speed construction, one storey a week and the roof on before the basement is finished, neither the owner, architect nor professional engineer can hope to supervise all the work, which should be inspected hour by hour, and sometimes minute by minute, during the whole time of construction.

In theory, all will agree with the foregoing, but many subordinates in the contracting business object, especially those with an engineering training. They imagine that the presence of an inspector is a criticism of their ability; these individuals, unfortunately, look at only one side of the picture, viz., their duty as employees to work at a profit.

The contractor who stays in business is an honest man, who sincerely desires to live up to the spirit of his contract—but no matter how high minded and impartial he is, he cannot expect the same of all his employees, some at least of whom are men of more or less limited intelligence.

The employee—whether foreman or superintendent—holds his position on account of his ability to work at a profit, or to do fast work at a low cost; this is the opportunity for the inspector, who while recognizing the legitimate aim of the contractor to make profits, sees that specifications are followed.

The work of the inspector and the contractor is complementary, the latter to make profits, and the former to see that the work is good; no good work can be accomplished except under the stimulus of adequate compensation, and no material progress can be made, unless the work done is increasingly better and more efficient. To attain these ends and to enable them to work harmoniously together, the representatives of the contractor and of the owner should have equal standing: in other words, on the same piece of work, they should receive equal remuneration.

The ordinary person always thinks in terms of money, a man's worth is reflected in his pay cheque, and it is not long, on any job, before the foreman finds out how much the inspector is getting, and his respect varies directly as the amount. There are of course, men of high morale, who can command respect while labouring under the handicap of poor pay, but they are not common.

To obtain greater efficiency and economy in construction work, two things are highly desirable. Firstly, that plans and specifications be gone over by the inspector with the designer (the architect or professional engineer) before the contract is let. Secondly, that the inspector should receive the same remuneration as the superintendent or foreman with whom he is working. Doubtless the designer will object, saying that he knows quite well what he wants, and is prepared to pay a fair price for it. Undoubtedly he knows what he wants, but is it commercially practical? Does he know what it will cost? Can he look at it from the same angle as the contractor? Does he know the psychological effect such ideas will have on the workmen? Is he prepared to risk his reputation on a problematical attitude on the part of the contractor?

With regard to greater remuneration for inspectors; once the need of inspection is recognized, greater remuneration will naturally follow, and instead of inexperienced men holding such positions, they will be filled by men of high ability.

It is not the object of the writer to exalt the position of inspector above designer but to demonstrate that the inspector is the liaison officer who can obtain for engineers the adequate recognition of their work. A designer can draw a few lines and show them to a banker and say—behold a pulp mill—a bridge—a skyscraper, but he does not thereby convey any idea of the innumerable operations and inspections which must take place between the getting the raw material out of the ground to the time that the operating man takes charge of the finished structure.

To demonstrate the value of inspection, examples must be given which will make prospective owners aware of the dangerous possibilities that occur in all engineering work, many of which, if allowed, can never be remedied; and the ideal way of doing this is, to get printed in the financial and municipal papers and magazines, a series of articles—short and to the point—similar to those which advertise the medical profession in the Montreal Star, under the heading, "That Athletic Body of Yours." These will keep continually before the financial public the work done by the engineer.

Summary

Practically all our material welfare is due to the activity of the engineer, what he has done in the past is only a fraction of what he could do in the future, if given the opportunity.

To obtain the opportunity his work must be known. To make his work known he must advertise—but he must place his announcements before the right people, the people who finance all engineering work—the bankers, trust companies and bond houses, etc. He must reach the vital point, and show them how the contents of their pocket books are dependent upon the excellence of the work done for them, that this excellency depends upon thorough inspection at all times and in all places, that such inspection will cost money, but that it will be money well spent.

This publicity will eventually arouse recognition; increased recognition will bring increased remuneration, and increased remuneration, opportunity for increased service as outlined in the beginning.

Yours truly,

C. D. NORTON, A.M.E.I.C.

BOOK REVIEW

Analytical Mechanics

By H. M. Dadourian. Van Nostrand, New York, 1931, cloth, 6 x 9 in., 427 pp., figs., tables, $4.00. 3rd ed., revised.

Lieut.-Col. E. J. Schmidlin, M.E.I.C.*

It is difficult, in a work on such a fundamental subject as Mechanics, to introduce much material which is of an entirely novel character. The author of such a work must therefore rely, for success in his effort to gain recognition, on his skill in arranging his subject matter, on his methods of presentation, and on the use of illustrative examples to clothe the bare bones of the basic theories which he is expounding. Professor Dadourian's book indicates that the author, himself a teacher of wide experience in the field of Mechanics, has been fully cognizant of these requirements—as, in fact, he states in the preface. The measure of success attained is sufficiently attested by the fact that the book has reached a third edition.

The contents may be considered as divided into three sections, although no such division is shown, chapter headings only being used. The first section deals with statics, in four chapters which progress in perfectly logical order from the basic definitions, through the necessary conditions for equilibrium of a particle to the consideration of the equilibrium of rigid bodies, concluding with two chapters in which the foregoing principles are applied to the study of structural frames and flexible cords.

The treatment is unusual in that forces are considered throughout as physical entities, i.e., as applied to solid particles or bodies. This is, of course, strictly correct, but leads to the absence of the familiar paragraphs on resolutes, resultants, equilibrium, etc., of disembodied system of forces, and may seem strange at first sight to one who studied his mechanics in an earlier day. The method has much to recommend it when the subject is being introduced to junior students.

A feature of this section of the work which is worthy of note is the extensive discussion of static friction and its application to various problems of equilibrium.

Following the section on Statics comes a single chapter on Kinematics—the geometry of motion—which is the natural and necessary

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precursor of the third and largest section of the book. This third section deals, of course, with particles and bodies in motion, and, like the first section, it has some decidedly original characteristics, of which perhaps the most noteworthy is the stressing of the analogy between translatory and rotational motion of bodies.

It is usual to find the discussion of these two classes of motion definitely separated—sometimes even in separate volumes—but Professor Dadourian brings out clearly their essential similarity by treating them side by side, and generally in absolutely parallel manner. The result is highly interesting and instructive, and the idea is undoubtedly excellent. It is not quite so certain, however, that the exclusive use of the calculus throughout this section is so desirable. In many problems, of course, this is the best, and perhaps the only method, but a purely mathematical treatment in all cases may lead the student to forget what was so carefully emphasized in the Statics section—namely, that the actions under consideration are physical.

The use of the Newtonian notation ($\dot{V} = \frac{dv}{dt}$, etc.) for derivatives with respect to time is also open to criticism. This notation is not particularly legible, and the close attention to the text which it demands makes some of the longer derivations more fatiguing to read than they should be.

Engineers reading this section of the work may not agree with Professor Dadourian's action in making his fundamental definitions in accordance with the Einstein hypotheses, but they cannot fail to find the result interesting, particularly as several numerical examples of the effect of relativity are given. After all, whether we consider "inertia" as a property of matter, or as the "kinetic reaction" of the universe, the results obtained in the sort of problems which have to be solved in practice are precisely the same. The engineer may consider himself fortunate that he need not, for the present at any rate, concern himself either with the ultimate nature of matter or with velocities of solid bodies approaching that of light.

It is gratifying to note that a full discussion is given of the relations between the "absolute" and "Engineering" units of force, work and energy, and that the latter are used. This is a matter which still, unfortunately, proves a stumbling block to many a student who has learned his mechanics entirely on the "absolute" system.

In conclusion, attention may be drawn to one unusual inclusion, and one regrettable omission in the final section of the work. The first is a chapter on orbital motions, which is seldom found in a text of this character, although it is a most appropriate place. The second is the lack of any mention of gyroscopic action, which might well be included in the next edition.

Professor Dadourian's book is worthy of a place in the library of every engineer who wishes to keep his fundamental theory—and his calculus—up to date, and who desires a mechanics text which is thoroughly readable, plentifully supplied with excellent illustrative examples and problems, and contains many unusual and interesting features.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

The New Zealand Society of Civil Engineers: Proceedings, Vol. 17, 1930-31.
The Institution of Electrical Engineers: List of Corporate Members and of Non-Corporate Members, 1930.
The Institution of Mining and Metallurgy: Transactions, Vol. 39, 1929-30.
Society for the Promotion of Engineering Education: Proceedings, Vol. 38, 1930-31.
American Society for Testing Materials: 1931 Supplement to Book of A.S.T.M. Standards.
American Society for Testing Materials: Year Book, 1931.
The British Engineers' Association: Classified Handbook of Members and their Manufactures, 1931 ed.
The Canadian Electrical Association: Proceedings of the 41st Annual Convention, June 16-18, 1931.
Punjab Engineering Congress: Minutes of Proceedings, Vol. 19, 1931.

Reports, etc.

Dominion Water Power and Hydrometric Bureau, Canada:
Hydro-electric Progress in Canada in 1930.
Dept. of the Interior, Canada:
Publications of the Dominion Observatory, Ottawa. Vol. 10: Bibliography of Seismology, Nos. 7-10, July, 1930, to June, 1931.
Dept. of the Interior, Topographical Survey, Canada:
[Map of] Rainy River, Ontario.
[Map of] Grondines, Quebec.
Dept. of Marine, Hydrographic Service, Canada:
Catalogue of Marine Charts, Sailing Directions and Tidal Information, corrected to April 1st, 1931.
Dept. of Labour, Canada:
Labour Legislation in Canada, 1930.
Bureau of Statistics, Canada:
The Canada Year Book, 1931.
Geological Survey, Canada:
Memoir 166: Geology and Ore Deposits of Rouyn-Harricanaw Region, Quebec.
Memoir 167: Fort William and Port Arthur, and Thunder Cape Map-areas, Thunder Bay District, Ontario.
Research Council of Alberta:
Eleventh Annual Report, 1930.
Hydro-Electric Power Commission, Ontario:
List of Electrical Equipment Approved by the Commission, 1931.
Bureau of Mines, United States:
Fluorspar and Cryolite in 1930.
Potash in 1930.
Bulletin 341: Coal Mine Fatalities in the United States, 1929.
342: Metal-Mine Accidents in the United States, 1929.
Tech. Paper 499: Treating a Complex Ore.
Bureau of Standards, United States:
Commercial Standard CS28-32: Cotton Fabric Tents, Tarpaulins and Covers.
Circular 393: Reclaimed Rubber.
394: Design of Gas Burners for Domestic Use.
Public Health Service, United States:
Reprint No. 1475: Experimental Studies of Natural Purification in Polluted Waters. Part 5: The Selection of Dilution Waters for Use in Oxygen Demand Tests.
1480: Experimental Studies of Natural Purification in Polluted Waters. Part 6: Rate of Disappearance of Oxygen in Sludge.
Geological Survey, United States:
Bulletin 818: Geology and Mineral Resources of the Cleveland District, Ohio.
Prof'l Paper 162: Geology and Ore Deposits of the Goodsprings Quadrangle, Nevada.
163: The Significance of Geologic Conditions in Naval Petroleum Reserve No. 3, Wyoming.
165-C: Geology of the Eastern Part of the Santa Monica Mountains, Los Angeles County, California.
Water-Supply Paper 637-D: Geology and Water Resources of the Middle Deschutes River Basin, Oregon.
638-A: A Preliminary Report on the Artesian Water Supply of Memphis, Tennessee.
642: Surface Water Supply of the United States, 1927: Pt. 2: South Atlantic Slope and Eastern Gulf of Mexico Basins.
651: Surface Water Supply of the United States, 1927: Pt. 11: Pacific Slope Basins in California.
652: Surface Water Supply of the United States, 1927: Pt. 12: North Pacific Slope Drainage Basins (A), Pacific Slope Basins in Washington and Upper Columbia River Basin.
653: Surface Water Supply of the United States, 1927: Pt. 12: North Pacific Slope Drainage Basins (B), Snake River Basin.
654: Surface Water Supply of the United States, 1927; Pt. 12: North Pacific Slope Drainage Basins (C), Pacific Slope Basins in Oregon and Lower Columbia River Basins.
661: Surface Water Supply of the United States, 1928: Pt. 1: North Atlantic Slope Drainage Basins.
664: Surface Water Supply of the United States, 1928: Pt. 4: St. Lawrence River Basin.
665: Surface Water Supply of the United States, 1928; Pt. 5: Hudson Bay and Upper Mississippi River Basins.
666: Surface Water Supply of the United States, 1928: Pt. 6: Missouri River Basin.
667: Surface Water Supply of the United States, 1928: Pt. 7: Lower Mississippi River Basin.
668: Surface Water Supply of the United States, 1928, Pt. 8: Western Gulf of Mexico Basins.
669: Surface Water Supply of the United States, 1928, Pt. 9: Colorado River Basin.

Water-Supply Paper 670: Surface Water Supply of the United States, 1928, Pt. 10: The Great Basin.
671: Surface Water Supply of the United States, 1928, Pt. 11: Pacific Slope Basins in California.
672: Surface Water Supply of the United States, 1928, Pt. 12: North Pacific Slope Drainage Basins (A), Pacific Slope Basins in Washington and Upper Columbia River Basin.
673: Surface Water Supply of the United States, 1928, Pt. 12: North Pacific Slope Drainage Basins (B), Snake River Basin.
674: Surface Water Supply of the United States, 1928, Pt. 12: North Pacific Slope Drainage Basins (C), Pacific Slope Basins.
691: Surface Water Supply of the United States, 1929, Pt. 11: Pacific Slope Basins in California.

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Insurance Committee: Report, 1931.
Prime Movers' Committee, Engineering National Section: Boilers, Superheaters and Economizers.
Prime Movers' Committee, Engineering National Section: Turbines.
Fixed Capital Committee, Accounting National Section: Fixed Capital Records—Their Uses and Advantages.
Underground Systems Committee, Eng'g National Section: Conduit and Manhole Construction.
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Public Relations, National Section: Report of the Customer Ownership Committee, 1931.
Industrial Relations Committee, Public Relations National Section: Health Training.
Overhead Systems Committee, Engineering National Section: Methods and Procedures for Inspection of Materials Used on Overhead Lines.

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34: Tables and Charts of Specific Gravity and Hardness for Use in the Determination of Minerals.

Agricultural and Mechanical College of Texas:
Bulletin No. 39: Design of the Reinforced Concrete Road Slab.
40: Sludge Temperatures and Capacities of Digestive Tanks and Gravel as a Trickling Filter Medium.

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Engineering Experiment Station. Bulletin No. 62: Belt Drives with Cast-Iron Pulleys and Paper Pulleys.

Technical Books, etc.

Purchased:
The Civil Engineer's Reference-Book, 20th ed., 1929, edited by John C. Trautwine, Jr.
Patent Office, Great Britain: Subject-Matter Index of Specifications of Patents, Nos. 323171 to 340200, A.D. 1930.
American Standard: Safety Code for Elevators, Dumbwaiters and Escalators, 2nd revision, 1931.

Presented by Sherwood Press, Inc.:
Secondary Aluminum, by Robert J. Anderson. 1931.

Presented by Universal Oil Products Company:
The Decomposition of the Paraffin Hydrocarbons, [142 pp.],—Reprinted from the Journal of Physical Chemistry, August, 1930.

Presented by Ateliers de Construction Oerlikon:
Bulletin Oerlikon, June-July, 1931.

Catalogues

The Hughes-Owens Co. Ltd.:
Samples of Papers for Engineers, Architects and Draughtsmen.
Catalogue No. 28: Drawing Materials, Mathematical Instruments.

De Laval Steam Turbine Company:
De Laval Single Stage Double Suction Pumps [12 pp.].

Yale & Towne Manufacturing Company:
Yale Hoisting Hints, Vol. 1, no. 2, [4 pp.].

Harvey Hubbell Company of Canada, Ltd.
Catalogue No. 20, 1930-31: Electrical Specialties, [50 pp.].

Canadian Westinghouse Co. Ltd.:
Westinghouse Complete "B" Line Oil Circuit Breakers, [19 pp.].
Class 11-200 Linestarters [4 pp.].

The Steel Company of Canada, Ltd.:
Stelco Galvanized Steel Sheets [folder].

The Garlock Packing Company:
Garlock 701 Industrial Brake Lining, [4 pp.].

BRANCH NEWS

Cape Breton Branch

S. C. Miflen, M.E.I.C., Secretary-Treasurer.
Louis Frost, Branch Affiliate, Branch News Editor.

The Cape Breton Branch, through the courtesy of the Canada Cement Company, Ltd., was able to avail itself of an exceptionally fine series of lectures on concrete mixtures. The course, covering a series of nine lectures, was presented at Sydney by Messrs. J. M. Portugais, B.Sc., A.M.E.I.C., technical engineer, and S. Boyd, B.Sc., chemical engineer, of the Canada Cement Company. More than one hundred engineers from municipal centres in Cape Breton attended these lectures which commenced on Tuesday, September 15th, and were concluded on September 22nd. The branch chairman, A. P. Theuerkauf, M.E.I.C., presided at the opening and concluding lectures, with Y. C. Barrington, A.M.E.I.C., and J. A. Fraser, A.M.E.I.C., presiding at the second and third lectures respectively.

During the course, desirability of establishing proper balance in strength was stressed, also the durability and economy, by apportioning the design of the concrete mixture to the relationship of cement to water in the ratio which as established by extensive research will give the greatest compressive, flexural and tensile strengths, impermeability, and resistance to weathering.

The selection of aggregates, testing, and control of the concrete mixes in the field was fully described and a series of practical demonstrations on the sampling and testing of aggregates and concrete mixtures were given.

The following lectures were delivered:

Fundamentals of Concrete.	Design of Mixtures.
Manufacture of Portland Cement.	Tests of Cements and Concretes.
Aggregates.	Quality Control in the Field.
Manufacture of Concrete.	Pavements.
Curing of Concrete.	

The complete set of lectures in book form as well as a good deal of interesting literature on the design and control of concrete mixtures was presented to those attending the course.

At the conclusion of the final lecture a vote of thanks was tendered the lecturers and the Canada Cement Company, Ltd., for their courtesy in allowing the lecturers to come to Sydney.

Halifax Branch

R. R. Murray, A.M.E.I.C., Secretary-Treasurer.
W. J. DeWolfe, A.M.E.I.C., Branch News Editor.

The Halifax Branch of The Institute held a special meeting on the evening of September 25th to extend a welcome to the President of The Institute, S. G. Porter, M.E.I.C. The meeting was preceded by a supper at the Nova Scotian hotel, there being some forty members present. J. Lorn Allan, M.E.I.C., chairman of the branch, presided.

Mr. Allan, before introducing Mr. Porter, asked D. W. Robb, M.E.I.C., for a few remarks re the Chignecto ship canal scheme, a proposal to connect the Bay of Fundy with Northumberland strait, thereby converting Nova Scotia into a virtual island. Mr. Robb, who has recently appointed to the Commission to investigate the practicability of the scheme, acceded to the request, and gave a short outline of the usefulness and value of the canal from the standpoint of trade development, inasmuch as the canal, if constructed, will shorten the water distance between the St. Lawrence river and eastern United States points and the south.

A letter of regret from Professor F. R. Faulkner, M.E.I.C., vice-president of The Institute, was read, he being unable to attend on account of illness.

Mr. Allan then indicated the pleasure the branch members felt in greeting the President.

Mr. Porter referred to the number of ways in which the branches can further the work of The Institute, and commented on the size of the Dominion and the difficulties encountered in getting members together. In his opinion, the Plenary and Annual Meetings seemed to be two ways of overcoming this separation of branches and through these meetings, improve the contact with headquarters.

He suggested that live branches mean a live Institute and, that when papers are to be read a well-developed discussion should be organized in advance with the younger members induced to take part. Moving pictures have their value and even "talkies" on some large projects might be secured. Visits to construction works, increasing the number of affiliates, attendance committees to call members to meetings; social meetings, such as ladies' night, golf tournaments, large dances, etc., etc., were among the further suggestions offered as a means of boosting interest in the branch. Mr. Porter also made a plea for new members and explained that it is the branches which must be depended upon to obtain them.

He next referred to the efforts being made to effect a co-ordination of the work of The Institute and the various Provincial Associations of Professional Engineers. It was his opinion that, while the British

North America Act might prevent engineers from obtaining a Dominion charter, yet the matter could be done by individual branches and associations working together for a central body which would permit, without interfering with local autonomy, all members to function in any province. Mr. Porter said these were only suggestions, offered in good faith, as ways and means of advancing the Engineering Profession.

He then spoke on the status of the engineer in the present economic depression and of the great services the engineer can and should be able to render to the world.

On the conclusion of his address, a standing vote of thanks was extended to Mr. Porter.

A motion expressing the deep regret of the branch in the death of the late Lieutenant-Governor, Mr. Frank Stanfield, and offering sympathy to the bereaved family, was passed unanimously.

Moncton Branch

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

A large and representative gathering of Branch members met in the Y.M.C.A. on September 26th, to welcome S. G. Porter, M.E.I.C., President of The Engineering Institute of Canada, and to hear him speak on matters of importance to engineers. G. E. Smith, A.M.E.I.C., chairman of the branch, presided.

Mr. Porter expressed his pleasure at this, his first visit to the provinces by the sea. He was agreeably surprised to find in Moncton such a live and agressive branch of The Institute. In the case of a nation-wide organization, strength in the widely separated individual branches was highly essential.

The speaker stressed the improved status of engineers. The practical self-educated engineer has had his day and that day is nearly over and the profession now requires thorough technically trained men. The progress of negotiations for the co-ordination of the work of the various provincial associations with The Institute was dealt with at some length. Under the British North America Act each province must control the practice of engineering within its own borders, and it is probable that in the proposed union, the provincial units will continue to administer their respective laws and protect the public against so-called and incompetent engineers, while the national body will provide technical, social and economic service.

Mr. Porter's address was followed by a lively discussion. A. S. Gunn, A.M.E.I.C., enquired if there was a possibility of a merger of provincial associations into one federal union. Mr. Porter replied that under the British North America Act, this could not happen. J. G. MacKinnon, A.M.E.I.C., pointed out that the act referred to was a stumbling block not only to engineers but to other professions as well. The medical men had their provincial associations and their Dominion association, and a practitioner licensed in one province had his own troubles in obtaining the right to practice in other parts of the Dominion. C. S. G. Rogers, A.M.E.I.C., expressed the opinion that The Institute should maintain its academic standing and not become a semi-protective organization. Professor H. W. McKiel, M.E.I.C., enquired as to just what opposition there was to the proposed co-ordination of work. The majority of the members of the New Brunswick Association, he said, possibly 85 per cent, were also members of The Institute, and whole-heartedly in favour of the union.

A vote of thanks was tendered Mr. Porter, on motion of C. S. G. Rogers, A.M.E.I.C., seconded by G. C. Torrens, A.M.E.I.C. Refreshments were then served, after which the meeting adjourned.

Niagara Peninsula Branch

Paul E. Buss, A.M.E.I.C., Secretary-Treasurer.

Construction of the "Akron"

The Niagara Peninsula Branch held a very well attended meeting at the Fox Head inn, Niagara Falls, on October 6th, to hear Mr. W. C. Young relate some of the problems connected with the recent construction of the dirigible "Akron."

Mr. Young is manager of the Aeronautics Department of the Goodyear Tire and Rubber Company and sales manager of the Goodyear-Zeppelin Corporation.

He made the trip to Germany in connection with the preliminary arrangements regarding the bringing of the German Zeppelin patents and Dr. Karl Arnstein, noted airship designer, to the Goodyear-Zeppelin Corporation. He assisted in the plans for closing the contract with the United States navy in 1928 for the construction of two huge airships.

The two United States navy ships now under construction will each be nearly twice the size of the Graf-Zeppelin and about three times the size of the Los Angeles, and will have greater speed and load carrying capacities than any airship ever built. The great airship dock in which the "Akron" was constructed is 1,200 feet long, 325 feet wide and 210 feet high, without interior supports.

Mr. Young stated that there should be no quarrel between the lighter-than-air and the heavier-than-air advocates. Both types are developing into very distinct spheres of action; the first for long distance overseas transport and the latter for land transport. The economical non-stop flight for planes is less than 500 miles, whereas the modern dirigible can carry sufficient fuel to go half-way around the world and the cost of mooring comprises a large percentage of the flight cost on short hops.

The crusing speed of the Pittsburg-New York planes is 120 m.p.h., which can be speeded up to 160 m.p.h. when necessary, and Mr. Young quite expects to see cruising speeds as high as 250 m.p.h. in the near future.

The research and engineering problems, which are engaging the attention of aircraft officials at the present time, resolve themselves into three groups: first, better streamline shapes; second, lighter and stronger metals; third, more efficient motive power.

Duralumin, with an elastic limit of about 50,000 pounds per square inch, is the favoured metal at present, particularly in the design of airships, but the metal beryllium is receiving very close attention. It has the advantage of possessing an elastic limit about twice that of duralumin while the weight is approximately 25 per cent less and it can be welded and otherwise worked without losing strength under heat.

Although it has not yet been proven, the belief is prevalent that the "Akron" will be capable of doing the same work as six scouting cruisers. She will cost about $5,000,000, as against $10,500,000 for each cruiser, will have three times the speed and will present a more difficult target for enemy artillery. The saving in personnel is also a great consideration. Dirigibles would not be so seriously considered in the United States were it not for the advantages enjoyed in the production of helium. This gas, which originally cost $1,500 per cubic foot to produce, now costs $7.60 per 1,000 cubic feet and is cheaper than hydrogen, which costs $10. The lifting power is about 62 pounds per 1,000 cubic feet, as against 68 pounds with hydrogen, and, of course, the great advantage is that it is non-inflammable.

One of the most interesting points in the design of the "Akron" is the construction of the twelve large gas bags. These are made on somewhat the same principle as the puncture proof tire. A very fine cotton fabric is covered with several thin coats of latex, followed by several coats of gelatin and then several more coats of rubber. The gelatin is tacky and acts as a filler, flowing into any holes or pores which may exist, or which may form, in the rubber and thus reducing gas loss to practically zero. At one time gold-beater skin was used instead of the gelatin, but this was costly.

"The "Akron" has a designed speed of 82 m.p.h. and a cruising radius of 11,000 miles. She is 785 feet long and 133 feet diameter. The eight motors of 560 h.p. each were developed by the German-Zeppelin Corporation and use Blau fuel gas or gasoline. No dirigible motors has as yet been constructed on this side of the Atlantic. The engines are mounted within the hull, four on each side, and drive the 17-foot propellers through bevel gear shafts which are mounted on outriggers. The propellers and their fixed portion of the shafts may be moved up or down in a vertical arc, thus giving assistance to the dirigible in rising or descending. A variation is made in the pitch of each following propeller in order to avoid turbulance from the back-wash of the preceding propeller. The total weight of material in the "Akron" amounts to 85 tons, which, following an observed characteristic of all aircraft design, is slightly greater than the calculated weight. She carries a crew of 15 officers and 50 men, and if converted to a commercial trade could carry a load of about one hundred passengers.

Five aeroplanes are carried within the hull, all of which may be launched through trap doors and picked up again while in flight. The question of fastening these planes below and outside the hull received consideration, but was finally abandoned. The arguments in favour of the outside position consisted of a theoretical assistance in uplift from the wings of the planes and an emergency source of extra power from the engines.

As a matter of comparison, Mr. Young gave the "Akron's" gas capacity as 6,500,000 cubic feet; the "R100" as 5,000,000 cubic feet and the "Graf Zeppelin" as 3,700,000 cubic feet.

Walter Jackson, M.E.I.C., presided at the meeting, and Alex. Milne, M.E.I.C., proposed the vote of thanks to Mr. Young and to the Goodyear Company for the excellent films which illustrated the construction features. E. G. Cameron, A.M.E.I.C., welcomed the visitors from Hamilton, Buffalo and Niagara Falls, and Mr. Graham, Chairman of the A.I.E.E., Frontier section, introduced the speaker.

Ottawa Branch

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

Luncheon to President

The Ottawa branch were favoured with a visit from the President of The Institute, S. G. Porter, M.E.I.C., of Calgary, Alberta, at their noon luncheon held at the Chateau Laurier on October 2. The occasion was in the nature of a "get-together" meeting affording the members an opportunity of becoming acquainted with the President and of listening to him.

G. J. Desbarats, C.M.G., M.E.I.C., chairman of the Branch, in introducing Mr. Porter referred briefly to his career since coming to Canada, first in the Civil Service and later with the Canadian Pacific Railway.

Mr. Porter stated that he had been spending his holidays visiting the various branches in the Maritimes and in Quebec and hoped on his way back to the west to be able to visit other branches as well. The Engineering Institute, owing to the wide range of country covered by its activities, suffers to some extent by its very bigness. Members from widely scattered points are largely prevented from coming into intimate contact with each other and it is in this regard that the branches fill an important function, namely, that of allowing the members in the various localities to get together among themselves, thereby carrying on more effectively the work of the organization. It was true of The Institute, just as of any other organization, that "what you get out of it is measured by what you put into it."

The President at this point dwelt upon the matter of increasing the membership of The Institute and stated that this was a concern largely for the branches themselves working through the individual members.

A considerable portion of the President's address was taken up with the question of bringing about a closer relationship between the various provincial engineering associations and The Engineering Institute of Canada. In eight out of the nine provinces of Canada there are now registered Provincial Engineering Associations, each organization being based upon the Provincial Act for that province. Uniform legislation in this regard is most difficult of achievement and it is hoped that The Engineering Institute of Canada might be able to assist in obtaining, if not a uniform act, legislation of as near uniformity as possible.

The President also spoke of the place of the engineer in public affairs and stated that he should find opportunities to contribute more thoroughly than he has done to the solution of society's problems. The engineer's place in our social structure is particularly important in a country like Canada on account of its newness and the vast amount of work that requires to be done in connection with the country's development.

Engineers are beginning to occupy in increasing numbers administrative positions of importance, and this is as it should be, for in these positions he might well take his place along with the sociologist and the educationalist in solving the present vitally pressing problems relating to a proper distribution of labour. How pressing these problems are may at once be recognized when it is stated that the work of ten men only a decade ago may be produced equally well by seven men today.

Professional Engineers of Ontario

At the noon luncheon on October 8th the local branch listened to addresses by A. H. Harkness, M.E.I.C., President of the Ontario Association of Professional Engineers, and H. Hellmuth of Toronto, also of the same Association.

Mr. Harkness outlined briefly the history of the Ontario Association of Professional Engineers and stated that since its inception in 1919 it has attained a membership of nearly 1,200. Its main object was the obtaining of proper legal recognition of the profession of engineering in Ontario and, in this connection it was backed by an act of the legislature of Ontario. Unfortunately, however, two clauses dealing with penalties for those who represented themselves as engineers without authority which were intended to be included in the Act, had been struck out at the time it was passed. This, stated Mr. Harkness, really destroyed the value of the Act so far as its main purposes were concerned, and it was in an endeavour to get over this difficulty that further action was contemplated.

Mr. Harkness mentioned that there seemed to be a tendency among the members of The Engineering Institute not to take an active part in the affairs of the Association. This was unfortunate as there was no intention to have the activities of the Association infringe in any way upon those of The Institute. Each has its own field and these do not conflict. The Ontario Association of Professional Engineers is not a technical organization, as that term is generally understood, but is a body created purely for the purpose of protecting its members against unscrupulous practitioners, and the public in their endeavours to obtain professional engineering services.

Mr. Hellmuth, who spoke next, elaborated upon some of the points mentioned by Mr. Harkness. He compared the profession of engineering with that of law, medicine and other professions in Ontario and stated that all had a standing which engineering itself lacked.

Prince Edward Island is the only province in Canada where there is no engineering legislation. All other provinces require registration excepting Ontario. If the Ontario Professional Engineers Act was made similar to the acts of other provinces it would be possible to seek and to ask for reciprocal action in the matter of registration and right to practise. At this point, Mr. Hellmuth mentioned that graduates in the professions find adequate protection in Ontario in everything except the profession of engineering (outside of land surveying), thus influencing them to seek other provinces or other places where such protection could be secured. The lack of this is a result of the lack of interest on the part of the public and the deplorable laxness on the part of the engineers themselves.

The present Ontario Act, as had been intimated by Mr. Harkness, was considered inadequate and a new bill was being drafted for presentation at the next session of the legislature. It was intended to send a copy of this bill beforehand to every member of The Engineering Institute of Canada for suggestions and comments.

Visit to Fuel Research Plant

A tour of inspection of the Fuel Research and Ore Dressing laboratories of the Department of Mines on Booth street was made on Tuesday evening, October 13, by the members of the Ottawa Branch and their friends. The tour was arranged through the courtesy of John McLeish, M.E.I.C., director of the Mines Branch, and invitations were also extended to the ladies. About a hundred of the members and their friends were present.

The apparatus used in the laboratories in conducting tests upon coals with particular reference to their coking qualities, and upon oils, oil-shales, gasolines, bituminous shales, etc., was examined. The conduct of this examination was facilitated by descriptive placards attached to each piece of apparatus. A special feature of the evening was the "pushing" of the coke oven, wherein the experimental oven maintained as a part of the equipment of the laboratories was emptied of a charge of coal which had been converted into coke.

The determination of the coking qualities of various Canadian coals is a valuable work of these laboratories, having an important bearing upon the utilization of these coals, particularly for industrial purposes.

Quebec Branch

Marc Boyer, S.E.I.C., Secretary-Treasurer.

On September 27th and 28th, the Quebec Branch was honoured by the visit of the President of The Institute.

On the afternoon of his arrival in Quebec, Mr. Porter was the guest of Hector Cimon, M.E.I.C., chairman of the Branch, at his home, where the officers of the Quebec Branch had gathered.

On September 28th, over thirty members of the Quebec Branch availed themselves of the opportunity of meeting the President, at a luncheon held at the Chateau Frontenac, and presided over by Mr. Cimon.

Upon introducing the President, Mr. Cimon made it clear that although this was Mr. Porter's first visit to Quebec, he was indeed not a stranger to the Quebec Branch, "because his many activities in connection with The Institute were well known, and more recently, his able work as chairman of the Committee on Relations of The Engineering Institute of Canada with the Provincial Professional Associations had been highly appreciated by every engineer," and particularly by the engineers of Quebec. As early as 1910 and 1912, Mr. Cimon pointed out, the Quebec Branch made the first steps towards the organization of provincial engineering associations throughout Canada. Mr. Cimon added a few words of hearty welcome to Mr. Louis St. Laurent, K.C., President of the Canadian Bar Association, who had kindly accepted the invitation of the Branch to attend the meeting.

Mr. Porter's most interesting address embodied the ideals of The Engineering Institute as well as that of every professional engineering association. The President made a strong appeal for the co-operation of every member and branch of The Institute, and ultimately for the co-operation of all professional engineering institutions, in progressing towards one representative, nation-wide organization.

Mr. Louis St. Laurent congratulated the Branch on the address of the President, Mr. Porter, and compared the Canadian Bar Association to The Engineering Institute of Canada, the object of both being to promote a better understanding and to facilitate interchange of knowledge among its members for the benefit of the public and of the country as a whole.

A. R. Decary, M.E.I.C., and W. G. Mitchell, M.E.I.C., added a few words of thanks in the name of the Quebec Branch, and the meeting adjourned.

Following the luncheon, Mr. S. G. Porter, accompanied by a small group of members, visited the new C.P.O.S. terminal and wharf at l'Anse au Foulon and the government dry-docks at Lauzon, two very interesting pieces of modern engineering.

Saint John Branch

G. H. Thurber, A.M.E.I.C., Secretary-Treasurer.
C. G. Clark, A.M.E.I.C., Branch News Editor.

A meeting of the Saint John Branch of The Engineering Institute of Canada was held on September 24th, the speaker being S. G. Porter, M.E.I.C., President of The Institute. Prior to the meeting members attended an informal dinner held at the Admiral Beatty hotel. John N. Flood, A.M.E.I.C., chairman of the Branch, presided.

Mr. Porter stated that branch activities constitute the real life of The Institute due to the fact that such a small percentage of the members can attend the annual meetings. It is thus essential that interest of all members be maintained in branch affairs. He made a number of practical suggestions for increasing and holding the interest of members, such as prepared discussions on papers before presentation, meetings devoted to non-technical subjects of local interest, which would encourage the attendance of men outside the profession, engaged in allied occupations, who could join The Institute as affiliates. A number of moving picture films are available and could be used advantageously. Social activities were also to be encouraged. Zone committees could assist branches by the exchange of speakers and papers.

Mr. Porter also touched on the work of the committee at present engaged in drafting a plan to obtain closer co-operation between the various Provincial Associations of Engineers and The Institute. This, he said, should result in greater uniformity of legislation affecting engineers.

Observations on the Engineering Profession

Mr. Porter said the chief object of The Institute was the exchange of ideas for mutual benefit by members of the profession. He stated that the standards for admitting men to the profession should be as high as possible, especially with reference to fundamental education.

The obligations of engineers to the profession were stressed, as only by national solidarity could public confidence and the influence of the profession be increased. As to the obligation to the public, Mr. Porter stated that the chief reason for lack of public recognition was the backwardness of engineers to take an active part in public governing bodies. He stated that an engineer's training made him well adapted to the solution of social problems.

It was also pointed out by Mr. Porter that whereas only a few decades ago engineers' activities were confined to designing and building, now they have extended their working sphere in many directions, notably towards the management side, many leading executives being technical men.

As to the cause of present economic conditions, it was stated as being largely due to the fact that engineering development had gone beyond the power of civilization to absorb its products. Mr. Porter suggested that the engineer could very materially aid the economist and sociologist in the solution of the present problems.

In the discussion which followed A. A. Turnbull, a.m.e.i.c., suggested that a branch meeting be held to receive the reports of branch representatives acting on national committees. Dr. John Stephens, m.e.i.c., President of the Association of Professional Engineers of New Brunswick, stated the Association would favour any attempt at co-operation between provincial associations which would not jeopardize the standings of these associations.

A hearty vote of thanks to Mr. Porter, moved by C. C. Kirby, m.e.i.c., and seconded by G. G. Murdoch, m.e.i.c., was unanimously passed.

While many of our permanent members, due to seasonal activities, were absent from the city and could not be present at the meeting, the attendance was gratifyingly large owing to the presence of a number of the engineers who have recently been added to our Branch membership through their coming here to engage in work, chiefly in connection with the Saint John Harbour reconstruction.

It is a great pleasure to have these men as members of our Branch and their attendance at our regular meetings during the coming season will be of great value in making the season a successful one.

Sault Ste. Marie Branch

A. A. Rose, A.M.E.I.C., Secretary-Treasurer

Dredging, with Particular Application to the St. Marys River

The first regular meeting of the Sault Ste. Marie Branch after the summer vacation was held on Friday, Sept. 25, 1931, at the New Windsor hotel, dinner being at 7 p.m. and the meeting at 8 o'clock.

The speaker of the evening was Mr. O. M. Frederick, engineer, Sault Ste. Marie, Michigan. Mr. Frederick spoke on the subject, "Dredging, with Particular Application to the St. Marys River."

In his opening remarks Mr. Frederick surveyed the operations of his department in the sixty-mile-long St. Marys river, forty of which have been dredged beginning in 1855. In the river there are many stretches where the water is less than twelve feet deep and previous to 1928 the channel had been deepened to twenty-one feet and widened to three hundred feet in the one-way section and between five and six hundred feet in the two-way channel. This has resulted in a great decrease in the cost of transportation. Under the present plans the whole system is being widened to five hundred feet and deepening of the whole system is being considered.

The speaker then gave in detail the methods of taking soundings and probings from which complete plans and accurate quantity and cost estimates are made. The specifications are as complete and brief as possible, the whole engineering work being so accurately done that contractors can depend on its results. He described the various dredging jobs completed since 1928 and those now in progress, giving details of their extent, materials encountered, methods of dredging, and costs.

The whole paper was most interesting and informative and following a lively discussion those present expressed their appreciation of Mr. Frederick's kindness in giving the branch this paper, by a hearty vote of thanks.

Vancouver Branch

W. O. Scott, Jr.E.I.C., Secretary.

Economic Effect of Russian Five-Year Plan on Canada and the United States

The meeting of October 14th, 1931, was held in the Auditorium of the Medical-Dental Building at 8 p.m.

Speaker—J. Friend Day, Associate Professor, Department of Economics, University of British Columbia.

Subject—The Economic effect of the success of the Russian Five-Year Plan on Canada and the United States.

This subject was most ably presented and the speaker without doubt had a very clear insight of Russia and her problems.

Professor Day began with a brief résumé of Russian history and traced the various changes of government and government policy from sometime previous to 1913 to the present date.

A brief outline of the Five-Year Plan was then given and a few control figures suggested to give a fair idea of the progress made in the plan. Difficulties had been pointed out but these had been overcome and he stated that this was only the beginning of Russia's industrial expansion, that the Five-Year Plan was not by any means the end.

He further touched on Russia's vast storehouse of raw materials, timber, mining, oil, water power, etc. and pointed out the development in the past few years.

He mentioned how Canada and the United States were linked in this great problem, through the various commodities that Russia required in the raw state or through the competitive nature of manufactured articles on the world market.

A hearty vote of thanks was moved and seconded by Messrs. E. E. Brydone-Jack, m.e.i.c., and A. S. Wootton, m.e.i.c., to the speaker for the splendid presentation.

Future meetings will be held in the same auditorium and on the second Monday of each month, unless otherwise notified.

Winnipeg Branch

Eric W. M. James, A.M.E.I.C., Secretary-Treasurer.

The regular semi-monthly meeting of the Winnipeg Branch of The Engineering Institute of Canada was held in the Engineering building, University of Manitoba, on October 15th, 1931, at 8.15 p.m. Charles T. Barnes, a.m.e.i.c., occupied the chair, there being 24 members and visitors present, according to the register. Moved by J. W. Sanger, a.m.e.i.c., seconded by Professor Norman Hall, m.e.i.c., that the appreciation of the Branch be extended to our Secretary for his complete report of our last meeting. Carried. Professor Hall read a letter received from S. G. Porter, m.e.i.c., President of The Engineering Institute of Canada, stating that he would visit Winnipeg on October 26th, 1931, and would like to meet the members of the Winnipeg Branch in the evening. Moved by Professor J. N. Finlayson, m.e.i.c., seconded by Professor R. W. Moffatt, a.m.e.i.c., that a special meeting be held on that evening to meet Mr. Porter, it being left to the Executive Committee to decide whether this would be a dinner meeting or not. Carried. Moved by Mr. Sanger, seconded by R. H. Andrews, a.m.e.i.c., that we proceed with the paper in spite of the small attendance. Carried.

Impact Values of Rail and other Steels at Low Temperatures

J. F. Cunningham, affil.e.i.c., Superintendent, Testing Laboratories, University of Manitoba, then read a paper prepared by James Gilchrist, chief inspector of materials, Canadian National Railways, and himself, entitled "Impact Values of Rail and other Steels at Low Temperatures." In the pearlitic rail steels tested, a reduction in impact resistance was found to occur gradually down to temperatures of 18 degrees below zero, F., to 20 degrees below zero, F. From that temperature down, the resistance to shock has reversals at fairly definite temperatures. Tests were also made on 0.92 per cent Carbon, 0.42 per cent Carbon, 0.10 per cent Carbon steels and Armco Iron. With the exception of the 0.10 per cent rivet steel, all the materials show this definite change in impact values at similar temperatures. The 0.10 per cent rivet steel does not show similar reversals, but gradually loses resistance to shock after a temperature of 40 degrees below zero, F., is passed, The conclusions were advanced that the different components in these steels (cementite or iron carbide, ferrite, etc.) may have different coefficients of contraction due to temperature change, and cause minute strains in the structure which are fully developed at or near 18 degrees to 20 degrees below zero, F., and also that these coefficients may be constant down to a temperature of −18 degrees F. to −20 degrees F., but not below that temperature.

The acting secretary read a letter from Professor A. N. Campbell, Department of Chemistry, University of Manitoba, in connection with allotropic properties of steel. Mr. Gilchrist described the discussion at the convention of the American Steel Treaters' Association in Boston, Mass., last September. The paper was one of 37 chosen for publication out of a total of 160 papers submitted, and was well received by the large number of members present, there being considerable discussion.

Professor Hall asked if tensile tests at low temperatures could be tied up with impact tests, but Professor Moffatt thought this could not be done.

Mr. Sanger wanted to know the practical value of finding this critical temperature of about 20 degrees below zero, F., and Mr. Cunningham replied that if the low impact resistance point (−18 degrees F. to −20 degrees F.) could be moved down to say −58 degrees F., by changing the composition of the steel, the methods of forging, rolling, etc., or the heat treatment of the steel, we would have less failures of steel rails, for instance, at low temperatures until 50 degrees below zero, F., was reached.

Mr. Gilchrist stated that engine-drivers could run faster at 30 or 40 degrees below zero than at 20 degrees below zero, with safety, and that all steel rails should be normalized after rolling, to take care of the stresses due to the unequal sections of the rail, i.e. head, web, and foot. He also stated that Bessemer steel is not as good as the acid open hearth steel for rails, but that rails do not get as many passes through the rolls as was the case thirty years ago, which is a great disadvantage.

Professor Hall moved, Mr. Sanger seconded, a vote of thanks to Messrs. Gilchrist and Cunningham for their interesting paper.

The meeting adjourned at 10.50 p.m. for refreshments.

Unemployment

There were 44 members and visitors present according to the register.

After the reading and confirmation of the minutes of the previous Branch meeting, the Secretary read a letter of resignation as member of the Executive Committee from W. E. Hobbs, A.M.E.I.C., who has been ordered by his physician to refrain from all possible activities. The Chairman invited the Branch to nominate a successor to Mr. Hobbs; but upon the motion of J. W. Sanger, A.M.E.I.C., seconded by E. V. Caton, M.E.I.C., it was resolved that the appointment should rest with the Executive Committee.

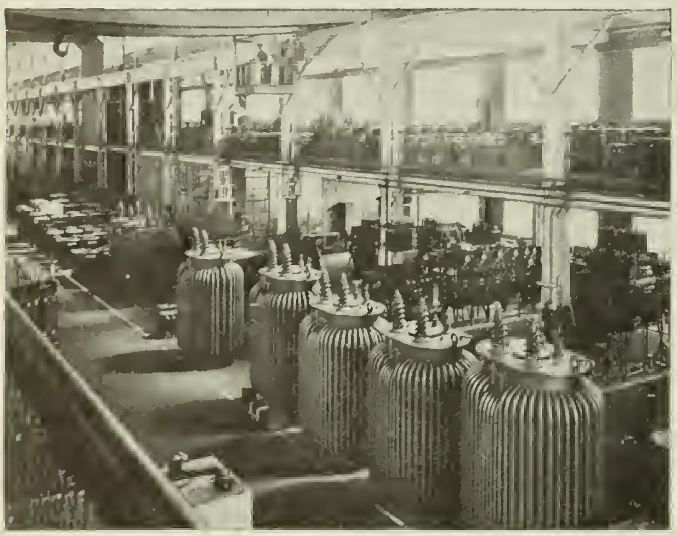
The Chairman then introduced the speaker of the evening, F. H. Martin, M.E.I.C., consulting engineer, Northwestern Power Co., who delivered a most timely and interesting address under the title of "Unemployment."

Mr. Martin designated a new principle contained in his paper as "Employment Insurance" as opposed to unemployment insurance, or the dole system, and stated that in brief the paper might be entitled "Surplus Work for Surplus Labour."

It was pointed out by the speaker that a large number of public works could be undertaken by the Federal government for the relief of unemployment, and that such work could be financed by the underwriting of a twenty-year endowment policy which could be subscribed by people whose surplus funds are at present on deposit in savings banks. Such activities as would be undertaken by the government for the relief of unemployment could be done without in any way interfering with private enterprise; and so when industrial conditions should improve to the extent that private activities could be resumed, surplus labour would be released from government pay rolls to fill the needs of private enterprise.

Mr. Martin's paper was well received, and the subsequent discussion was carried on in a very spirited manner until a late hour in the evening, when it was moved by J. W. Porter, M.E.I.C., that the discussion should be continued at a later date, and that mimeographed copies of Mr. Martin's paper should be distributed to the Branch members in advance of the date fixed for discussion, so that the details of Mr. Martin's well worked out principle could be intelligently discussed.

Among the visitors who took part in the preliminary discussion were Mr. Jules Proudhomme, city solicitor for Winnipeg, and Mr. H. E. McLuhan.



The above illustration shows part of the test department in the new Ferranti transformer factory with a number of 264,000-volt transformers for the Hydro-Electric Power Commission of Ontario ready for test. The dimensions of the factory which is situated on 16 acres of land between Mount Dennis airport and the Canadian Kodak factory, are 110 feet by 400 feet, plus two extensions containing: (*a*) a heating plant, transformer-oil storage, oil treating equipment and (*b*) varnish impregnating tanks and heating ovens. Average night illumination is 14-foot candles and vita glass has been used throughout the building.

Smart Turner Machine Company Ltd., Hamilton, Ont., has recently added to its other lines the manufacture of a stainless steel pump for various industrial plants. These are of the regular centrifugal type with only slight alterations made in the design to simplify the machining of the stainless steel or to conform to the requirements of the special service for which they are being used. The metal used in their construction, KA2, is a low carbon ferrous metal containing 8 to 10 per cent nickel and 18 to 20 per cent chromium, with a specific gravity of 7.6. It is non-magnetic and in its heat treated condition it is highly resistant to chemical attack of many acids and to high temperatures.

Power Supply in Yugoslavia

Great efforts have been made in Yugoslavia since the war to improve the production and the distribution of electric power. Several large power stations have been built by municipalities as well as under government control. A number of private companies with mainly foreign interests are owners of a number of plants supplying electric current to large towns and to the Yugoslavian chemical industry.

Among the latter the Kralyevac water power station should be mentioned. This power station belongs to a French company, which uses the largest part of the output in its chemical works on the Adriatic shore. To a small extent the power is absorbed by the city of Split. The power house, which is situated on the Cetina river, 65 kilometres distant from Split, includes two 16,000 kv.a. and two 26,000 kv.a. generating sets, giving a total output of 84,000 kv.a. The power is transmitted from the power house to the substations through an 80-kv. overhead line.

Another important water power plant has been built by a Swiss company on the Drava river in the vicinity of Maribor. The output of this power station is 34,700 kv.a. Here again the power is distributed through an 80-kv. overhead transmission line. The power station is connected to a steam power plant at Trbovlje, this allowing a very satisfactory distribution of the load between the two stations. The capital of Croatia, Zagreb, possesses a large fuel power plant, which is connected to a small water station at Karlovac. The present output of the Zagreb power plant is 19,500 kw., the largest turbo-generating unit having an output of 10,000 kw.

The most important fuel power plant in Yugoslavia is that which supplies Belgrade, the capital of the country. The power station of Belgrade is now increased by the installation of three new 6,000 kv.a. turbo generating units. This power plant is built by a Swiss company, which will also be responsible for the power distribution among the different parts of the area which surround Belgrade.

A Swedish company owns a number of power plants installed at Subotica, Senta, N. Becej, Velk Beckerek, Zemun, Pancevo, Pozarevac, Svilanajac, Lesovac and Scoplje, all situated in the north-eastern part of the country. The output of these power plants is small, as only units having an output of 200-300 kv.a. are in use. The construction of one large power plant which would supply the electrical current to all the towns mentioned above is under consideration.

An American firm recently acquired the concession for the power plant at Novi-Sad with an output of about 5,000 kv.a. It is quite possible that the company will be extending its interests in the near future as a need for a larger power supply is available in this part of Yugoslavia.

At present some fifty-seven water power plants have been registered in Yugoslavia. The number of fuel power plants including engine-driven generators supplying electrical current for electric light and power was recently one hundred and fifteen. From the 302,000,000 kw.hrs. produced during 1929, 200,000,000 kw.hrs. have been supplied to electro-chemical works, leaving only 100,000,000 kw.hrs. for general purposes and giving a yearly consumption which corresponds to about 9 kw. per inhabitant.—*Nikolay Von Kotschubey in The Electrical Times.*

National Research Council and Radio Research

Radio research has been assigned a definite place in the plans of the National Research Laboratories. An associate committee on radio research has been appointed and is expected to do work similar to that of the radio research boards of the other Dominions. There will be close co-operation with the radio work of other government departments. Arrangements are being made whereby the radio standardization laboratories of the Department of Marine will be placed in the new National Research Laboratories building.

Numerous radio problems have already been brought to the attention of the Research Council. One of the most important is that of assuring that Canada shall have at all times a highly accurate primary standard of radio frequency. Administration of radio in Canada, including allotment of frequencies to stations and seeing that they are adhered to, is the responsibility of the Department of Marine. This department is being equipped with a frequency standard apparatus of a high degree of precision but has joined in a recommendation that the National Research Council undertake a study of the frequency standard problem, that Canada may not be at a disadvantage in this important respect. Other problems which it has been suggested that the Research Council should attack are: Refraction over fresh water, impediments to long distance transmission in certain regions, height of the Heaviside layer, effect of the aurora on wave propagation, superimposed waves or discrepancy in frequency when received as compared with frequency when transmitted, and dependence of wave propagation on meteorological conditions.

Cork Insulation Company, Inc., 154 Nassau street, New York, have issued a 39-page booklet entitled "Corinco Cork Products," describing their product and outlining its uses. In Canada this company is known as Cork Insulation Company (Canada) Ltd., with offices at Montreal, Que., and Vancouver, B.C.

Preliminary Notice

of Applications for Admission and for Transfer

October 20th, 1931

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 1931.

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

FOULIS—ALLAN DODGE, of Saint John, N.B., Born at Yarmouth, N.S., June 25th, 1906; Educ., B.Sc. (M.E.), N.S. Tech. Coll., 1929; Since graduation with The Canadian Fairbanks-Morse Co. Ltd., first six months in engrg. dept. of scale factory at St. Johnsbury, Vt., obtaining knowledge of various types of scales and later on design of larger types of rly. track, hopper and special scales. On returning to Saint John placed in charge of scale dept., covering Maritime Provinces and Nfld. Also does considerable sales engrg. work on Diesel engines, pumps, motors and various lines manufactured by company.

References: F. R. Faulkner, G. H. Burchill, K. L. Dawson, J. L. Allen, A. Sutherland.

PINKERTON—WALLACE A., of Calgary, Alta., Born at Portland, Ont., Aug. 7th, 1879; Educ., B.Sc., Queen's Univ., 1906; 1906-08, Westinghouse Electric and Mfg. Co., Pittsburgh, Pa,; 1908 (4 mos.), Hughes Electric Co., Edmonton; 1918-29, school teacher in Alberta; Oct. 1929 to date, instructor, Institute of Technology and Art, Calgary, Alta.

References: W. H. Broughton, L. R. Brereton, F. N. Rhodes.

FOR TRANSFER FROM THE CLASS OF JUNIOR TO A HIGHER CLASS

LEGGET—ROBERT FERGUSON, of Montreal,Que., Born at Liverpool, England, Sept. 29th, 1904; Educ., B.Eng., 1925, M.Eng., 1927, Liverpool University; A.M.Inst.C.E. 1929; 1923 (summer), asst. engr., Gladstone Dock Works, Mersey Dock and Harbour Board, Liverpool; 1924 (summer), asst. engr., Roads and Sewer Dept., City Engineer's Office, Liverpool; 1925-29, asst. engr., Messrs. C. S. Meik & Buchanan, Consltg. Engrs., London, England, for three years as personal asst. to Mr. W. T. Halcrow, M.I.C.E., gen. civil engrg. work, mainly on hydro-electric developments in Finland, Greece, Italy, and Scotlaud—dock and harbour developments iu East Africa Two periods, July to Oct. 1927, and Oct. 1928 to Mar. 1929, asst. to res. engr., Lochaber Water Power Works, Scotland; April 1929 to date, res. engr., constrn. divn., Power Corporation of Canada, Ltd., gen. design and estimating, also 18 mos. as res. engr. and asst. to the supt. of constrn., on Upper Notch Hydro Electric Plant, in Nor. Ontario. (*Jr. 1929.*)

References: J. S. H. Wurtele, L. C. Jacobs, J. H. Trimingham, C. N. Mitchell, R. S. Lea, A. D. Swan, E. H. James.

SCOTT—WILLIAM ORVILLE CRAIG, of No. 6, 1086-West 12th Street, Vancouver, B.C., Born at Kenora, Ont., Aug. 13th, 1897; Educ., B.A.Sc., 1922, M.A.Sc., 1923, Univ. of B.C.; 1921-22 (summers), asst. on constrn., Coast Quarries, Ltd., Granite Falls; 1923, mech'l. engr. and sales of Diesel engines, John W. Thompson & Co.; 1924-25, asst. water works dept., City of Vancouver; 1925-26, smoke inspr., City of Vancouver; 1927 (Jan.-Sept.) sales, Diesel engines, Scott Foster & Co.; 1927 (Sept.-Oct.), erector on Diesel plant, B.C. Elec. Rly.; 1927-28, erector, Diesel plant, Scott Foster & Co.; 1928 (Feb.-Mar.), Armstrong Morrison Paving Co., Gr. Van. Water Dist.; 1928 (Mar.-Nov.), franchise sales, Canadian Utilities Ltd.; 1928-29, designing engr., Coast Quarries Ltd.; 1929-30, chief inspr., Gr. Van. Water Dist.; 1930 (Apr.-Aug.), asst. inspr., No. 4 pipeline, Jordan River, B.C. Elec. Rly.; 1930 (Mar.-Apr.), chief inspr. on welded pipe fabrication, and Sept. 1930 to Feb. 1931, survey of supply and distribution system of Point Grey area, City of Vancouver; Feb. 1931 to date, inspecting engr., Greater Vancouver Water District, Vancouver, B.C. (*S. 1922, Jr. 1926.*)

References: W. H. Powell, E. A. Cleveland, R. Rome, C. Brakenridge, E. A. Wheatley, E. W. Bowness.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

CRUMP—MORRIS ROY, of Lethbridge, Alta., Born at Revelstoke, B.C , July 30th, 1904; Educ., B.Sc. (Mech.), Purdue Univ., 1929; 1920-25, machinist ap'tice, C.P.R., in B.C. and Man. Vacations 1926-27-29, fitter; 1928 (June-Aug.), instr'man., C.P.R., Swift Current, Sask.; Oct. 1929 to Jan. 1930, dftsman., Winnipeg elect'l. dept., Winnipeg; 1930 (Jan.-Mar.), mech. designer, Winnipeg Hydro Electric; Mar. 1930 to Jan. 1931, night loco. foreman, C.P.R., Saskatoon; Jan. 1931 to date, shop foreman, C.P.R., Lethbridge, Alta. (*S. 1928.*)

References: T. C. Macnabb, J. N. Finlayson, N. M. Hall, H. R. Miles, J. W. Sanger, J. A. Carruthers.

LANG—JOHN TAYLOR, of 13 Mitchell St., Halifax, N.S., Born at Greenock, Scotland, Sept. 27th, 1910; Educ., B.Sc. (M.E.), N.S. Tech. Coll., 1931; 1927 and 1929 (summers), dftsman., Halifax Shipyards, Limited; 1930-31, asst. engr., in direct charge of trials, N.S. Advisory Board of Fuel Investigation, Halifax, N.S. (*S. 1930.*)

References: F. R. Faulkner, G. H. Burchill, W. P. Copp, W. H. Noonan, A. F. Dyer.

NEILSON—CHARLES SHIBLEY, of Walkerville, Ont., Born at Wilton, Ont., Oct. 19th, 1902; Educ., B.Sc. (Civil), Queen's Univ., 1926; 1926 to date, designing, detailing and checking struct'l. steel, also field work, Canadian Bridge Co. Ltd., Walkerville, Ont. (*S. 1925.*)

References: D. T. Alexander, P. E. Adams, G. V. Davies, H. J. A. Chambers, R. A. Spencer.

The Frick Company, Inc., Waynesboro, Penna., has issued bulletin No. 208-A, describing and illustrating the company's system of split-stage low temperature refrigeration. In this system, it is stated, operation of the first stage machine under a vacuum is avoided by substituting carbon dioxide equipment in place of ammonia machinery for the low pressure, low temperature part of the cycle. Carbon dioxide affords temperatures down to − 60 degrees F. and even lower, while still maintaining a positive pressure in the suction piping. This suction pressure will vary in practice between about 60 and 200 pounds gauge—which for carbon dioxide compressors is very moderate. Copies of this booklet may be secured from the company's offices at Waynesboro, Penna., U.S.A.

The Combustion Engineering Corporation, 200 Madison avenue, New York, have recently published a pamphlet entitled "X-Ray Examination of Welded Pressure Vessel Seams," in which the X-ray method of testing, which is prescribed in the A.S.M.E. Code, is discussed, and an installation of X-ray equipment which is representative of the latest development is illustrated and described. Copies of the booklet may be secured from the company at the above mentioned address.

EMPLOYMENT SERVICE BUREAU

This Service is operated for the benefit of members of the Engineering Profession and 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

All notices intended for publication must be received not later than the Tuesday of the week preceding the date of the issue in which they are to be inserted.

Situations Wanted

ELECTRICAL ENGINEER, graduate 1924, experienced home and foreign in electrical design and construction, surveys, reports, etc., capable of taking charge of same, desires any opening in engineering work. Age 32, married. Location immaterial, including foreign countries. Apply to Box No. 7-W.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '28. Experience in the design and testing of broadcast radio receivers, including latest superheterodyne practice, and capable of constructing apparatus for testing same. Also familiar with telephone and telephone repeater engineering. Thorough experience in design, construction and inspection of municipal conduits. Apply to Box No. 12-W.

TECHNICALLY TRAINED INDUSTRIAL EXECUTIVE, open for employment. Canadian, age 40, with extensive Canadian and American industrial experience, particularly in metal manufacturing industries, including grey iron and steel foundries, machine and steel fabricating shops—arrangement and equipment of plant and mechanical handling systems to improve manufacturing methods, cut costs, step up production and quality of product wants connection with progressive company in Canada preparing for business expansion. Apply to Box No. 35-W.

ELECTRICAL ENGINEER, graduate '25. G.E. test: switchgear eng. dept., relay engineer, public utility. First-class record. R.P.E., B.C. Apply to Box No. 68-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.

MECHANICAL ENGINEER, B.Sc. McGill 1919, A.M.E.I.C., married. Eleven years experience, including structural, reinforced concrete, piping and high pressure boiler and furnace design, heating and ventilating, hydraulic and boiler plant operating problems. Apply to Box No. 265-W.

CIVIL ENGINEER, B.A.Sc., C.E., A.M.E.I.C., age 29, married. Experience over nine years includes railway location and construction as resident engineer. Hydro-electric report on estimates and investigation, also design, construction and teaching on hydraulic structures, bridge foundations and caissons. Location immaterial. Apply to Box No. 447-W.

CIVIL ENGINEER, B.Sc., A.M.E.I.C., with six years experience in paper mill and hydro-electric work, desires position in western Canada. Capable of handling reinforced concrete and steel design, paper mill equipment and piping layout, estimates, field surveys, or acting as resident engineer on construction. Now on west coast and available at once. Apply to Box No. 482-W.

DESIGNING ENGINEER, A.M.E.I.C., P.E.Q., with extensive experience in design and construction of power plants, industrial buildings and hydraulic structures, desires position as designing engineer or resident engineer on construction. Apply to Box No. 492-W.

MECHANICAL ENGINEER, Jr.E.I.C., B.Sc., '26. Ten months experience in pulp and paper steam control. Four years experience in detail and design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

MECHANICAL GRADUATE, 1927, age 26. One year with specialized piping contractor on design and cost estimates. Three years on hydro-electric power plant design, proportioned 25 per cent electrical, 25 per cent civil and 50 per cent mechanical. Five months field engineering on hydro-electric power house construction. Pre-graduate experience on power plant operation and general construction. Canadian, married. Available at once. Apply to Box 528-W.

ELECTRICAL ENGINEER, married, graduate of McGill University, desires position in Ottawa, Montreal or Toronto. Experience includes four summers with a building concern as instrumentman and assistant engineer, two and one-half years with the Canadian Westinghouse Co., this time being distributed between tests, design and sales. At present employed but available on short notice. Apply to Box No. 533-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, B.Sc. McGill Univ., Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

MECHANICAL ENGINEER, A.M.E.I.C., experience in the design and maintenance of steel mills, zinc and sulphuric acid plants, cement plants; power house layouts; familiar with shop practices and costs, desires connection. Apply to Box No. 571-W.

YOUNG ENGINEER, Jr.E.I.C., experienced in design, details and erection of steel and concrete structures. Also a good theoretical and practical knowledge of steam, hydraulic and I.C. engine power plant. Good practical mechanical and electrical engineer, able to operate and maintain any type of machinery or power plant. Location immaterial. Apply to Box No. 572-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc., (Univ. of B.C., '30), Undergraduate experience in pulp mill. One year's experience, Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

PARTNER. Full time engineering partner to establish welding firm. Must have business and structural steel experience, and be able to invest substantial amount in firm. Apply to Box No. 589-W.

MECHANICAL ENGINEER, S.E.I.C., age 21, four years mechanical engineering, Queen's University, desires permanent employment. Experience in wood work, machine shop work, draughting and surveying. Location immaterial. Available at once. Apply to Box No. 600-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building, desires change. Location immaterial. Available on one month's notice. Apply to Box No. 601-W.

CHEMICAL ENGINEER, S.E.I.C., University of Alberta, '30, desires a position in any industry with chemical control. Experience includes three summer vacation periods of five months each as assistant chemist, and ten months as chief chemist with a cement company. Age 29. Single. Available at short notice. Apply to Box No. 609-W.

MECHANICAL ENGINEER, Jr.E.I.C., five years apprenticeship on general mechanical engineering; 10 years experience on heating and ventilating and mechanical equipment of buildings. Design, draughting and production. Desires change. Capable of taking charge of engineering department. Further particulars if required. Apply to Box No. 616-W.

POWER ENGINEER, M.E.I.C., age 42. Married. Thoroughly conversant with electrical, steam, mechanical and industrial engineering, desires executive position with large industrial, power or financial corporation. Best of references as to ability and positions held. Apply to Box No. 617-W.

CIVIL ENGINEER, Jr.E.I.C., B.A.Sc. '24, age 35, married. Five years designer and estimator with well-known firm of industrial builders; two years detailing, designing and estimating structural steel for bridges and buildings, also survey and municipal experience. Open for position immediately, will go anywhere. Apply to Box No. 618-W.

CIVIL AND MECHANICAL ENGINEER, experienced in design, layout, installation and selling. Sixteen years association with largest Canadian industries manufacturing equipment particularly relating to pulp, paper and lumber and five years design and construction of sulphite mill, including electrolytic bleachmaking from salt. Apply to Box No. 633-W.

ELECTRICAL ENGINEER, B.Sc. '26, Jr.E.I.C. Age 31. Experience includes one year operation and maintenance work in hydro-electric power plant. Three years on power plant construction work, consisting mostly of relay, meter, and remote control wiring. One year out-door sub-station construction, as assistant engineer. Also geological survey and highway construction experience. Desires position of any kind. Available at once. Apply to Box No. 636-W.

ELECTRICAL ENGINEER, B.Sc., N.S. Tech. Coll., '31. Experience includes geological survey work in Rouyn mining area and hydro-electric power plant construction, both civil and electrical work. Available at once. Apply to Box No. 639-W.

Situations Wanted

SALES ENGINEER, A.M.E.I.C., McGill '23. Past four years sales representative electrical power apparatus in Northern Ontario mining district, western Canada and with some sales experience in Montreal, Toronto, Ottawa and eastern Ontario. Two years electrical estimating and engineering on steel mill applications, mine hoists, elevators, pulp and paper drives, crushing and cement and other special applications. Two years design, engineering, test and some erection on steam turbines. Available short notice; location immaterial. Apply to Box No. 641-W.

ELECTRICAL GRADUATE, McGill '30, S.E.I.C., with thirteen months experience on General Electric test course, twelve months draughting and five months as instrumentman on power plant construction. Available September first. Location immaterial. Apply to Box No. 644-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E. (Ont.), extensive experience as executive and in charge of construction of complete water power developments, including transmission lines, harbour developments, including hydraulic, dredging and land reclamation, industrial plants and municipal works. Apply to Box No. 647-W.

OPERATING ENGINEER. Position wanted as operating superintendent or assistant. Age 43. Married. No children. Nineteen years experience operating hydro-electric plants, sub-stations, transmission lines. Available immediately at any reasonable salary and for any location. Apply to Box No. 654-W.

ELECTRICAL ENGINEER, Jr.E.I.C., 1926 grad. of English Tech. Coll. Past two years inspector of communication apparatus; three years varied power and sub-station experience, including automatic sub-stations, on comprehensive training scheme. Age 24, single. Location immaterial. Available at once. References. Apply to Box No. 658-W.

ELECTRICAL ENGINEER, B.Sc.E.E., 1931. N.S. Tech. Coll. Experienced in armature winding and apparatus repairs, in conduit and cable work. Students' course in elevator manufacture, ship's electrician on tropical run. Good cultural education. Available at once, for Canada or tropics. Apply to Box No. 659-W.

ELECTRICAL ENGINEER, university graduate '28. Experience includes one year with operating department of a large public utility and two years with manufacturer of electrical equipment, work including design, test and correspondence. Available on short notice. Apply to Box No. 660-W.

MECHANICAL ENGINEER. Age 26, university graduate. Experience in machine shop and foundry productions and cost control, and considerable experience with arc welding. Interested in sales engineering. First-class references. Available at once for any location. Apply to Box No. 664-W.

ELECTRICAL ENGINEER, B.Sc., S.E.I.C. Experience: Installation staff Can. Gen. Elect.; students test course with the same company, concrete inspection, transmission line surveying and inspection, also some railway construction experience. References. Desires position with electrical concern. Location immaterial. Available at once. Apply to Box No. 665-W.

RADIO ENGINEER, with thorough general experience covering short wave, marine, broadcast, wire communication, and sound picture work. Capable of taking responsibility in engineering, operating, manufacturing or executive fields. University graduate; single; age 27. Apply to Box No. 667-W.

MECHANICAL ENGINEER, desires position with manufacturing or other company offering opportunity in design and draughting. Thorough technical training and four years experience since graduation. Prefer western Canada, but location and salary of secondary importance. Age 29, unmarried, thoroughly reliable and capable of handling junior position of responsibility or taking charge of technical work for small concern. Apply to Box No. 669-W.

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Electrification of Canadian Copper Refiners Plant, Montreal East, Que.

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Manager, Canadian Comstock Company, Ltd., Montreal.

Paper presented before the Montreal Branch of The Engineering Institute of Canada, October 22nd, 1931.

SUMMARY.—This paper deals with some of the important problems in electrical design which arose in connection with the installation of an electrolytic copper refinery having a capacity of 75,000 tons per year. It includes a general account of the buildings, equipment and the process carried out, and discusses in some detail the design and construction of the electrical equipment, particularly with reference to the bus bar system which is unusually heavy and extensive. Its construction required the solution of a number of special problems. Precautions had to be taken to ensure absolute continuity of supply and adequate protection for the power system.

The completion of the Canadian Copper Refiners plant at Montreal East definitely places Canada in the position of an exporter of electrolytically refined copper, as well as the world's third largest producer.

The plant has a capacity of 75,000 tons per year, and is of particular interest to the electrical engineering profession, since it is completely electrified and the product is largely consumed in the electrical industry. It is situated on the Canadian National Railway, near the St. Lawrence river, and is favourably located in regard to power, labour and shipping facilities. A considerable portion of the product is taken by the Canada Wire and Cable Company, who have built a rod mill and cable plant adjacent to the refinery.

The refinery is designed to receive blister copper from the smelter and ship refined copper as wire bars or ingots. Provision is also made for reclaiming precious metals contained in the blister copper.

Before proceeding with a description of the plant, it may be of interest to give a few particulars in regard to the fundamental principles of electrically refining copper. The process is very simple. If two plates of copper are placed near each other in a solution of copper sulphate and sulphuric acid, and direct current made to flow from one plate called the *anode* to the other called the *cathode*, it will be found that the anode is eaten away while pure copper is plated on the cathode. In the refinery, the anode consists of blister copper, and a thin sheet of pure copper forms the cathode. Under the action of the current, the copper sulphate may be considered to break up into Cu ions and SO_4 ions. The Cu ions are attracted to the cathode and deposited, while the SO_4 ion migrates to the anode where copper becomes ionized in equivalent amount. The less active metals and impurities are not ionized in the presence of the more active copper, and fall to the bottom, as sludge.

At the plant under discussion, the cycle of operations consists of weighing and sampling the blister copper, casting the blister into anodes, refining the anodes into pure cathodes, casting the cathodes into wire bars, purification of the electrolyte, and treatment of the slimes to obtain the precious metals. This process is carried on in a building 1,000 feet long, of one-storey construction, with a basement under the tank house.

Many interesting problems were solved in the design and construction of the electrical plant, caused principally by the following:

1. Necessity for continuous operation throughout the year.
2. High cost of shutdowns through failure of any part of the plant.
3. The presence of acid fumes in certain parts of the refinery.
4. Massive size and length of bus bars.

An economic study was made in the design of each constituent part, so that the cost would be a minimum consistent with all factors involved.

Tank House

The tank house where actual refining is carried on, is 660 feet long and 120 feet wide, contains forty-eight commercial tanks for electrolytic refining and four stripper tanks for making starting sheets. Each tank is divided into nine cells, making a total of four hundred and thirty-two commercial cells and thirty-six stripper cells. Each commercial cell is 16 feet 7 inches by 3 feet 7½ inches and 4 feet 1½ inches deep, and is lined with sheet lead.

The tanks are built of monolithic concrete with 5-inch walls, each mounted on twenty concrete columns. The tanks are separated from the floor on all sides by an air space and insulated from ground by column cappings consisting of a glass plate 1½ inches thick, and a rubber sheet. Wooden launders, lined with sheet lead, are provided in the basement beneath the tanks to convey the slimes to tanks in the basement floor.

The electrolyte is conveyed to and from the tanks by lead pipes. The feed and return pipes are connected to the cells by rubber tubes to prevent loss of current through

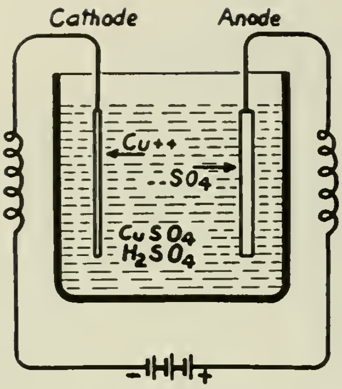

Fig. 1—Simple Electrolytic Cell.

the solution lines, which would also cause copper to deposit in the pipes. This electrolyte consists of a solution of copper sulphate and sulphuric acid, maintained at a temperature of 140 degrees F. and circulated continuously.

Each cell is charged with forty-two anodes of blister copper weighing 700 pounds each, and forty-three starting sheets. A current density of about 17 amperes per square foot of anode surface is maintained, and when the cathodes reach a weight of about 200 pounds, they are removed and new starting sheets put in. The anodes last approximately thirty-five days and about three cathodes are made from each anode. After being washed in an automatic washing machine, to remove the electrolyte, the cathodes are sent to the cathode furnace to be cast into wire bars or ingots.

The starting sheets are made in the thirty-six stripper cells by depositing copper on specially treated starting blanks. The deposit reaches a thickness of about 1/30 inch in twenty-four hours, after which it is stripped from the blank cathode, trimmed and attached to a conducting bar for use in the commercial section.

The fifty-two tanks are connected in series, but the nine cells of each tank form a series-parallel connection. The bus current of 15,000 amperes flows into each cell through the forty-two anodes and out at the other side through the forty-three cathodes. The cathodes of one cell make contact with the anodes of the next, so that while the cells are in series with each other there are forty-two paths through the nine cells of each tank.

A small test switchboard with a mimic bus representing the tank circuit is installed near the foreman's office. A wire from each side of each tank is so connected to contacts on this switchboard that the voltage across any tank can be read by means of a voltmeter.

A pump bay extending along one side of the tank-house contains solution pumps, storage tanks and miscellaneous equipment required for the handling and control of the electrolyte.

Casting Building

The blister copper received at the plant is melted in a reverberatory oil-fired furnace for casting into anodes. The molten copper from this furnace is run into copper moulds set on the periphery of a casting wheel 39 feet in diameter.

The cathodes of pure copper are melted in a similar furnace and cast into ingots or wire bars in copper moulds set on a wheel with a diameter of 44 feet. The wire bar or ingot when solidified is automatically dumped from the mould into a Bosch conveyor tank containing water, and conveyed to the inspection platform before going to the shipping bay.

The casting wheels are motor-driven and each is equipped with a motor tilted ladle. During the casting operation, liquid copper runs continuously from the furnace to the ladle which is tilted intermittently to fill the moulds as they pass in succession. The controls for the various operations are located in a control station where the operator and electrical equipment are protected from the intense heat.

Both furnaces are provided with waste heat boilers and the steam generated is used for heating the electrolyte in the tank house and for heating the buildings.

A Morgan charging machine operated by seven slip-ring motors and running on a special track is used for charging the furnaces with copper.

Power Requirements

The total power required is not large, but the continuity of supply is most exacting. The electrolytic process runs continuously twenty-four hours a day, each day of the year. Certain parts of the system would be seriously injured by a power interruption of over a few minutes and, for several reasons, serious loss would follow a protracted interruption. The largest load consists of the motor generators, which supply direct current to the electrolytic process. Power is also used for cranes, hoists, pumps, air compressors, furnace charging machines, casting wheels, machine shop, locomotive battery charging, lighting, etc. The total connected load is 5,830 h.p. in one hundred and seventy-two motors, ranging in size from ¼ to 980 h.p.

It may be of interest to note that, in a single electrolytic cell, 380 ampere-hours will deposit one pound of copper. An average figure for the energy consumed in the refining process is 290 kw.-hr. per ton of copper.

Power is supplied by the Montreal Light, Heat and Power Consolidated at 12,000 volts, 3-phase, 60 cycles, from two different substations, over two separate lines. One line is always used as a reserve, and can be instantly switched into service, in case of trouble on the other circuit.

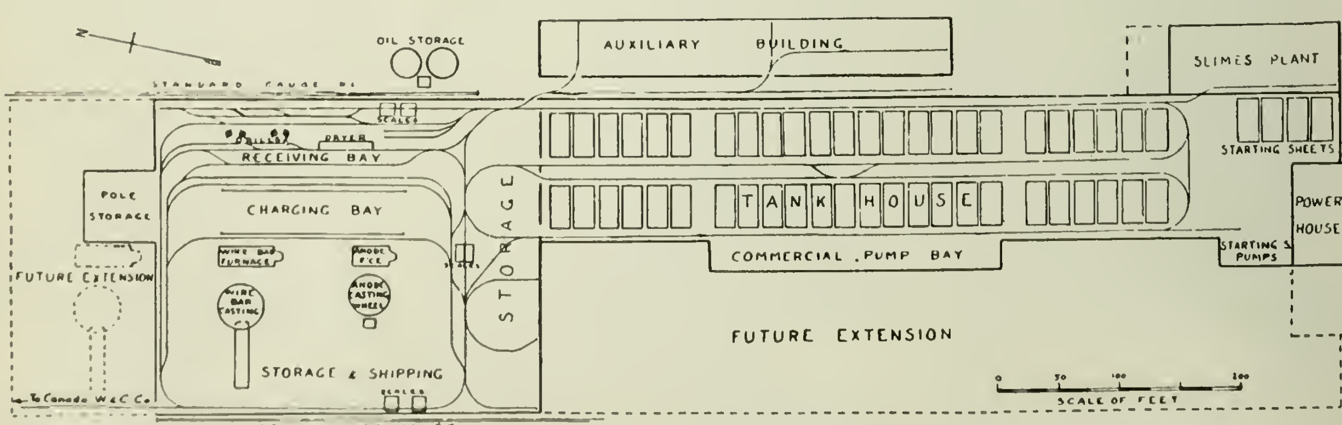

Fig. 2 General Arrangement of Plant.

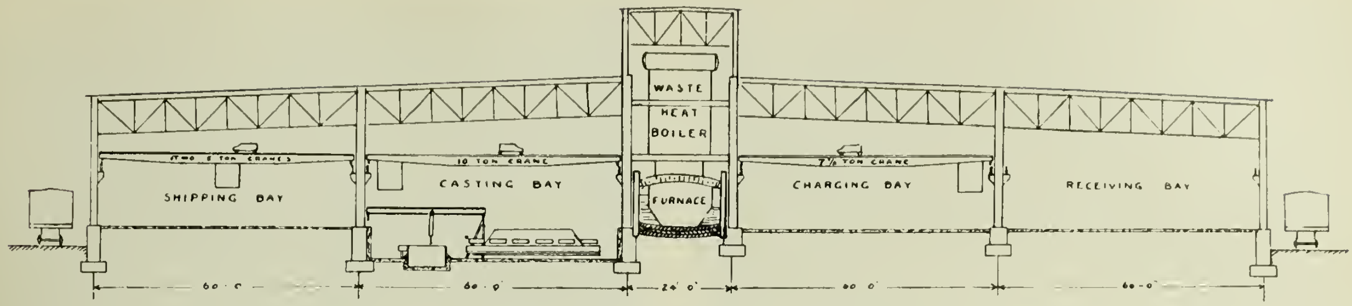

Fig. 3—Cross Section of Refinery.

Bus Bars

At each end of every tank is a massive copper bus bar, which is thought to be the largest ever used. These bus bars are of four different sizes and shapes, the largest being 17 inches wide, 3 inches thick and 19 feet long, and, when received from the rolling mill, weighed 3,500 pounds. These bars were cast at Laurel Hill, N.Y., rolled in Detroit, machined at Lachine, and hand finished at the site. (See fig. 8.)

The design and installation of the copper bus bars presented the most interesting problem connected with the electrification of the plant. Application of Kelvin's law involving power cost, copper resistance-loss and capital cost of copper, showed that a cross-section of 40 square inches was the most economical bus section to carry the normal current of 15,000 amperes. After this, the problem of jointing, heat dissipation, bending and installation required solution. The problem hinged around the fact that, at one hundred and four places in a bus 3,500 feet long, the section must consist of only one bar. While charts are readily available, showing the carrying capacity of smaller bus bars, the sizes of bars necessary for this installation were located on the charts far beyond the curves which dipped sharply toward that area representing high temperature and low capacity. A search for information indicated that little was known regarding the use of large bus bars or the best method of jointing in the larger sizes. It was therefore necessary to sift from available information all that would serve as a guide and complete the design from basic principles. Zest was added to the problem by the large amount of copper involved and the fact that the plant would be tied up by a failure of any part of the bus system. (See fig. 9.)

The bus was finally designed to consist of eight 10-inch by ½-inch copper bars, spaced ½ inch apart, in parallel on the main runs, two 10-inch by 2-inch U-connector bars, and one 10-inch by 3-inch connection between tank bars.

Lap joints were adopted in all cases, and the lap was made as short as possible, resulting in the saving of copper and, owing to the method of installation, in producing an extremely efficient joint.

Bars ½-inch thick came from the rolling mill with a good finish and required only draw filing with emery cloth to remove oxide before installation. The 2-inch and 3-inch bars were planed and scraped, since commercial rolling did not produce the even surface required. All joints were bolted under a pressure of approximately 2,000 pounds per square inch. High tensile steel bolts were used to reduce the size of section required for bolt holes, and the bolt pressure was evenly distributed by thick, flat washers. All joints were assembled with the surfaces covered with vaseline. The bolts were stressed so that changes of temperature would not cause loadings beyond the elastic limit. This design has proved relatively cheap in first cost and the maintenance has been nil. After eight months service, each joint has proved to have less resistance than an equal length of solid bus.

The current is transmitted from bus to anode and from cathode to bus, through knife-edge contacts. These contacts consist of triangular sections arc-welded to the 3-inch bus bars. About 4,000 lineal feet of arc-welding was required. A neat and very satisfactory joint was obtained. So far as the writer can determine, this was the first time copper had been arc-welded for carrying currents of any magnitude.

No expansion joints were used, although straight runs of bus as great as 500 feet were installed. Each end of each bus was connected to the tank bar through a 90-degree horizontal angle, as well as a 90-degree vertical angle. The horizontal runs were suspended by strain insulators and swivels, so that the bus was given perfect freedom of motion in the horizontal plane. This freedom of motion, together with the bends at each end, relieved all expansion strains. (See fig. 4.)

The bus weighs 160 pounds per lineal foot, and was suspended at 10-foot intervals from I-beams cast in the concrete floor beams. A very simple and efficient bus hanger was designed, consisting of slotted pitch-pine blocks

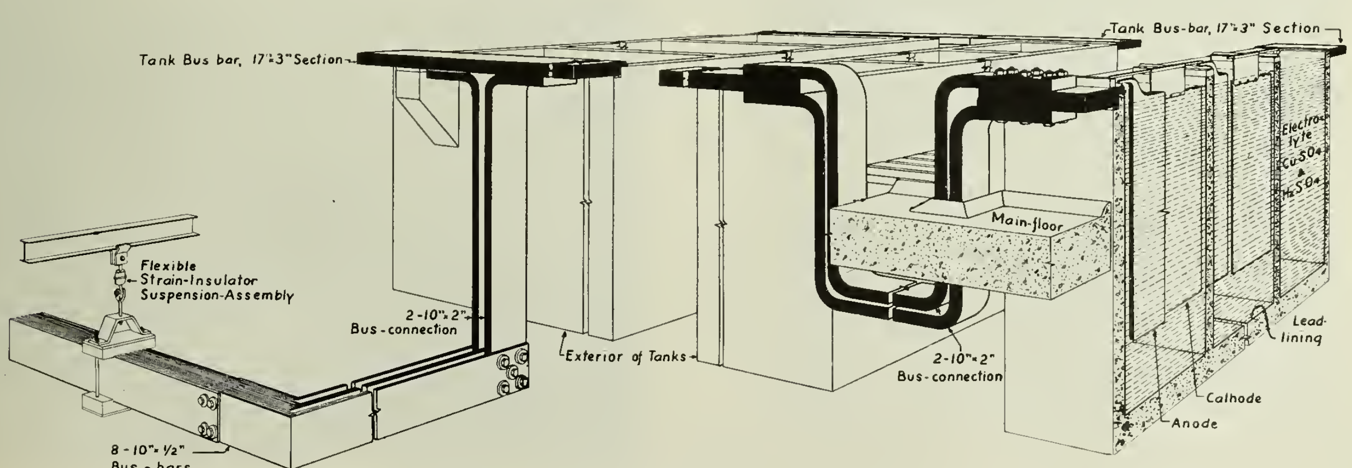

Fig. 4—Section Through Electrolytic Tanks.

placed above and below the bus and clamped by flat steel members and through-bolts. These blocks served as spacers to separate the laminations, as well as to prevent electrolysis between the copper and steel, should acid be present. Supported in this manner, the bus formed a continuous beam which offered considerable resistance to bending. Since lengths up to 500 feet were necessary, it was recognized that a dangerous situation would arise if local settling of the building columns should occur. However, the strength of the strain insulators gave a factor of safety of 12 in respect to the weight of the bus, and it was decided this safety factor, together with an occasional inspection during the first few months to see that all hangers were under strain, would solve the situation. (See fig. 9.)

An interesting problem in the design of the bus was to calculate the loading capacity of the 500-foot section when considered as a column, to determine the possibility of buckling when the expansion force would be opposed by the stiffness of the two right angle end connections. The bus must be regarded as a composite column of eight laminations bolted together every 20 feet and the end connections are also laminated and bolted near the angles.

The 10-inch by ½-inch sections were received in 20-foot lengths weighing 400 pounds each, and were drilled in sets of eight clamped together, by two radial drills set

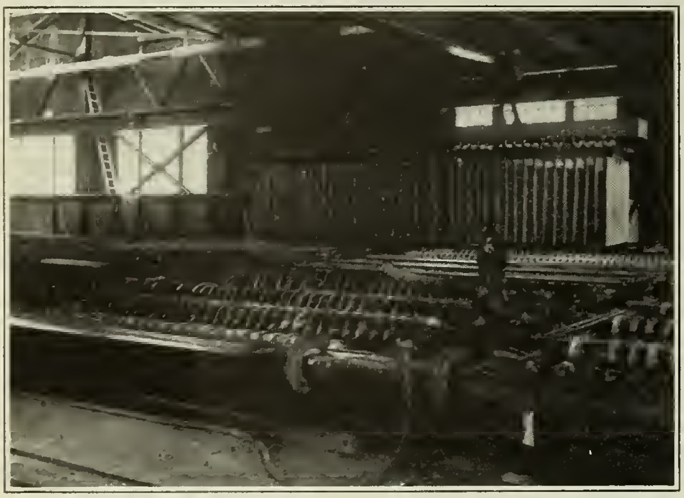

Fig. 5—Method of Removing Cathode with Tanks Short Circuited.

twenty feet apart. Methodical identification and routing of bars facilitated assembly.

The large bars installed on the tanks were insulated by means of ⅜-inch sheet-fibre set in asphalt and pitch. This proved very effective, since the voltage in each tank was of the magnitude of 2.5 volts only.

About 300 tons of copper was required for the bus bar system, and this was ordered cut to length in the various cross sections required, before the building was erected. It is interesting to note that only 500 pounds remained as scrap, exclusive of drillings and planings, after the bus was assembled.

Outdoor Substation

A study of the relative advantages of indoor and outdoor transformer stations showed that the outdoor system should be adopted. This system proved much lower in cost and permitted flexibility for future expansion, at the same time making possible a very convenient arrangement of the power house.

A single line diagram of the switching and circuit arrangement is shown in fig. 6.

The two incoming 12,000-volt transmission lines, consisting of No. 4/0 stranded cable, are dead ended at the outdoor substation on an A-frame structure. This structure

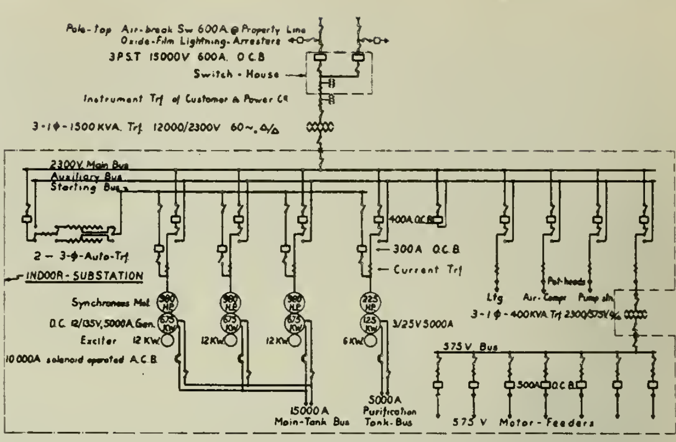

Fig. 6—Diagram of Switching and Circuit Arrangement.

also carries two 600-ampere, 3-pole, gang operated disconnecting switches, as well as two sets of oxide film lightning arresters with single pole disconnecting switches. Two 15,000-volt, 600-ampere oil circuit breakers, with a rupturing capacity of 6,600 amperes, at 12,000 volts, serve for main line switching and transformer protection. These circuit breakers, mounted in an outdoor switch house, are electrically interlocked and controlled from the power house switchboard. Provision is made to prevent operation of the line disconnecting switches, while the circuit breakers are closed, by means of a simple interlock system.

The primary transformer bank consists of three 1,500-kv.-a., single-phase, 12,000/2,300-volt, o.i.s.c. power transformers, fitted with externally operated ratio adjusters and conservator tanks. A bank of three 400 kv.-a., 2,300/575-volt, o.i.s.c. transformers is used for the 550 volt supply. Both transformer banks are connected delta-delta, and disconnecting switches are installed on both primary and secondary sides of all transformers. This permits a quick change to open delta operation, in case of failure of any transformer. Power is carried overhead from the substation to the main 2,300-volt and 550-volt bus in the power house, by 1,300,000 cir. mil cable.

The A-frame and bus structures are built of angle iron framing arc-welded together on the site. All insulators have porcelain designed for 33,000 volts to prevent flashovers owing to gas, smoke and other air impurities present in the district.

Power House

The power house, located adjacent to the tank house, contains control switchboard, switching equipment, motor generator set, storage battery and auxiliary equipment.

Fig. 7—Wire Bar Casting Wheel.

Fig. 8—General View of Tank House Showing Method of Splicing Bus Bar.

The building is of solid brick construction, with dimensions of 80 feet by 45 feet, is 33 feet high, with basement, and provides ample space for the convenient arrangement of equipment. Ventilation is provided by adjustable louvres admitting cool air to the main floor and basement, while the heated air is discharged through roof ventilators.

Three synchronous motor generator sets, consisting of 675-kw., 135-12 volts, 5,000-ampere, direct-current generators driven by 980-h.p., 760-kv.a. unity power factor, 3-phase, 60-cycle, 2,300-volt motors and each having 12 kw., 125-volt direct connected exciters, operating in parallel, supply 15,000 amperes to the main electrolytic circuit. Another set consisting of 125 kw., 25-3-volt, 5,000-ampere direct-current generator driven by a 225-h.p., 180-kv.-a. unity power factor 2,300-volt synchronous motor and having a 6-kw., 125-volt direct connected exciter, is used for the purification circuit. These sets are mounted at main floor level but on foundations separate from the building. The synchronous motors are sufficient to bring the plant power factor well beyond the limits set by the penalty clause of the power contract.

The switching equipment consists of a 2,300-volt switch structure for controlling the synchronous motors and 2,300-volt feeders, and a 550-volt switch structure for the 550-volt feeders. The 2,300-volt oil circuit breakers have a rupturing capacity of 27,000 amperes at 2,500 volts, while the 550-volt circuit breakers have a rupturing capacity of 25,000 amperes at 750 volts. The 2,300-volt switch structure containing the electrically controlled circuit breakers and the necessary disconnecting switches is mounted on the main floor. The 550-volt structure with manually operated circuit breakers is installed in the basement, directly beneath the switchboard on which are mounted the operating handles. Each generator circuit is provided with a 10,000-ampere air circuit breaker mounted in the basement and conveniently arranged for connection in the bus system. (See fig. 11.)

The control switchboard is made of ebony asbestos lumber with iron pipe frame work and space is saved by mounting all main line voltmeters, ammeters, power factor meter, as well as a common exciter voltmeter, on a swinging bracket. The 12,000-volt incoming power and power factor is measured by a polyphase watthour meter, a polyphase watthour meter connected to read reactive energy, and a graphic wattmeter with peak load alarm.

A concrete wiring trough is constructed in the floor, immediately behind the board for the arrangement of control cables.

Overload protection consists of induction type inverse time relays on 2,300-volt circuit breakers, dash-pot type inverse time relays on 550-volt circuit breakers, and instantaneous relays on the 10,000-ampere direct-current air circuit breakers. The latter are also equipped with reverse current relays.

Auto transformers are installed for starting the synchronous motors. A considerable saving in the cost of the starting equipment has been effected by using low rupturing capacity circuit breakers, which function only as oil immersed disconnecting switches, and do not open or close under load. They are electrically interlocked, so as to be fully protected by the circuit breaker which energizes the auto transformer.

Since the 2,300-volt circuit breakers are in continuous service, an auxiliary bus and disconnecting switches were installed, so that any 2,300-volt circuit can be connected directly to this bus. This bus is fed through an auxiliary circuit breaker. The purpose of this auxiliary bus and circuit breaker is to provide rapid and complete substitution for any main circuit breaker taken out of service for inspection, or in case of failure. This auxiliary circuit breaker is not furnished with any form of control or protection directly. When it is desired to substitute this breaker for any other, it is simply necessary to operate a Yale lock switch on the panel controlling the faulty breaker, after which the control and protective system of the faulty circuit breaker will apply to the auxiliary circuit breaker.

A 60-cell storage battery with a rating of 35 amperes for eight hours is installed in the basement. It provides energy for closing and tripping circuit breakers for pilot lights and for the emergency lighting system.

Duplicate motor generator sets rated 7½ kw. each are used for charging the battery. The charging equipment is automatic in operation, except that charging must be manually started.

Motors and Control

The motors are standard induction type, with acid-proof windings and ball or roller bearings. Motors rated

Fig. 9—View of Main Bus Bar Showing eight 10 by ½ inch Bars in Parallel.

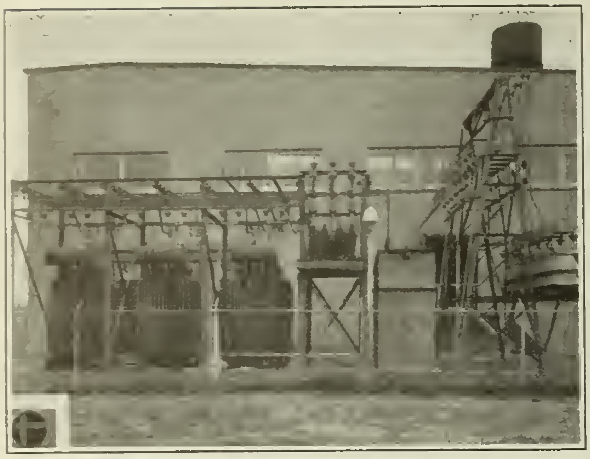

Fig. 10—Outdoor Sub-Station.

50-h.p. and under operate at 550-volt, 3-phase, while larger motors operate at 2,200 volts. Squirrel cage motors of 50 h.p. and smaller are started by application of full voltage.

All 550-volt motors are controlled and protected by magnetic type starters with thermal overload relays. Standard fused safety type switches protect all motor circuits. Both motor starters and safety switches are placed on power distribution racks and the motor starter push button near the motor. This arrangement eliminated the necessity for an extra safety switch per motor. The secondary control of slip ring motors consists of standard resistors and drum controllers. The 2,200-volt motors are protected and controlled by starting compensators and disconnecting switches.

Motor starters and safety switches were selected with the maximum clearance between parts of opposite polarity to prevent short circuits that are liable to occur when dust, acid fumes and moisture are present. Since fuses in the motor circuits are used only for short circuit protection, a make of fuse giving a long time delay was selected to prevent blowing fuses when starting motors.

Fig. 11—Method of Connecting 10,000-ampere Air Circuit Breaker in the Circuit.

All cranes are equipped with face plate controllers, placed on the crane bridge above the cab and operated by vertical levers. This arrangement gives the operator the clear field of vision so important for the work required.

Power Distribution

Electric power was carried from the power house to distribution centres throughout the plant by means of paper insulated, lead covered cable, in rigid iron conduit. The use of this type of cable proved lower in first cost than braided cable, while the lead sheath insured against deterioration from acid fumes.

Braided cable of 30 per cent para rubber was generally used for motor feeders, since the Canadian Code requirements, combined with the high cost of lead covered cables when used on short runs with numerous bends, made lead covered cable more costly than several replacements of braided cable.

At certain locations in the casting building, cables are subjected to high temperatures, wide ranges of temperature, and high moisture content. In these locations, rubber insulated, lead sheathed cables were used, to meet these trying conditions.

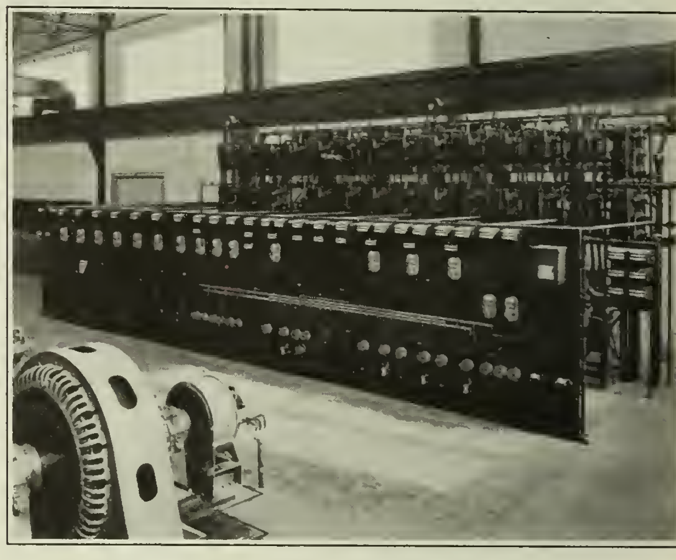

Fig. 12—Main Control Board.

The 550-volt distribution centres consist of sheet steel boxes in which the feeder cables are carried by insulators to form a three-phase bus. Taps from this bus extend to the safety switches and starters which are mounted beneath the box on iron pipe frame work with flat iron cross members. This arrangement of distribution centres proved low in installation cost and economical of floor space, since each rack carries protective and starting equipment for one motor per foot of length of rack.

All cables are carried in rigid metal conduit painted with acid-proof paint and cast iron condulets were used for all fittings. Condulets were fitted with special acid-resisting gaskets and all cable joints were painted with acid-resisting varnish to prevent electrolytic action between the solder and the copper.

Plant Lighting

The lights operate at 110 volts from 110/220-volt, 3-wire panels. In general, all branch circuits are switched at the panels. Special acid-proof lighting cabinets were installed in the tank house. Power for lighting is distributed through the plant by a 2,300-volt, 3-phase, cable, which feeds five lighting transformers. Each transformer is located near its load centre and the secondary current is distributed to the lighting cabinets through safety switches located near each transformer.

It was realized that lighting fixtures would be subjected to the action of acid fumes, but acid-proof fixtures were very expensive and the action of the acid in etching the glass would decrease the efficiency. It was therefore decided to use standard R.L.M. reflectors, which could be cheaply replaced when necessary. Simple one-piece reflectors were selected, and chipping of enamel was replaced by acid-proof paint after installation. This solution has proved satisfactory, and it appears that the reflectors will last for many years.

An emergency lighting system fed by the power house storage battery is arranged to automatically go into service in the event of failure of the a.c. supply. The emergency lights are located as needed throughout the plant and can be turned off as conditions permit, by means of local switches. The emergency lighting cabinet is located in the power house and the operator can control the rate of battery discharge by opening the branch switches, should any department not reduce its emergency load within a scheduled time.

Purification of Electrolyte

In electrolytic refining, most impurities present in the blister copper anode find their way to the bottom of the cells as anode slime. Some of these impurities dissolve in the electrolyte and must be removed to assist in making a pure cathode. To purify the electrolyte, a certain portion is diverted to a set of tanks provided with insoluble anodes of lead, where the impurities are plated out and the acid returned to the circuit. A cascade system of cells is used for this purpose, and direct current is supplied from a 3-25-volt, 5,000-ampere, direct-current generator, through a bus of six 3/8-inch by 6-inch copper bars.

Slimes Plant

Since the copper being refined at the plant is of high gold and silver content, the treatment of the slimes is of great commercial importance. The sludge which is collected in the sump tanks in the tank house is pumped to the slimes plant. Here it passes in order through a thickener, filter and roaster. The roasted material is then leached, filtered, dried and finally fluxed in a dore furnace. The resulting alloy of gold and silver is cast into anodes and parted into gold and silver in electrolytic cells. This electrolytic process consists of five earthenware cells with cathodes of silver and the silver drops to the bottom of the tank in crystaline form. The anodes are enclosed in sacks to retain the gold. Power is supplied from a direct-current generator rated 7.5 kw.-7.5 volts, 1,000 amperes, with direct-connected exciter rated 1¼ kw.-125 volts, both of which are driven by a 10-h.p. induction motor.

The flue dust from the furnaces and roasters contains high gold and silver values. This dust is recovered by settling chambers, scrubbing towers and a Cottrell precipitator.

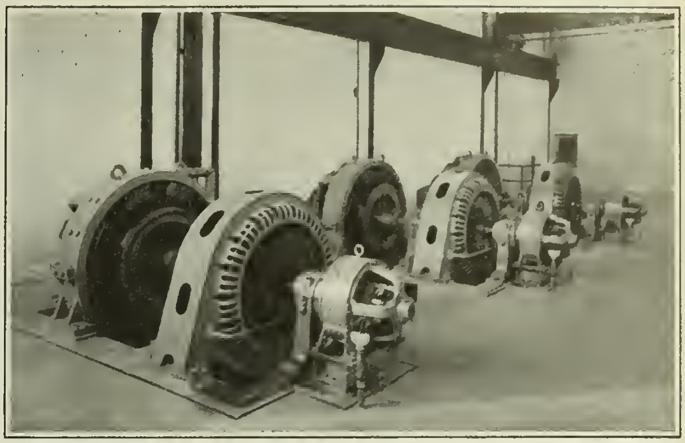

Fig. 13—Motor Generator Sets Supplying Current to Refining Circuit.

Miscellaneous

A well-equipped laboratory is located in the main office building near the refinery. Part of the work carried on there consists of assaying the blister copper received at the plant, to determine the copper and precious metal content. Forming part of the laboratory equipment is a miniature electrolytic refining plant, complete with motor generator and switchboard. This miniature plant is used exclusively for testing purposes.

Two storage battery type locomotives running on narrow gauge tracks are used to handle material in the plant. Each locomotive has a rated drawbar effort of 4,000 pounds and is provided with dynamic braking and series-parallel control. As the locomotives are in constant use during the day, two automatic battery charging sets are provided for night charging. This arrangement of charging equipment ensures against uncharged batteries, if one charging set should give trouble.

An air compressor plant containing four reciprocating compressors driven by two 150-h.p. and two 125-h.p. motors provides compressed air for hoists and furnaces.

A pumping plant installed at the St. Lawrence river, about one-half mile from the refinery, provides an adequate water supply. Two centrifugal pumps driven by one 250-h.p. motor and one 125-h.p. motor are used. This pumping plant is supplied with 2,300-volt power from the power house, by means of a wood pole transmission line.

A twenty-five-station automatic telephone system provides communication throughout the plant, and extends to the river pumping station.

A well-equipped machine shop, with individual motor-driven tools, is provided for plant maintenance and repairs.

The refinery was designed and erected by the Nichols Copper Company, Laurel Hill, N.Y., who operate it for the owners.

The complete electrical system was installed by the Canadian Comstock Company, Ltd.

The writer is deeply indebted to the late Mr. Frank R. Corwin, of the Nichols Copper Company, and to the works manager and staff of the Canadian Copper Refiners, for their advice and suggestions.

Arc Welding of High Conductivity Joints in Copper

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Steel, on account of its low cost, its natural higher physical properties and its scope of application, has long since displaced copper and its alloys as the medium in which man fashions the products of his mechanical mind. This, no doubt, accounts for the fact that the development of the joining of pure copper by welding has lagged behind that of steel.

At the present time, there are many ways of making connections between copper parts. Difficulties arise, however, when the sections are heavy, or where the equipment is subject to the attack of corrosive elements which cause either the formation of an insulating film of salts between the joined parts or the disintegration of the bonding material by chemical or electrolytic action. There seems little doubt, however, that research leading to a satisfactory method of joining copper parts by means of a positive, pure copper joint would, in many cases, be rewarded by an increase in the efficiency of apparatus and equipment in the electrical field in which this material plays such an important part.

An interesting example illustrating the necessity for a joint such as is described above is found in the manufacture of the bus bars which flank the batteries of tanks in a copper refinery and make electrical connection with the anode plates at one side and the cathode plates on the other. In normal production, the busses carry a comparatively high amperage current (15,000 amperes) at low voltage (about 100 volts), with a current density of 375 amperes per square inch, so that any fault in the circuit tending to increase electrical resistance figures largely in the cost of production.

In an endeavour to cut these losses to a minimum and to reduce maintenance costs on the joints in the bus bars to be used in their new Canadian plant, the Canadian Copper Refiners Limited decided to adopt a welded joint, as described below and illustrated in Fig. 1, providing it could be shown that such a joint could be made to comply with conductivity requirements.

Considerable research on welded connections was carried out by the Dominion Welding Engineering Company Limited in collaboration with the Canadian Comstock Company, which company held the contract for the installation of the electrical equipment. This research showed that such a joint was obtainable and consequently welding was decided upon.

The bus bars as designed for this plant consist of two parts,—the heavy current carrying bus with a cross section of approximately 13½ inches by 3 inches, and 18 to 19 feet long and an equilateral triangular strip of a little over one half square inch in cross sectional area, extending almost the full length of the bar and welded to it on the sharp edge on which rest the lugs of the plates suspended in the electrolyte, each bus weighing about 2,800 pounds. The problem was therefore one of welding continuously a light strip of copper to an exceptionally heavy one and since the bars run very close to the edge of the tanks, it was of vital importance that the joint be made of material which would not be affected by the corrosive action of the copper sulphate solution.

In order to decide on the welding procedure qualified to produce the most satisfactory results, it was necessary to run a series of preliminary tests. Triangular copper bars were machined from solid material similar to that which was ultimately to be used and welded in a number of different ways to a heavy section of copper corresponding to the bus bar. Two inch long sections of the welded bars were next parted off ready for testing. On account of the increased current density towards the apex of the triangular strip, it was thought advisable to measure the voltage drop across the joint between two points not further apart than would give a readable value on the instruments available, when comparing a similar section of pure copper. This minimum distance was found to be half an inch and points half an inch apart and straddling the joint line were marked for tapping.

Two distinct types of joint were investigated; the first was made by sweating the bars together using a spelter or silver solder; the second by depositing beads on each side of the triangular strip to form a current carrying fillet between the strip and the bar. It was found that while the first method produced a joint of neat appearance and comparatively high electrical conductivity, it had three distinct disadvantages:—

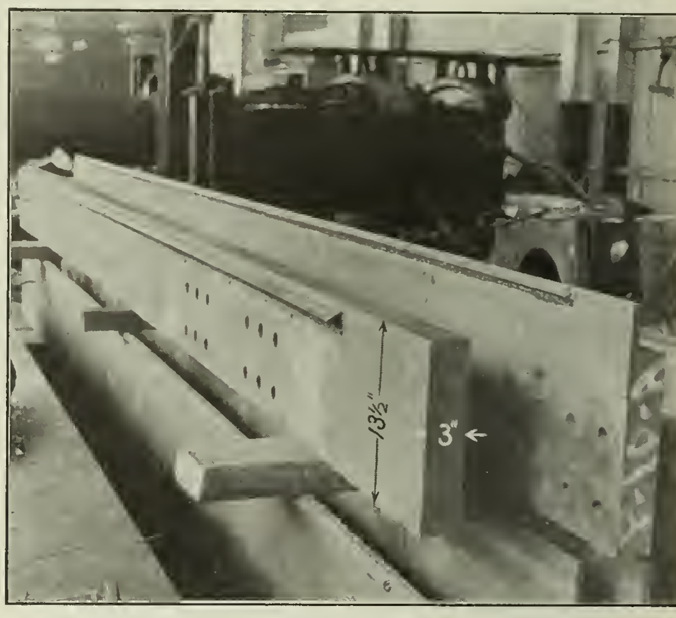

Fig. 1—Two Bus Bars on which Triangular Strips have been Welded.

(*a*) The cost of raising the temperature of the heavy section to the melting point of silver solder would be high.
(*b*) It was probable that the lower melting point spelters with their zinc content would be affected electrolytically by the refining solution.
(*c*) It was impossible to guarantee perfect "tinning" over the whole area of contact, and this type of joint precludes inspection.

Chiefly on account of easy inspection the second method was adopted and tests were next run on pure copper as a filler material and a phosphor copper welding rod produced by the Westinghouse Electric Manufacturing Company. Excellent results were obtained with the pure copper, showing that a joint of 95 per cent to 100 per cent conductivity efficiency could be made with this material. However, owing to a time limit for delivery, it was considered advisable to use the latter material as a filler because of its faster flowing qualities at somewhat lower temperatures giving a weld of adequate conductivity and neat appearance.

During the investigation outlined above, both the electric arc and the oxy-acetylene methods were tried. It had not been anticipated that the former method of welding would be applicable to such heavy sections and as far as is known to the writer, no data pertaining to the arc welding of such masses of copper existed at the time this work was carried out. Results, however, proved the contrary, and not only was this method found feasible but it was adopted, due consideration being given to the speed of arc welding and the lessening of the physical discomfort of operators working close to highly preheated material.

To assemble the bars for welding, special clamps, heavy enough to stand up to the high temperatures encountered, were made. It was also found necessary to protect the apex of the triangular strip from arc splashes and to this end a cold rolled steel bar was slotted to fit over it for its full length. The clamps spaced about twelve inches apart operated on the steel bar and held the whole assembly rigid.

The preheating was carried out in a furnace specially designed for the job and was arranged so that two bars could be heated simultaneously. Because of the liquid qualities of the weld metal, it was found necessary to make provision for rotating the bars about their longitudinal axes through an angle of thirty degrees from the horizontal position in both directions so as to form troughs between the sides of the triangular strip and the bus bar in order to retain the molten weld metal immediately after deposition from the filler rod.

This was accomplished by setting the bars on steel frames pivoted on the main structure of the furnace, which frames also served to support the bars should they tend to sag at the elevated temperatures. In a period of about three weeks, one hundred and four bus bars weighing over one hundred and twenty tons were handled.

After removal from the furnace and after cooling, the bus bars were rigidly inspected for thorough fusion, only the first four bars being rejected. After cleaning, all the bars were straightened, weighed and shipped.

Montreal Incinerators

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, April 16th, 1931.

SUMMARY.—After a brief discussion of the general problem of refuse disposal, and the system adopted in the city of Montreal, the paper describes the buildings and equipment of the incinerator recently constructed to serve the Northern Zone of the city, in which the rubbish is dried and burnt in cells provided with forced draught and preheated air supply. Details of the operation of the plant are given, together with the results of the acceptance tests during which the guaranteed performance was considerably exceeded.

Municipal engineers are called upon to solve problems in diversified branches of engineering and one of these, the problem of refuse collection and disposal in an efficient and sanitary manner, is not always easy of satisfactory solution, particularly when the public of a rapidly developing city has to be considered.

The growth of the city of Montreal has been phenomenal. Its population numbering 270,000 inhabitants in 1900 has more than tripled in thirty years and has been estimated at 900,000 in 1930. The realty value, in 1900 amounting to $185,228,477, in 1930 increased to $1,245,-734,559 or more than six times that of 1900.

The area of the city of Montreal is 50.24 square miles, and the area of the island of Montreal is 194 square miles.

The past growth of Montreal foretells what municipal engineers must foresee when solving their problems and in planning for the future. Therefore in the case of refuse disposal in the city of Montreal it was evident that methods other than that of dumping had to be resorted to.

This problem of refuse disposal may be divided into four parts:

1. The house treatment of refuse.
2. Collection.
3. Transportation.
4. Final disposal.

House treatment includes the preparation of the refuse in general and the separation of ashes and incombustibles from the garbage, rubbish and combustibles and also comprises the types of receptacles and the location from which refuse is to be collected.

The by-law actually in force in the city of Montreal provides for the separation above described, but does not specify the type of the receptacle although it limits its capacity to 100 pounds and stipulates that there shall be a free space of at least six inches between the contents and the top of the receptacle.

The householder is called upon to facilitate the collection by providing a proper receptacle and in separating combustible from incombustible material.

Receptacles are placed in the lanes, and where there are no lanes they are deposited at the edge of the sidewalk or at the yard entrance in residential districts.

A new by-law is now under advisement by the Public Works Commission, providing for the separation of combustible from incombustible material, for the wrapping of garbage, for proper receptacles, etc.

The city of Montreal, through its Department of Public Works, owns and operates all equipment used for the collection, which is effected by horse-drawn vehicles and motor trucks.

This equipment comprises:—

250 horses.
58 team drawn summer vehicles.
63 " " winter "
188 one-horse drawn summer vehicles.
204 " " " winter "
10 trucks.

On an average five hundred men are employed daily in the collection and transportation of refuse.

It is estimated that 406,670 tons of refuse were disposed of during 1930, at cost of $877,124.06, or $2.16 per ton, this being paid out of the revenue derived from municipal taxes.

Refuse is collected twice a week during the day from all sections of the city with the exception of the district included between Delorimier and McGill streets, from the St. Lawrence river to Craig street, where the collection is made during the night.

Refuse is transported to dumps, to transfer stations or to the incinerators.

There are at present two transfer or loading stations, one located on Western avenue, in Notre Dame de Grace ward, and the other near the intersection of Clarke and Lagauchetiere streets.

The buildings of these transfer stations are so designed that odours and dust cannot become objectionable.

Horse drawn vehicles deliver the refuse to the transfer stations from which motor trucks transport it to dumps or

Fig. 1—Incinerator on Des Carrieres Street, Montreal.

to the incinerators. All ashes and some refuse are deposited in dumps which are kept sanitary and sightly by covering with chloride of lime and by periodic grading. Valuable land has been reclaimed by dumping: Laurier and Prefontaine parks are examples of old quarries, 40 or more feet in depth, filled with city refuse.

The available dumps within the city limits have been decreasing and the resultant long haul has augmented the cost of final disposal.

The problem of final refuse disposal was then studied from all viewpoints and eventually incinerators were decided upon.

Local conditions were the deciding factors against the reduction process and in favour of incineration. The reduction process was discarded because of its cost, the variation in the price of the products of reduction making the financial returns uncertain, the absence of grease from our garbage during the winter due to our climatic conditions, the non-wasting characteristics of a large part of the population, the development of odours from reduction making the isolation of the plant necessary and resulting in a lengthy haul, and the probability of the city competing with industries in grease, fertilizer, etc., and the taxation of these industries to pay the losses of the municipal business.

Salvaging in connection with incineration was not considered, for it could not be recommended from a general health standpoint.

Another reason militating against salvaging was the proportionately small quantities of rubbish present in the refuse collected during the summer months, all such rubbish being necessary during that period for complete combustion of garbage otherwise the addition of fuel such as coal, oil or gas would be necessary.

With regard to the development of power by these incinerators, a project of the city for erecting and operating, for municipal services, a hydro-electric power plant by making use of its existing aqueduct canal, did not warrant an investment in steam boilers and power producing equipment in connection with these refuse disposal plants.

Furthermore, incineration permits disposing of the refuse near its source of production in a manner that is proven to be sanitary and inexpensive. It was therefore imperative to locate the incinerators as near as possible to the centre of the refuse production area, each plant to take care of the refuse collected in a specified zone.

The population density map of the city of Montreal, as prepared by the Bell Telephone Company, has been a great help in determining the centre of the production area. To limit the maximum economical haul of the horse-drawn vehicles to about two miles, the city has been divided into three zones, known as the Northern, Western and Eastern zones. The incinerator for the Northern zone has been erected at the cost of $350,000 last year on Des Carrieres street near Papineau avenue, on land adjoining the Canadian Pacific Railway, and that of the Western zone is now being constructed at the cost of $400,000 near the intersection of Atwater and Greene streets, on the site of the Thackeray incinerator erected in 1894 and destroyed by fire in 1920. The latter site is located next to the Canadian National Railway line. The construction of the third incinerator, that of the Eastern zone, is not yet authorized and the site not located.

Each zone has at present, including contributing areas through the transfer or loading stations of the central business district and of Notre Dame de Grace ward, a population of approximately 300,000.

It has been estimated that the location of the Northern zone incinerator would result, from a decreased haul, in a saving sufficient to partly compensate for the cost of the operation of the plant. The vehicles, before operating the Northern zone incinerator, transported on an average three loads per day to the dumps. At present, they are transporting an average of five loads to the incinerating plant.

The average production of garbage and rubbish is estimated at 800 pounds per thousand population per day. A population of 300,000 would therefore produce 240,000 pounds or 120 tons per day.

Allowing for district, seasonal, and daily variations 150 per cent of the average of 120 tons per day and allowing for increase in population and shut down periods, the rated capacity of each plant was fixed at 300 tons per day.

Description of Equipment

The incinerators are of the brick furnace Sterling type incorporating the use of forced draft and preheated air, using heat recovered from the flue gases. They are constructed with separate mutually assistant cells having common furnace chambers over the cells with brick drying hearths continuous throughout the furnace chambers and combustion chambers, regenerators and flues connecting to the chimney and properly dampered to provide independent control of each unit.

Each of the three furnaces is a completely independent unit throughout, permitting separate or simultaneous operation. Each furnace has a furnace chamber with four cells or grates, a drying hearth at the rear of the grates and one feed hole for each cell in the arch over the furnace chamber. Each cell has an individual ash pit provided with separate draft control and is separated above the grates from the adjoining cell for a distance high enough to permit separate and individual stoking and fire cleaning of each cell. Each furnace chamber is lined with nine inches of fire brick The outside walls are constructed 12 inches in thickness, leaving an air space of one inch between the fire brick lining and the outer wall. Each furnace is steel cased with No. 10 gauge plate. The roof arch of the furnace chamber has a secondary arch of common brick built over the fire brick arch. There is a 2-inch air space between the fire brick arch and the secondary arch. The whole furnace chamber lining is supported independent of the structural parts of the furnace and is so constructed that it can be erected without disturbing the outer walls or structural parts. The roof of the chamber is so constructed with cast iron relief beams and struts that repairs to the lining around the charging holes may be made without necessitating the rebuilding of the entire arch. All stoking door openings and clinker door openings are protected with air-cooled cast iron jamb blocks and arch bars.

Each cell is provided with stationary cast iron grates carried on cast iron supports and built in two sections, front and rear Each grate is separated from the adjoining grate by means of a heavy air-cooled casting to permit of separate stoking and fire cleaning. At the rear of the grate between the grate surface and the drying hearth and the sides of the two end grates between the grate surface and the fire brickwork, there is protection provided for the brickwork by means of a heavy casting of similar pattern to the castings which separate the adjoining grates.

The drying hearth upon which the refuse falls after passing through the charging hole is built at the rear of the grates for the entire length of each furnace chamber. Its width is 45 inches. It is constructed of fire brick laid on edge.

In the space below each grate is an individual ash pit separated in each case from the adjoining one and provided with a draft control device, so that the forced draft pressure may be individually controlled in each ash pit. The draft control is accomplished by means of a butterfly valve built into a cast iron air nozzle entering the rear wall of each ash pit. The operating mechanism for the butterfly valve is carried to the front of the furnace and the control is by means of a lever operating between buckstays near the floor line at the front of the furnace.

The stoking doors are of cast iron fire brick lined of the guillotine type. A stoking opening is provided in each stoking door, so that the fire can be stoked without raising the entire door.

The dead plate is of cast iron one inch in thickness.

Steel charging chutes connect the feeding floor with the feed holes in the tops of the furnace. Each chute, built in two sections, is provided with hopper doors at the lower end to prevent excessive back lash of hot gases and to prevent the refuse in the containers coming in contact with the heated surface of the charging hole cover. The bottom hopper doors are arranged to operate simultaneously with the feed hole cover and is under control of the stoker and mechanically operated by compressed air. The containers are hung from the building structure and are entirely free and independent from the furnace structure.

Each furnace of four cells is provided with a combustion chamber, having a volume of 1,600 cubic feet, which is proportioned and designed to give a rolling action to the gases to insure complete combustion and to cause the fine dust to be trapped. The lining and outer walls and roof of the combustion chamber have the same construction as

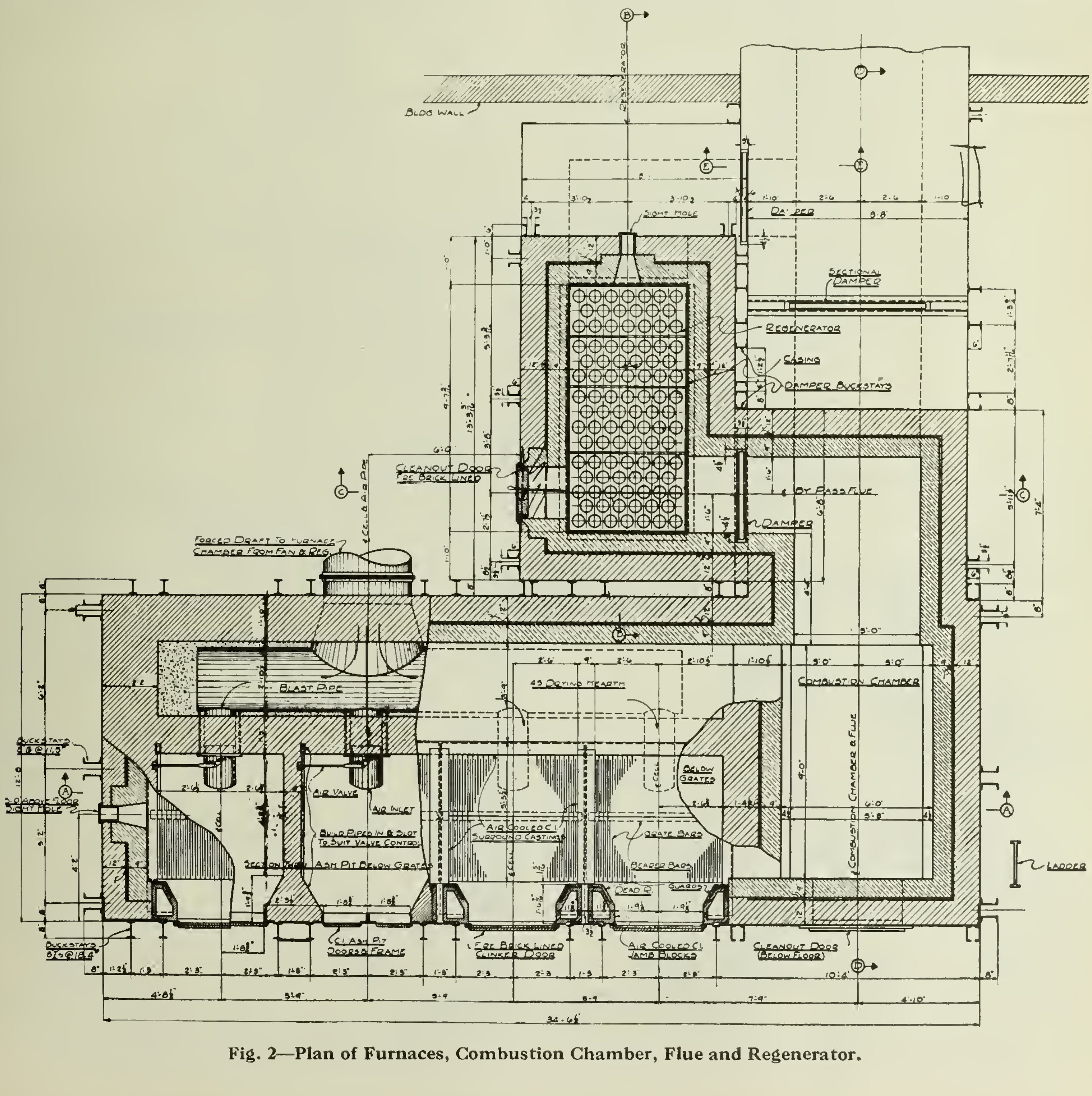

Fig. 2—Plan of Furnaces, Combustion Chamber, Flue and Regenerator.

those of the furnace chamber. The floor of the combustion chamber is paved with 4½ inches of fire brick.

From the main flue of each furnace, gases can be by-passed through a regenerator to heat air supplied for combustion. Dampers are provided so that a sufficient quantity of flue gas can be by-passed through the regenerator to produce a temperature of not less than 300 degrees F. in the forced draft. The regenerator is constructed of cast iron plates and tubes built up in sections so that renewals can be easily effected. There are ninety-nine tubes per regenerator, consisting of 5-inch wrought iron pipes, 6 feet long.

The regenerator is provided with baffle plates and the entire structure of plates and tubes is encased in a steel housing ¼-inch in thickness, the whole set in brickwork.

The tubes and surfaces of plates can readily be cleaned and the tubes can be withdrawn in the setting.

The regenerator is constructed with four sections of tube plates at the top and four at the bottom. These plates are made of cast iron and machined on their edges so that there is an air tight fit between the adjoining plates or baffles or regenerator housing, as the case may be. These plates are built with ribs and provided with bosses for packing the tubes air tight.

The upper flue gas chamber regenerator is covered with a flat fire brick roof held in castings. This roof is built in sections easily removed for renewals of tubes and plates.

When the refuse contains large quantities of moisture, the regenerator cannot be dispensed with, as it makes combustion possible. Besides improving the starting of fires, it serves to drive off the moisture previous to ignition, and owing to the increased eagerness with which the oxygen will combine with the carbon, it is possible to decrease the excess of air, so that the gases are not so diluted, which means that for the same fuel a much higher temperature is obtained.

The advantages of the preheater are therefore as follows:—

The addition of a considerable amount of heat units to the furnace side of the heat balance sheet:

A reduction of the excess air supplied and the consequent diminution of the dilution of the combustion gases;

Increase in the rapidity of igniting a fresh charge of refuse;

Increase in the temperature obtained in the combustion chamber;

Increase in the evaporation due to the above advantages.

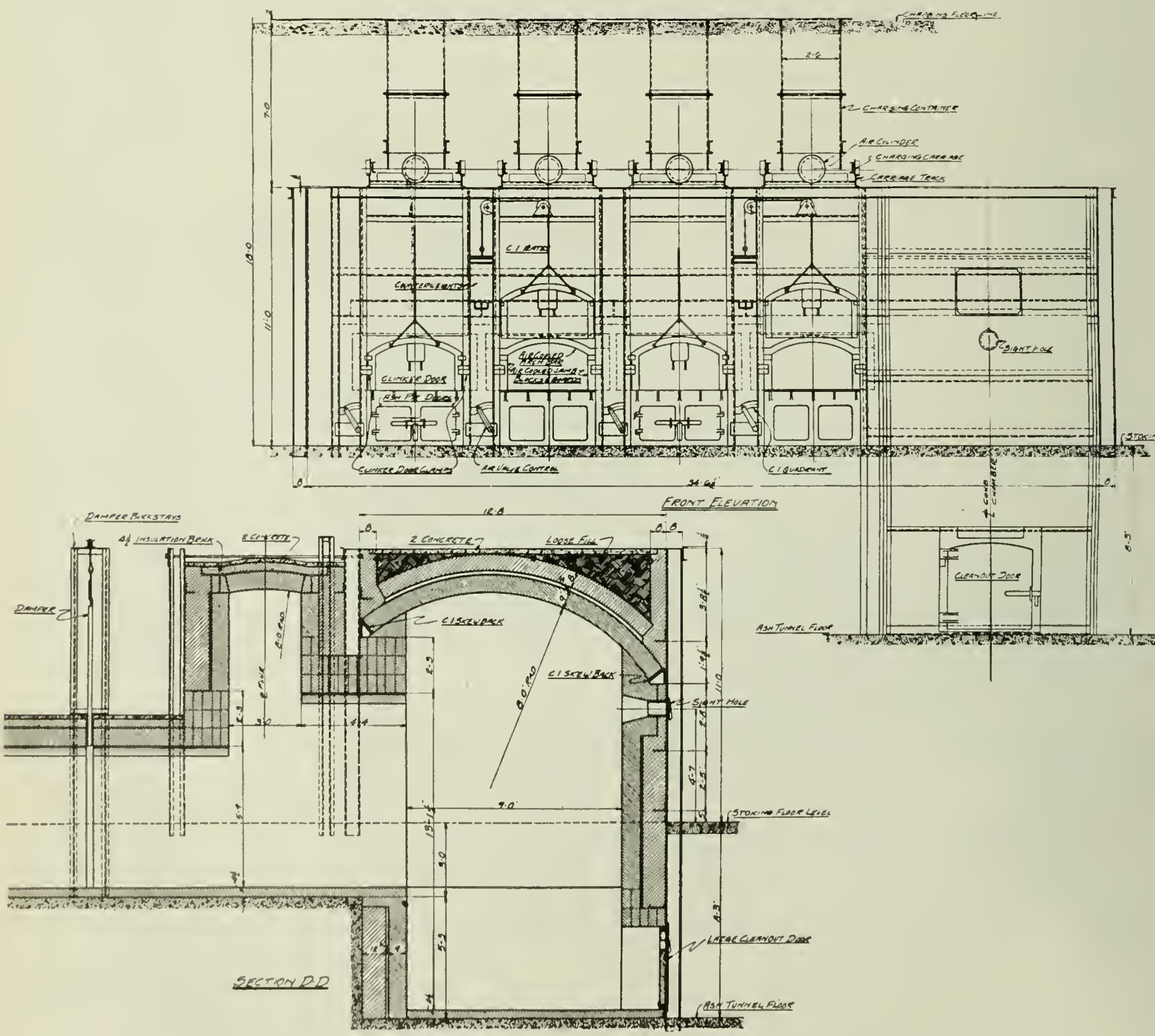

Fig. 3—Front Elevation of Furnace and Combustion Chamber. Section Through Combustion Chamber.

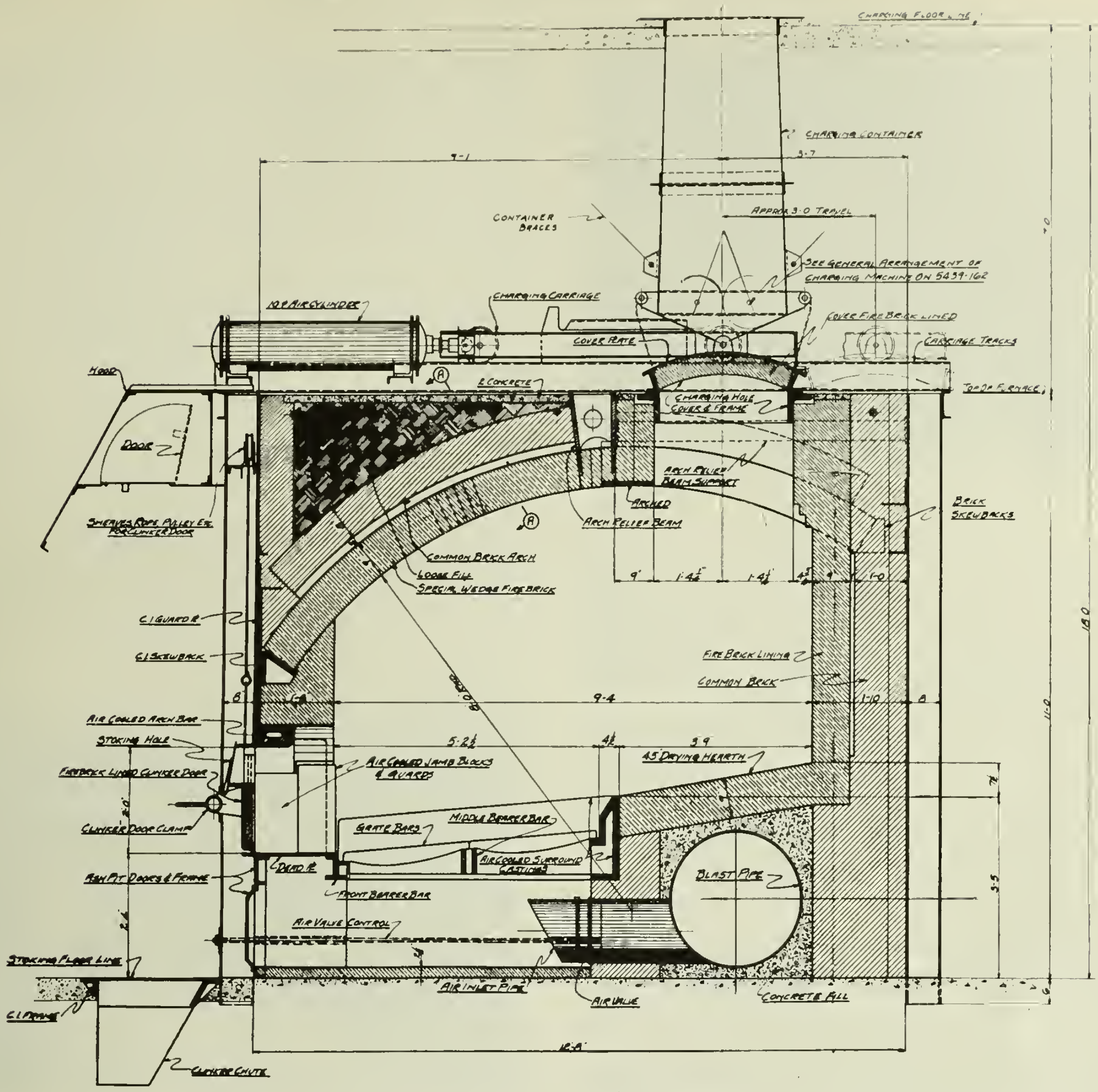

Fig. 4—Section Through Furnace.

The area of all flues and gas passages is sufficient to prevent back lashing of the furnace. The flues are constructed with a 9-inch fire brick wall lining and a 9-inch fire brick arch, and with a 9-inch common brick outside wall and secondary arch, with an air space between the fire brick and the common brick. Outside walls are encased with 10-gauge steel plate. The floors of all flues are paved with a 4½-inch fire brick.

The radial brick chimney is 150 feet high and 9 feet inside diameter. It has an independently supported fire brick lining throughout the entire length guaranteed for 2,250 degrees F. regular operating temperature.

The interior lining is constructed using steel bands with vertical sections between the bands, which is commonly termed "corset" construction, to minimize the effects of expansion and to prevent cracks. This lining is used up to a height of 50 feet in order to assure stability. A target wall 4½ inches in thickness is constructed on the interior of this lining for a height of 30 feet. This target wall is entirely independent of the fire brick column or lining of the chimney and is installed to take the brunt of the hot gases coming from the furnaces as they enter the chimney and to protect the self-supporting lining.

The brickwork of all furnace chambers, combustion chambers, flues and regenerators are securely bound together using heavy vertical buckstays, structural steel belt channels and angles, and tie rods provided with lock nuts. The furnaces and flues are securely tied so that they act as one unit and take up the stresses without dislocation or rupture. The main fire brick arch over the furnace chamber is carried on cast iron skewbacks in front and on fire brick skewbacks in the rear backed up with structural steel angles and channels, so that all horizontal stresses are carried directly to the buckstays and the entire fire

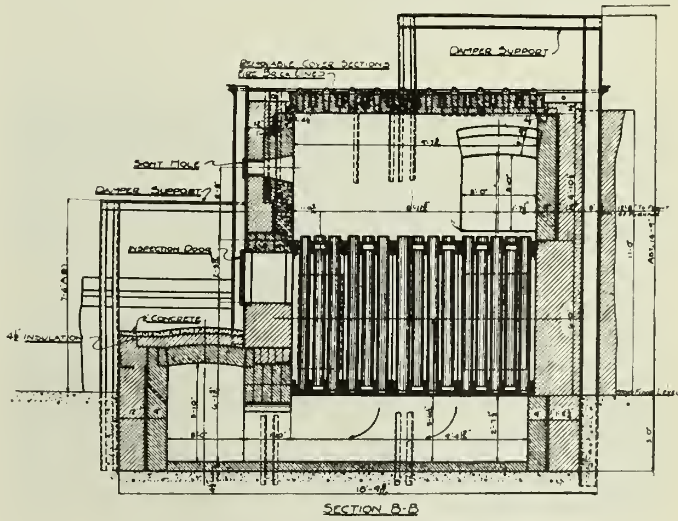

Fig. 5—Section Through Regenerator.

Fig. 6—Feeding Floor.

brick lining in the walls below the arch can be renewed without disturbing the arch in any way.

The main fire brick arch over the combustion chamber is carried both front and rear on cast iron skewbacks, so that the entire arch is supported directly between the buckstays and the fire brick wall lining can be renewed entirely without disturbing the main arch.

The main buckstays front and rear of the cells are made of 8-inch by 18.4-pound I-beams. These buckstays are each built with two I-beams tied in pairs with main tie rods of 1¼-inch diameter. The buckstays at front and rear of the combustion chamber are built of channels tied in pairs, each channel being 8-inch by 11.5-pounds.

The furnaces, combustion chambers, flues and regenerators are all metal cased with No. 10 gauge steel plate bolted to the buckstays.

The fire brick used throughout the furnaces, combustion chamber, regenerators and flues have a pyrometric cone equivalent of 32 to 33.

There are two direct connected electric motor driven air compressors of the duplex single acting vertical type. The compressors have a piston displacement of 95 cubic feet per minute at a discharge pressure of 100. The compressors supply air to the rams which open the charging doors.

The necessary draft for combustion is supplied by means of a direct connected electric motor driven centrifugal fan (one motor and one fan for each furnace), each fan having a capacity of 10,000 cubic feet of air per minute, at 70 degrees F., when operating at a speed of 1,160 r.p.m. against 4½ inches static pressure.

Operation

The refuse is delivered to the receiving pit in horse-drawn wagons and motor trucks and transferred to the charging hoppers by means of the grab bucket cranes The refuse in the hoppers falls by gravity into the charging containers located on top of the furnaces as previously described. The bottom of the charging container is closed to prevent the material coming in contact with the hot surface of the furnace. The charging door is moved backward mechanically by controls operated by the stoker from the stoking floor. As the door travels back to full opening it engages with lugs on the side of the charging containers and automatically opens the doors on the bottom of the charging container, dropping the full charge into the furnace.

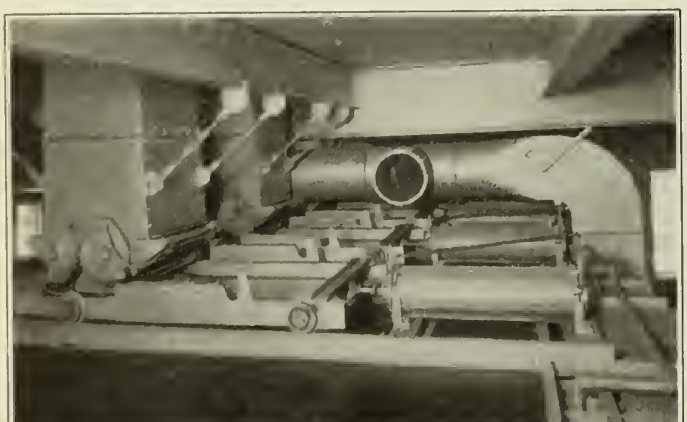

Fig. 7—Chutes Connecting Feeding Floor to Furnaces, Hopper Doors and Rams.

The containers are specially designed to prevent refuse sticking and to permit free and rapid discharge when doors are opened.

The charge is dropped on a drying hearth at the rear of the furnace, where the hot gases assist in drying the refuse before it is drawn forward on the grate by the stoker.

The refuse when drawn on the grate is consumed and the operation is continued by dropping successive charges as needed.

The furnace chamber being continuous above the four grates, permits the dropping of charges on alternate grates, so that the hot fire from the adjoining grates will assist in the combustion of the fresh charges of refuse.

As the gases from the furnace chamber pass into the combustion chamber at one end of the row of cells, they

Fig. 8—Ash Tunnel.

strike the farther wall of the combustion chamber and produce a rolling action and a thorough mixture of the gases, so that final and complete combustion takes place developing a temperature higher than 1,200 degrees F. While passing through the combustion chamber most of the dust is deposited.

Part of the gases from the combustion chamber are carried by flues direct to the chimney and part are passed through the regenerator for heating the forced draft air used in the furnaces, thereby utilizing a large part of the waste heat and returning the same to the furnace. The regenerator being installed in a separate chamber permits its being closed off entirely by means of a damper and the regulation of the quantity of hot gases to pass through the regenerator.

In operating the furnaces, the forced draft and the passage of gases through the regenerator as well as the charging of the furnaces, can be regulated to meet the varying conditions, each furnace being equipped with recording pyrometer and each regenerator with a recording thermometer.

Fires are cleaned separately from each cell of a furnace, by raking the ashes and clinkers from the grate and dropping them into cars in the ash tunnel. The bodies of the cars are emptied into truck bodies placed in the ash pit of the building. From there the furnace residue is transported to dumps.

Tests

The city, before accepting the plant on DesCarrieres street, appointed a Board of Engineers and Aldermen to inspect and test the incinerator. The results of the test were as follows:—

Date	Tuesday, October 14th, 1930.
Weather	Fair.
Temperature	Max. 74.0 degrees F.
	Min. 56.2 "
	Mean 64.4 "
Barometer	Max. 30.01 ins.
	Min. 29.93 "
	Mean 29.97 "
Humidity	71 per cent.
Start of test	9.50 a.m.
Finish of test	8.55 p.m.
Duration of test	11 hours, 5 minutes = 11.08 hours.
Weight consumed	206.7 tons.
Weight of residue	50.45 tons with water content for quenching ash.

Percentage of moisture in refuse	39.83 per cent
Pounds of moisture per ton of refuse	796.6 pounds
Percentage of organic matter in refuse	44.92 per cent
Pounds of organic matter per ton of refuse	898.4 pounds
Percentage of inorganic ash, tin, glass, etc.	15.25 per cent
Pounds of inorganic ash, tin, glass, etc. per ton of refuse	305.0 pounds

Area of grate surface, three furnaces at 100 square feet =	300 square feet
Rate of burning per square foot grate per hour obtained by test	124.4 pounds
Rate of burning per square foot grate per hour guaranteed by contractor	104.1 "

Rate of burning tons per furnace hour	6.22 tons
Guaranteed rate of burning tons per furnace hour	5.2 "

Capacity of plant per 24 hours	448 tons
" " " " " specified	300 "
" " " " " guaranteed	375 "
Actual increase in capacity, percentage over specified capacity	49⅓ per cent

Furnace No. 1

Maximum temperature of combustion chamber	2,025 degrees F.
Minimum " " " "	1,500 "
Average " " " "	1,730 "

Furnace No. 2

Maximum temperature of combustion chamber	2,250 degrees F.
Minimum " " " "	1,350 "
Average " " " "	1,975 "

Furnace No. 3

Maximum temperature of combustion chamber	In excess of 1,800 degrees F.
Minimum " " " "	1,370 degrees F.
Average " " " "	1,720 degrees F. approx.

Combustion chamber temperature guaranteed not less than 1,250 degrees F., for more than 3 minutes, average temperature at least 1,400 degrees F.

Furnace No. 1

Maximum temperature of regenerator air	480 degrees F.
Minimum " " " "	300 "
Average " " " "	370 "

Furnace No. 2

Maximum temperature of regenerator air	450 degrees F.
Minimum " " " "	280 "
Average " " " "	360 "

Furnace No. 3

Maximum temperature of regenerator air	400 degrees F.
Minimum " " " "	300 "
Average " " " "	350 "

Analysis of residue—	Moisture	14.37 per cent
	Unburnt garbage brought out from drying hearth with the clinker by careless stoker	2.80 "
	Glass, metal, etc	47.41 "
	Carbon dioxide	4.74 "
	Ash residue	30.07 "
	Combustible organic matter excluding carbon	0.61 "

Residue content of organic guaranteed not more than 1 per cent of organic matter exclusive of carbon.

Total man hours of labour, actual burning including cranemen, chargers, stokers and ash-run men	135 man hours
Man hours of labour per ton	0.653 man hour
Guaranteed man hours of labour per ton	0.9 " "

Electric power consumed during test for operating forced draft equipment, air compressor, cranes and other equipment of building	560 kilowatt hours
Kw.h. per ton of refuse obtained	2.7 "
" " " " guaranteed	3.6 "

Density of smoke—Chart No. 1 of Ringelmann's Smoke Scale.
Density of smoke guaranteed—not greater than Chart No. 1 of Ringelmann's Smoke Scale.

Nuisance through escape of noxious odours, gases, sparks or dust. None.

Since the above paper has been written, the second plant on Atwater avenue has been tested, giving the following results:—

Date	Thursday, September 10th, 1931.
Weather	Mostly fair and warm—Showers.
Temperature	9 a.m. 72 degrees F.
	1 p.m. 84 "
	5 p.m. 86 "
Barometer	29.85 ins.
	29.82 "
	29.79 "
Humidity	78 per cent.
Wind	South-west.
Start of test	9.45 a.m.
Finish of test	8.58 p.m.
Duration of test	11 hours, 13 minutes = 11.22 hours.
Weight consumed	212.81 tons.
Weight of residue	52.75 tons with water content for quenching ash.

Percentage of moisture in refuse	53.23 per cent
Pounds of moisture per ton of refuse	1,064.6 pounds
Percentage of organic matter in refuse	24.95 per cent
Pounds of organic matter per ton of refuse	499 pounds
Percentage of inorganic ash, tin, glass, etc.	21.82 per cent
Pounds of inorganic ash, tin, glass, etc. per ton of refuse	436.4 pounds

Area of grate surface, three furnaces at 100 square feet	300 square feet
Rate of burning per square foot grate per hour obtained by test	126.4 pounds
Rate of burning per square foot grate per hour guaranteed by contractor	104.1 "

Rate of burning tons per furnace hour	6.32 tons
Guaranteed rate of burning tons per furnace hour	5.2 "

Capacity of plant per 24 hours	455 tons
" " " " " " specified	300 "
" " " " " " guaranteed	375 "
Actual increase in capacity, percentage over specified capacity	51⅔ per cent

Furnace No. 1

Maximum temperature of combustion chamber	2,230 degrees F.
Minimum " " " "	1,830 "
Average " " " "	2,050 "

Furnace No. 2

Maximum temperature of combustion chamber	2,230 degrees F.
Minimum " " " "	1,580 "
Average " " " "	1,930 "

Furnace No. 3

Maximum temperature of combustion chamber	2,220 degrees F.
Minimum " " " "	1,610 "
Average " " " "	1,980 "

Combustion chamber temperature guaranteed not less than 1,250 degrees F., for more than 3 minutes, average temperature at least 1,400 degrees F.

Furnace No. 1

Maximum temperature of regenerator air	435 degrees F.
Minimum " " " "	300 "
Average " " " "	344 "

Furnace No. 2

Maximum temperature of regenerator air	420 degrees F.
Minimum " " " "	285 "
Average " " " "	339 "

Furnace No. 3

Maximum temperature of regenerator air	430 degrees F.
Minimum " " " "	295 "
Average " " " "	340 "

Analysis of residue—Moisture	2.25 per cent	
Carbon as carbon	1.24	"
Combustible organic matter excluding carbon	0.28	"
Glass, metal, etc.	38.28	"
Carbon dioxide	0.10	"
Ash residue	57.85	"

Residue content of organic guaranteed not more than 1 per cent of organic matter exclusive of carbon.

Total man hours of labour, actual burning including cranemen, chargers, stokers and ash-run men	135 man hours
Man hours of labour per ton	0.63 man hour
Guaranteed men hours of labour per ton	0.9 "

Electric power consumed during test for operating forced draft equipment, air compressor, cranes and other equipment of building	600 kilowatt hrs.
Kw.h. per ton of refuse obtained	2.82 "
" " " " " guaranteed	3.6 "

Density of smoke—Chart No. 1 of Ringelmann's Smoke scale.
Density of smoke guaranteed—not greater than Chart No. 1 of Ringelmann's Smoke Scale.

Nuisance through escape of noxious odours, gases, sparks or dust. . None.

Both plants are now operated by the city of Montreal.

Discussion on "The Practical Application of the Microscope in Railway Service"

Paper by F. H. Williams, M.Sc.[1]

C. F. Pascoe[2]

Mr. Pascoe observed that the paper had been very interesting but it seemed to him that the importance of coarse crystalline structure had been over-emphasized. He had found that this was not so important a factor as inspecting engineers often seemed to think.

F. H. Williams[3]

The author in reply stated that he believed the answer could be found in the slides which had just been shown. A great proportion of these had shown the whole fracture and not the microstructure. Besides coarse grain as a cause of failure, the results of overheating in service, scratches in fillets, etc., had been shown, while he maintained that coarse grain was often a cause contributing to the growth of a fatigue crack or a sudden failure; he realized that there were numerous other factors.

Harold J. Roast[4]

Mr. Roast remarked that the author had mentioned in several instances the effect of "overheating" and showed micrographs showing a fine grain, which he had attributed to overheating. He was accustomed to think that overheating caused a coarse grain and he wondered if the author would explain this point.

F. H. Williams

The author replied that in many cases of overheating the fine grain was caused by the chilling action of the interior of the heavy axle.

G. St. G. Sproule, A.M.E.I.C.[5]

Professor Sproule stated that before proposing a formal vote of thanks, he wished to make a few remarks regarding the very interesting talk which had been given. The subject was really of fundamental interest to all engineers, involving as it did, the design, material, workmanship and service treatment of mechanical parts, and he thought that the author had treated the subject in a well-balanced manner.

With regard to the question by Mr. Roast, this was a matter of ambiguity of terms. From the metallographic point of view, overheating meant raising the temperature of the metal to a *very high point*, which produced a coarse grain. From the mechanical point of view, a journal might be considered overheated when it reached the temperature of boiling water or 200 degrees C. or 300 degrees C., which would destroy the lubrication. In the cases of overheating which the author had illustrated, the temperature at the surface evidently reached a degree somewhat above the critical temperature that is sufficient to alter the grain but not to make it coarse.

The author had illustrated cases of failure due to various causes. His experience had usually been that a failure was due to a combination of causes. Even in Case 1, which had been described as being due to "one cause only—design," the coarse grain of the metal was also mentioned.

The case in which loose balls of metal from the fracture were found was very interesting indeed, if not unique. A point which engineers might well notice was the great area of the fatigue cracks before final failure. This might be taken as indicating good design, but it depended on the point of view. It would appear that if design, material and workmanship were more perfect, a much smaller amount of metal would have served the purpose. In some cases, structures appeared to be killing themselves with their own weight. The importance of preventing the start of a fatigue crack was very great, as once it was started, it would surely continue to grow with increasing rapidity. This was prevented by good design, ample fillets, good finish and sound, tough, elastic material, with good impact strength. It was up to engineers in general to insist on their steels being made by the best possible practice, fully deoxidized and cast in big-end-up moulds. This was not a criticism of the practice of Mr. Pascoe, because he was not making ingots for rolling and forging.

He remarked that there was one diagnosis of the author's which he wished to dispute, as he considered it open to question. This was the case of a main rod end in which a coarse microstructure was showed as being due to overheating in service, although, as mentioned previously, if through overheating in service the temperature rose above the critical point at all, usually gave a fine grain. He believed that main rods and crank pins actually did sometimes heat to a red heat, but it was doubtful if they ever became hot enough to grow a coarse grain such as was illustrated. He believed that the variable grain in this rod end was produced in the forging. Except for this point, he thought all would agree that the author's micrographs and photographs really showed what they claimed to show, which could not always be said for micrographs accompanying published articles.

Another very interesting case was the corrosion crack. This was a comparatively little-known thing, and attention should be drawn to the fact that it was referred to and illustrated in an article by Dr. A. Stansfield, M.E.I.C., presented before the Ottawa Branch of The Institute on April 9th, 1931, and published in the August, 1931, issue of The Engineering Journal.

In conclusion, Professor Sproule proposed a hearty vote of thanks to the author.

(1) This paper was presented before the Montreal Branch of The Institute on October 29th, 1931, and appeared in the November 1931 issue of The Engineering Journal.
(2) Superintendent, Canadian Steel Foundries, Longue Pointe, Que.
(3) Canadian National Railways, Montreal.
(4) Lecturer in Metallography, Department of Metallurgical Engineering, McGill University, Montreal.
(5) Assistant professor of metallurgy, McGill University, Montreal.

The Design and Construction of Metal Hulls for Boat Seaplanes

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SUMMARY—The general design of seaplane hulls and floats is carried out by methods familiar to naval architects, but modified to take account of the special conditions arising in aircraft work. The methods of construction and the materials employed in hulls and floats are discussed and the necessary investigations for strength are described. The shop procedure for metal hulls requires special precautions when aluminum alloys are employed and precautions must be taken to prevent damage from corrosion in service. The paper concludes with an appendix discussing some of the fundamental calculations involved in hull and float design.

The following paper is presented as a short survey of the procedure adopted when designing and building a boat seaplane, and most of the material has been published already at various times.

General Design

A good hull is one which combines satisfactorily the very different qualities—seaworthiness and airworthiness.

The requirements for seaworthiness can be divided into two distinct classes, namely:—

Seaworthiness while on the water (*a*) without engine running; (*b*) with engine running.

(*a*) requires excess buoyancy and good static stability in all directions; while (*b*) requires low water resistance and good dynamic stability both during taxying and planing.

In normal modern boat design the fully submerged buoyancy of the hull is always very much in excess of that required. Low water resistance is included as a requirement of seaworthiness as it is assumed that the quicker the take off time, the less is the need for true seaworthiness. That a quality which reduces the necessity for true seaworthiness should be deemed advantageous, may sound paradoxical, but it must be confessed that at the present stage of flying boat development, these aircraft are much more airworthy in rough air than they are seaworthy in rough sea. Seaworthiness exists only to a negligible extent in flying boats if the standard of comparison is the normal sea going vessel. Fig. 1 shows a twin engine boat seaplane taking off.

A seaplane hull must also be capable of leaving the water in a reasonable time and of returning safely to the surface after flight. For quick take off, a flat bottom is preferable, but is liable to considerable damage from pounding when alighting. The evolution of planing bottom shapes has been from flat to straight vee and now to curved vee. These are shown in Fig. 2. In each case it has been necessary to add steps (see Fig. 3) so that when taking off the surface tension of the water is overcome by breaking down the flow.

The questions of static and dynamic stability are considered in detail later.

Airworthiness requirements are, low air resistance with the centre of resistance as high as possible and convenient accommodation for the crew, load, and for the manipulation of any special equipment.

Design work commences with weight estimates of the various components and of the position of the centre of gravity of the fully loaded boat. When these estimates are sufficiently satisfactory to fix the all-up weight the lines of some predetermined hull shape are drawn out and the load water line added in side view (see Fig. 3). This line is first estimated from previous experience and is usually inclined at from 3 degrees to 5 degrees to the fore body keel line at the main step. A perpendicular to the water line and passing through the all-up centre of gravity should be slightly forward of the main step. The buoyancy of the under water body is then checked and modified until close agreement with the all-up weight is obtained.

The usual method of determining the under water volume is the same as that used by the naval architect, i.e., the half areas under water of the various sections have Simpson's Rule applied or are plotted as a curve (Fig. 4). The area of this curve multiplied by two and by the weight of water gives the required buoyancy in pounds.

The next step is to determine the centre of buoyancy by taking moments of volumes about some point of reference. A quick method of finding the longitudinal position is to cut out the curve shown in Fig. 4 and find its centre of gravity by the suspension method.

When the centre of buoyancy has been found and indicated on the side view of the boat the line joining the all-up centre of gravity and the centre of buoyancy should be perpendicular to the estimated water line. If this is not so, corrections must be made, for instance, assuming that the relative positions of centre of gravity and main step are correct, either the water line or the hull shape must be modified.

A model of the hull is now made to some convenient scale for tank testing in order to obtain data regarding its behaviour on the water.

Fig. 1—Seaplane Taking Off.

The method adopted follows closely that in use for many years by naval architects and which was used first by Froude. The model is towed in a long tank by means of an electrically driven carriage at various speeds, the support being such that the resultant loads on the model are accurately recorded. Tests on flying boats are necessarily more complex than for ships, because of the variation in support received by the hull and the wings at different speeds and attitudes. The flying boat model is pivoted at the all-up centre of gravity and the towing force applied at the centre of thrust. The attitude for any given speed is estimated and the corresponding lift from the wings calculated so that this lift can be reproduced on the model by means of counter weights. A preliminary run at the corresponding speed is then made to check the estimated attitude and any further corrections to wing lift made if this is found to vary.

When these corrections are found over the range of speeds required final runs are made and the total resistance recorded plotted against speed (see Fig. 5). Observations are made at the same time, usually by cameras, of the waves, spray, etc. Other runs are then made with varying pitching moments applied, to obtain qualitative data on the water stability of the design. Of all the data obtained from these tests, only a part of the total resistance follows Froude's Law of Corresponding Speeds. Stability data are

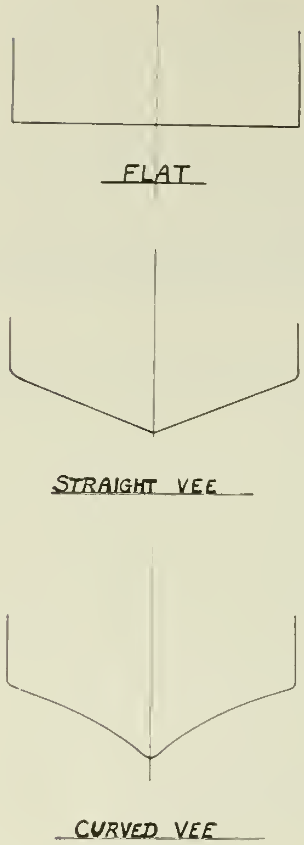

Fig. 2.

qualitative only and it is usually found that a stable model predicts stability in full scale.

The total tow rope resistance of a body moving on the surface of a fluid is made up of two main parts:—

(1) Skin friction and eddy making;

(2) Residuary resistances made up of (*a*) wave making resistance, (*b*) air resistance;

and only the residuary resistance follows Froude's Law. The following is the method for obtaining the division of these resistances from model tests. The skin resistance is a function of actual speed and size only and can be expressed in the form of

$$R = k\rho s v^2 \left(\frac{lv}{\nu}\right)^a$$

When

k = constant depending on the shape of the body.
ρ = mass density of the fluid.
s = wetted area of the body.
v = relative speed of the body.
l = linear dimension of the body.
ν = kinematic viscosity of the fluid.
a = constant depending on the shape of the body.

In R. and M. No. 1199 by Professor B. Jones, it is shown that for perfect streamlined bodies the flow is turbulent and the value of '*a*' is approximately .015.

From the model tests the total resistance is plotted against forward speed, see curve (1), Fig. 6.

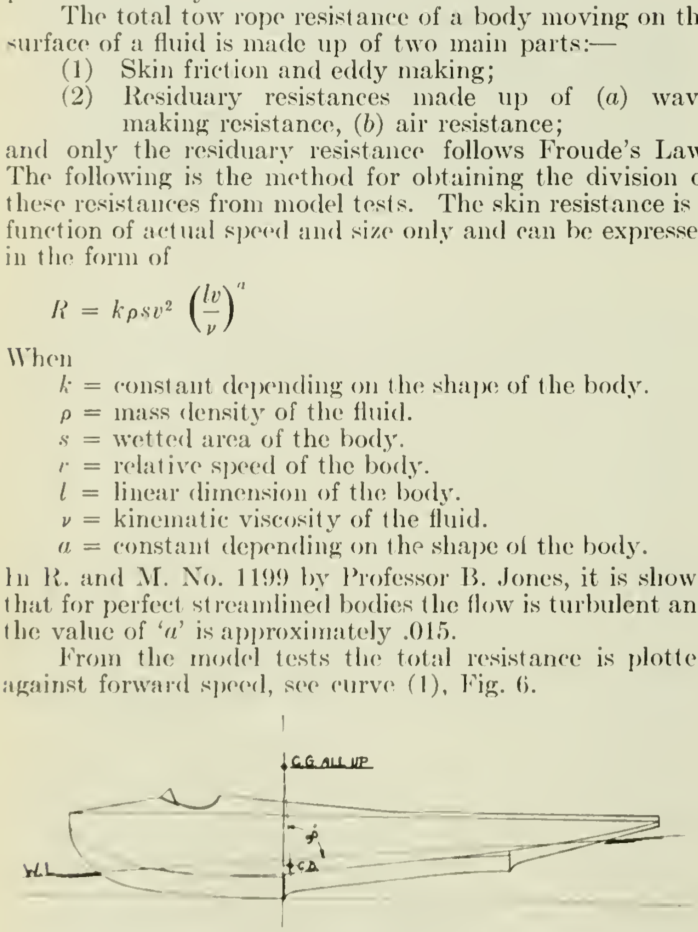

Fig. 3.

Then from the model conditions the skin friction is calculated by the above expression and plotted as curve (2). The intercepts between these curves then give the wave making resistance which can be corrected and plotted for full scale. The full scale skin resistance is calculated and added to the corrected wave making resistance giving the full scale total resistance. These figures can then be compared with those of a known successful design and used for estimating the water performance of the complete boat.

Stability

Flying boats are stabilized laterally either by stubs or by outboard floats, as the hull and superstructure alone are transversely unstable due to the fact that the metacentric height is negative. In order to estimate the required buoyancy of these stabilizers, it is necessary, therefore, to decide the position of the metacentre and the value of the metacentric height of the complete aircraft and the method is identical with that used by the naval architect (Fig. 7). The height of the metacentre above the centre of buoyancy is found from the simple expression

$$B.M. = \frac{I}{V}.$$

Where I = second moment of area of the water plane
V = volume of the underwater body.

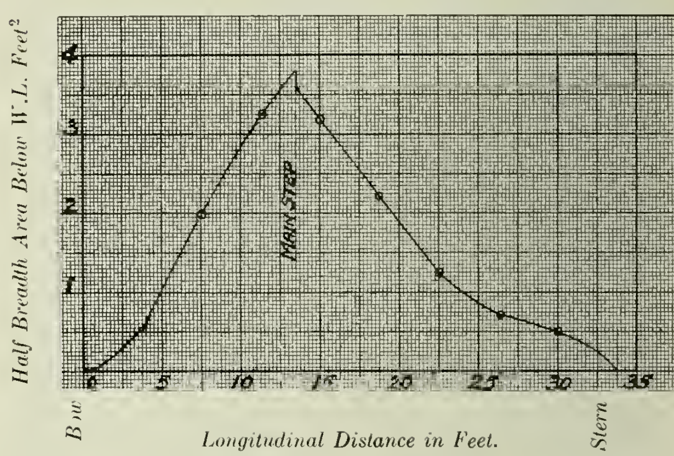

Fig. 4—Buoyancy to L.W.L.

I is obtained from the cubes of the ordinates of the water plane shape and the application of Simpson's Parabolic Rule.

In Fig. 8 $C.B.$ is the centre of buoyancy, $M.$ the metacentre and $C.G.$ the centre of gravity. Obviously the buoyancy acts upwards at $C.B.$ and the weight downwards at $C.G.$, and it will be seen that when the boat is slightly tilted to one side, these two forces do not act in the same line so that there is a resultant couple tending to increase the tilt. It is this upsetting couple which must be counteracted by the outboard floats or stubs.

The value of the upsetting couple is

$$W.\ (G.M)\ \sin\theta$$

Where W = all-up weight of boat
$G.M$ = metacentric height
θ = angle of tilt

and the righting couple (see Fig. 8) is represented by

$$BL \cos\theta$$

Where B = effective buoyancy of the outboard float
L = horizontal distance from $C.L.$ of the boat to the centre of buoyancy of the outboard float.

The totally submerged buoyancy of outboard floats should be at least 20 per cent in excess of that shown by

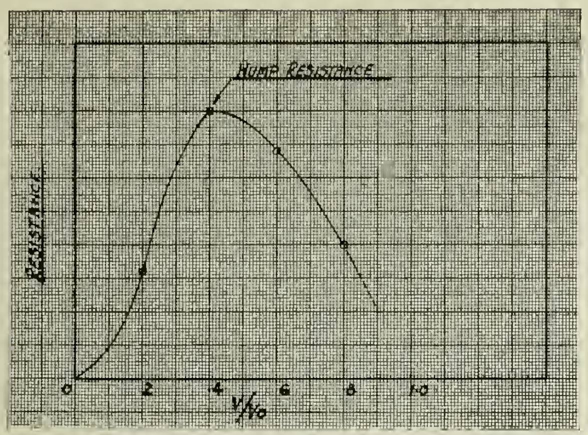

Fig. 5.

the above method in order to satisfactorily counteract the effects of side winds.

From considerations of static stability only it will be seen that it is advantageous to have the buoyancy of the outboard floats become operative immediately the boat begins to roll, so that the upsetting moment is small. However, another condition affects the positioning of these floats, namely, taxying. Usually at approximately 20 knots the water forces on a hull are sufficient to preserve lateral stability and as, while taxying, the total resistance, and therefore the total wetted surface, should be reduced as much as possible, it is advisable to keep the floats high up. Also the forces on floats which are driven at high speed through waves are considerable and tend to unduly stress the wing structure so that the actual position of the stabilizing floats must be a compromise between the two requirements. Normal values of the natural angle of roll at rest on smooth water and with no wind vary from three to four degrees.

The usual British practice is to fit "wing tip" floats, that is, floats positioned as far as possible from the centre line of the boat. This arrangement offers two important advantages:—

(1) A reduction in weight due to the smaller buoyancy required with a large arm.
(2) A smaller resistance both on the water and in the air, again due to the reduced size of float.

It is possible that the hull fitted with stub stabilizers is the most seaworthy, but the weight of the stubs and loss of efficiency on the water due to the extra resistance is too costly at present, although with very large boats this may be considerably improved.

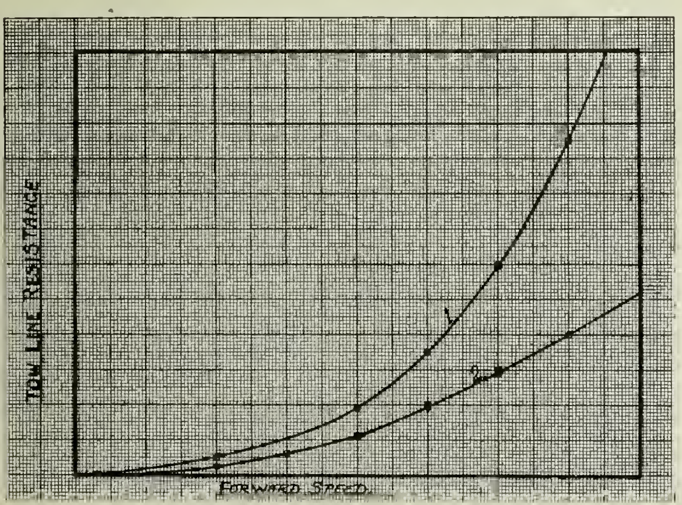

Fig. 6.

Inboard floats also must be proportionally larger and therefore heavier than wing tip floats, and for a given angle of roll, when fully submerged, must be closer to the normal water line, giving increased resistance during taxying.

The relative merits of outboard and inboard floats and stub stabilizers offers a subject for tank tests which urgently requires investigation as no truly comparable data are available at present.

The requirements for longitudinal stability have not been reduced yet to any form giving a simple solution and still offer difficulty in a new design which departs radically from shapes of known characteristics and proved performance. Longitudinal instability occurs in its worst form as "porpoising" during planing. Porpoising is a fore and aft oscillation obviously due to lack of damping moments and the elimination of this characteristic in any particular case is not obtainable by increasing the damping but rather by modifications to the primary causes, namely, the shape of the hull and the disposition of the various masses. Generally porpoising will occur if the centre of gravity of the complete boat is very far forward of the main step or if the distance between the steps is comparatively small. Very approximately it may be said that while planing the boat is supported at the two steps and a comparison of the two reactions is suggested as a subject for investigation. The full conditions, which must include airscrew thrust together with air and water resistances, are complex but it is believed that light would be thrown on a subject which is still somewhat obscure.

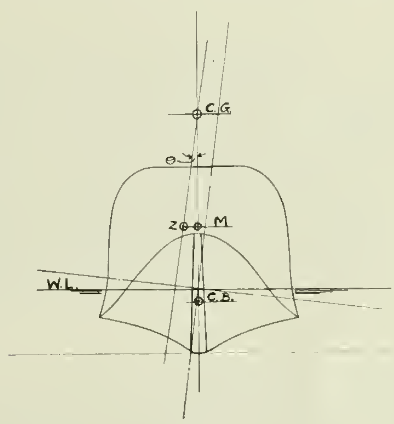

Fig. 7.

Construction and Materials

In the early types of successful boats, notably the F class, the hull construction was of the braced structure type, similar to the fuselage frames of present day land machines and divided into watertight compartments by means of bulkheads. After the war and due principally to the work of Linton Hope and Commander Porte, transverse construction was developed following closely the true monocoque. This method is still in use for wooden hulls and Fig. 9 shows a good example of this construction. Light frames closely spaced form the transverse sections and these are connected by light fore and aft members or stringers, the assembly forming a complete open framework of considerable strength but of light weight. The skin is then attached to this framework, the result being a very strong hull with a reasonable degree of flexibility.

The great disadvantage of wooden hulls is water soakage which in the course of a few days may exceed 14 per cent of the hull weight. Investigations of the possibilities of constructing metal hulls were made with the result that the first metal hull was commenced in 1924

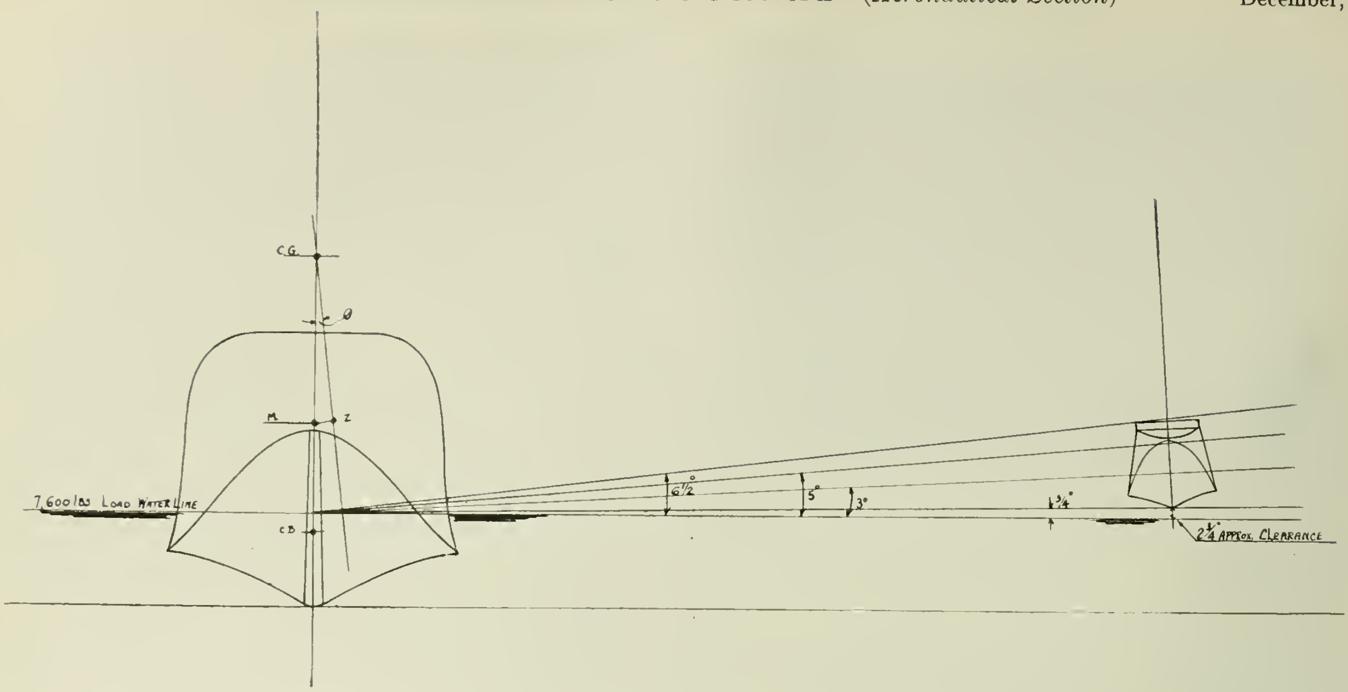

Fig. 8.*

by Short Bros. of England, the material being duralumin. This hull was adapted for the standard F5 superstructure and since then there has been rapid development as the construction has been found to present no serious difficulties. Not only has the weight been reduced by the elimination of soakage but the weight of a metal hull of modern design is less than its wooden prototype. Fig. 10 is a curve showing the variation of hull weight with all-up weight and indicates that larger boat seaplanes should show marked improvements. The usual type of construction adopted is longitudinal which differs from the transverse type in that the frames and stringers are deeper and spaced comparatively far apart. Typical spacings are 18 inches for frames and 6 inches for stringers. Frames are either built up or hooped, the built up type being more adapted to flat sided design. Examples of these two types are shown in Figs. 11 and 12. Stringers usually are continuous but sometimes are intercostal between the frames and bulkheads. Fig. 13 shows some of the sections commonly used. A very cheap construction is one based on hooped frames of approximately X section carrying continuous stringers supporting the skin, which is connected only to the frames at bulkheads and special points where concentrated loads exist. This method is indicated in Fig. 12. It will readily be seen that with any shell type of construction concentrated loads should not exist. As these occur principally at the wing spar joints, it follows that a multi-spar wing construction is desirable, i.e. the ideal is a shell type hull with shell type wings. With the present conventional wing construction these concentrated loads are distributed as quickly as possible through finger plates which, consistent with weight, should have a maximum number of connections to the main structure.

*Machine displacement in lbs. = 7,600.
Transverse *B.M.* = 29.875 inches.
Transverse *G.M.* = −46 inches.
C.B. above Datum = 20.8 inches.
Area of Load Water Plane = 19,040 sq. inches = 132 sq. feet.
Transverse M. of I. of Load Water Plane = 6,310,000 inches^4.
Volume of Wing Tip Float at 6½ degrees heel (Fully Submerged) = 14 cubic feet = 871 lbs. Δ
Volume of Δ of Float at 5 degrees heel = 11.4 cubic feet = 709 lbs. Δ
Volume of Δ of Float at 3 degrees heel = 4.65 cubic feet = 289 lbs. Δ
Volume of Δ of Float at 4 degrees heel = 8.36 cubic feet = 520 lbs. Δ
M.Z. = *G.M.* sin θ = at 6 degrees − 37′ = 46 × .11523 = 5.301 inches.
= at 4 degrees − 55′ = 46 × .08571 = 3.943 inches.
= at 2 degrees − 56′ = 46 × .05117 = 2.354 inches.
= at 4 degrees − 00′ = 46 × .06976 = 3.209 inches.
Pounds per inch immersion at Load Water Plane = 685 pounds.
Note:—Δ = Displacement.
Weight of Water Taken at 62.2 pounds per cubic foot.

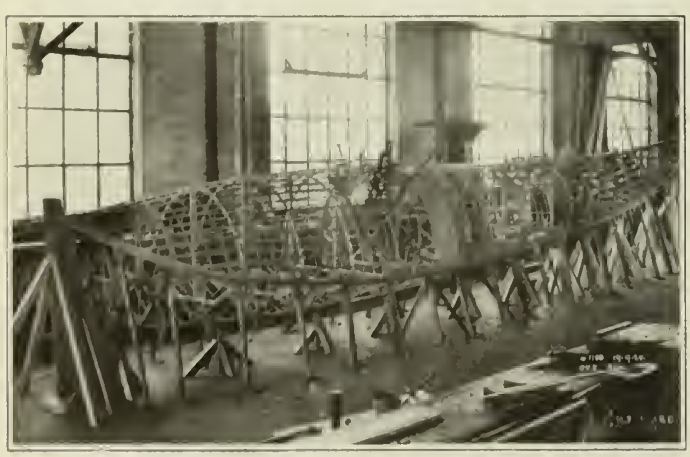

Fig. 9.

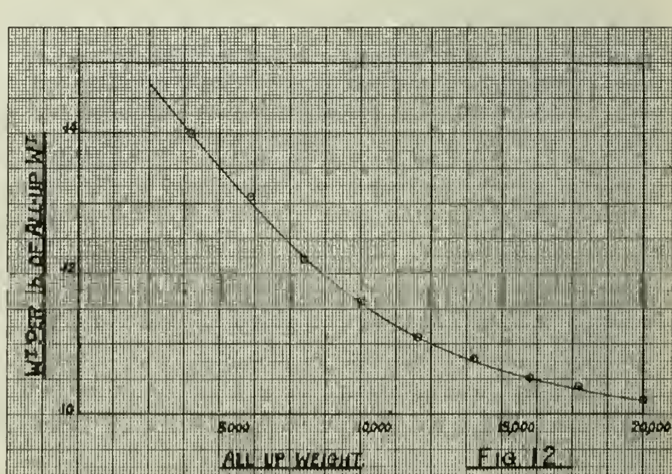

Fig. 10 Hull Weights.

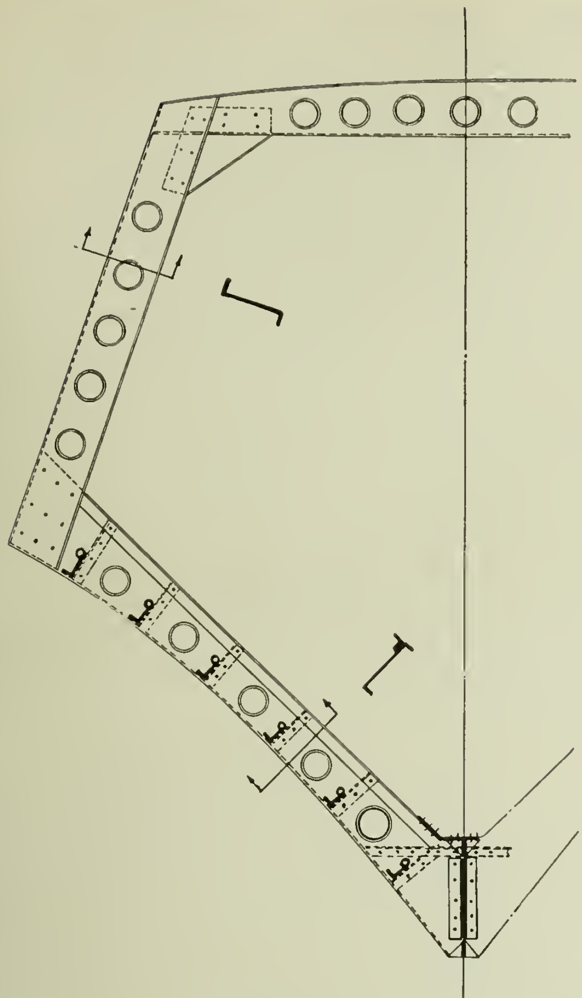

Fig. 11.

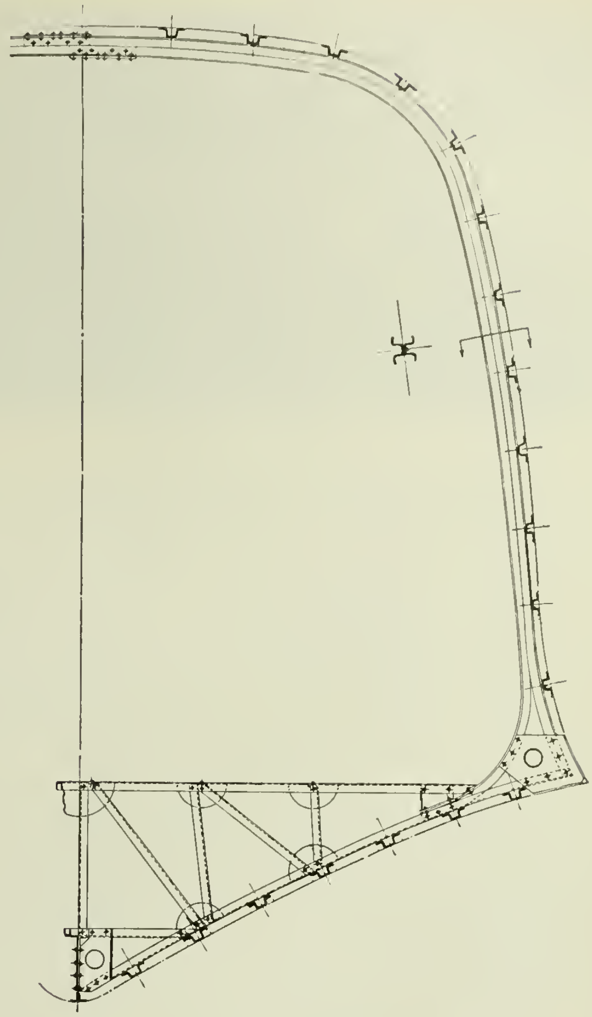

Fig. 12.

The complete hull structure is investigated for strength under several conditions of loading, which briefly are as follows:—

(*a*) At the maximum cross sectional area, the section is checked for strength under an applied bending moment calculated from an empirical expression which includes the length, breadth and depth of the under water volume.

(*b*) *Nose down landing.* The boat is assumed to land nose down at an angle of $\tan^{-1}\frac{1}{3}$ to the line joining bow and bottom of main step at the keel.

(*c*) *Step landing.* In this case it is assumed that the factored all-up weight is distributed evenly over that part of the planing bottom bounded by the wing spar frames and the chines. From full scale tests, carried out in America, the maximum pressure on one type of boat bottom has been found to be 15 pounds per square inch.

(*d*) *Two wave landing.* The boat is assumed to land on two wave crests, one at the rear step and the other at a point forward, determined by the standard (trochoidal) wave length for the particular hull, i.e. the "pitch" is equal to the length of still water line and the depth 1/15th of this.

(*e*) The fore body planing bottom is investigated for loading varying from zero at the bow to 7 pounds per square inch at the main step.

It will be seen that these various cases are all arbitrary but they are justified because they give satisfactory results, —indeed, satisfactory results are expected as the cases are based on known weaknesses in early boats and on the known strength of successful hulls. Stringers are checked as beams each supporting an area of plating given by (length of stringer between frames) times (stringer pitch) and the area is assumed to carry a loading equal to the appropriate pressure. Investigations are still proceeding into the strength of flat plates and various empirical formula are already in use. Reference to these are to be found particularly in "The Strength of Materials" by Case. At present, however, the thickness of planing bottoms, decking, etc. is usually fixed from experience and from practical considerations, although in very large hulls,

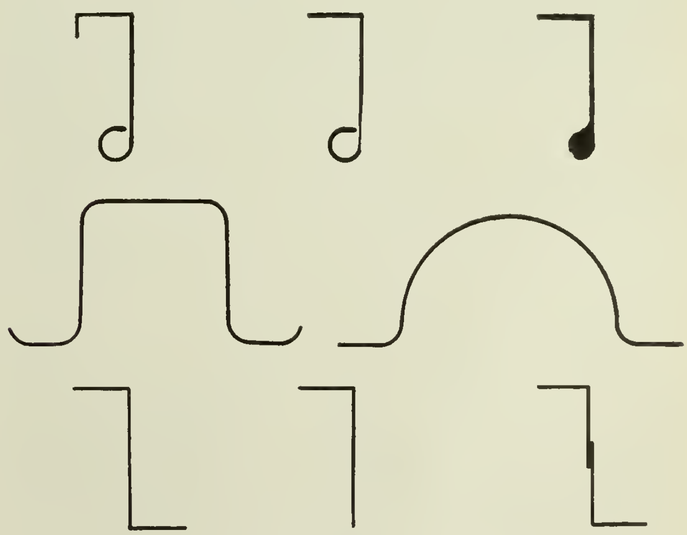

Fig. 13.

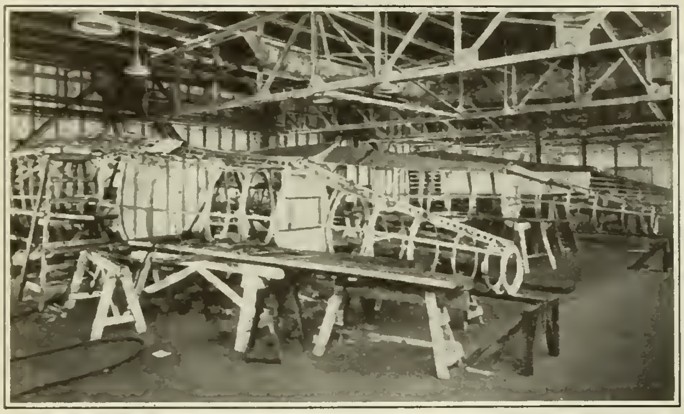

Fig. 14.

detailed investigations will probably result in appreciable saving in weight.

The most commonly used materials for metal hull construction are the aluminum alloys such as duralumin, but as these alloys are all subject, to some extent, to electrolytic action and corrosion when in contact with salt water, the use of stainless steel is growing steadily. Aluminum alloys are protected, with varying degrees of success, against corrosion, the best results being obtained from the use of gum base paints and anodic treatment. Anodic treatment is an electrolytic deposition of a thin film of an hydroxide of aluminum, which in turn requires protection against abrasion. Any hull which has been treated in this way requires constant attention, as should this film be broken, local and very concentrated corrosion will occur. The most recent form of aluminum alloy is Alclad, in which the alloy during manufacture is coated with very thin and pure aluminum which is not subject to corrosion. Not only does this film of pure metal protect the alloy, but in effect "attracts" the electrolytic action from any exposed alloy. The best anti-corrosion surface has been found from experiments in America to be Alclad, anodically treated and painted.

Shop Procedure

Shop work commences with the laying out full size of each frame and the keel and the manufacture of jigs for these parts.

The use of aluminum alloys such as duralumin and alclad present complications but no serious difficulty is experienced once a routine becomes familiar. Normally, these alloys crack and split when subjected to heavy cold working, but can be softened by heat treatment. Fully annealed alloy, i.e. soaked at 350 degrees C.-380 degrees C. and quenched in water, is amenable to complicated working without damage, but the material "ages" at room temperature, regaining nearly full strength and approaching semi hardness in about four days. By normalizing and ageing the material can be brought to its maximum hardness and strength although the full strength is not attained immediately after treatment. After twenty-four hours, almost full strength and hardness are reached but the material does not reach its final stage until after four days, when the condition is permanent until retreated.

For most working on hulls it is sufficient to normalize only, work the material for one hour, and if necessary, retreat. Every piece of material including rivets is subjected to this treatment, so that essential parts of the shop equipment are a large furnace to take full size sheets, and a small salt pot for treating rivets. As rivets are subjected to the most severe working, the time between salt pot and job should be as short as possible, and in one plant is as low as 15 minutes. Recent developments indicate that by refrigeration after treatment it will be possible to treat a week's supply of rivets at one time.

A complete set of frames and keel are made up to jigs, the workers being kept constantly supplied with freshly treated material and rivets, and when the finished parts have been inspected and accepted, assembly commences. For boats up to about 15,000 pounds all-up weight it is convenient to build the hulls upside down so that the riveting of the planing bottom can be given close attention without difficulty. The usual type of assembly jig consists of a heavy steel channel backbone firmly fixed to the floor, and carrying at the correct frame spacing steel ribs to which the frames are attached. (See Fig. 14.) When the frames have been squared and checked for alignment, the keel is positioned, checked, bolted up and then riveted so that the frames are held rigidly by the keel and by the jig. The stringers are laid on next and riveted and then plating begins. The planing bottom is finished first and as much side plating as can be conveniently finished, and the hull is then turned over, lined up on trestles, and the top plating finished. All interior flooring, etc., are mounted and fixed, and fittings for wings, tail, etc. assembled with jigs when the hull is ready for the erection shop.

All the photographic illustrations to this paper are of work designed and built in Canada and my acknowledgements are due to Canadian Vickers Limited for permission to use the original photographs.

Appendix I

Froude's Law of Corresponding Speeds

It is assumed that the total resistance to motion of a body towed along the surface of a fluid is dependent on

(1) The density of the fluid
(2) Relative velocity of motion
(3) Linear dimensions of the body
(4) Gravity.

The first three items obviously affect the resistance to motion and the fourth, i.e. gravity, is intimately related to the wave making resistance of the body.

Let R = total resistance made up of skin friction, wave making resistance, eddy resistance and wind resistance.
ρ = mass density of the fluid.
v = relative velocity of motion.
l = length of the body.
g = gravity acceleration.

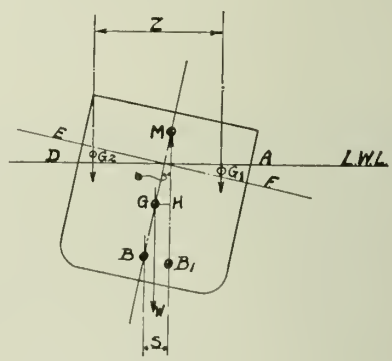

Fig. 1.

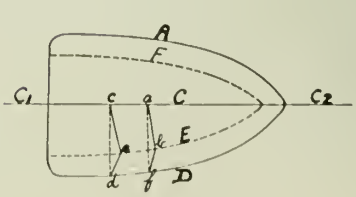

Fig. 2.

Assume,

$$R = f(\rho, v, l, g)$$
$$= \Sigma \rho^a v^b l^c g^d$$

Dimensionally,

$$MLT^{-2} = [ML^{-3}]^a [LT^{-1}]^b [L]^c [LT^{-2}]^d$$

Equating indices of like dimensions

$[M]$ $1 = a$ . . . . (1)

$[L]$ $1 = -3a - b + c + d$ . . . . (2)

$[T]$ $2 = -b - 2d$ . . . . (3)

Expressing b and c in terms of d

from (3) $b = 2 - 2d$

" (2) $c = 4 - (2 - 2d) - d$

$= 2 + d$

$$\therefore \quad R = \Sigma \rho v^{(2-2d)} l^{(2+d)} g^d$$
$$= \rho v^2 l^2 \Sigma \left(\frac{lg}{v^2}\right)^d$$
$$= \rho v^2 l^2 f\left(\frac{gl}{v^2}\right)$$

i.e. the total resistance is the product of the mass density of the fluid, relative velocity squared, length of body squared, and some non-dimensional constant which is a function of gravity acceleration times length of body over relative velocity squared.

This constant can be described as the variable co-efficient of resistance of a particular body to motion on the surface of a fluid whose mass density is ρ, the value of the co-efficient changing for different relative velocities.

The object of model tests of ships and flying hulls is to determine the values of this co-efficient of resistance at various speeds, and it will be seen that in order to obtain the full scale co-efficient from the model the value of $\left(\frac{gl}{v^2}\right)$ of the model tests must equal that for the predicted full scale results.

Neglecting the slight variation in the value of g, this requirement can be expressed as

$$v \propto \sqrt{l}$$

or
$$\frac{vm}{v} = \sqrt{\frac{lm}{l}}$$

or
$$vm = v\sqrt{\frac{lm}{l}} = v\sqrt{\frac{\text{scale}}{\text{ratio}}}$$

where suffix m signifies the model test conditions.

If this condition is satisfied, i.e. if $\frac{v^2}{l}$ is the same for both model and full scale, then the ratio of resistances is given by

$$\frac{Rm}{R} = \frac{\rho m\, l^2 m\, v^2 m}{\rho\, l^2 v^2} = \frac{\rho m}{\rho}\left(\frac{lm}{l}\right)^3$$

Appendix II

To Calculate the Metacentric Height

Assume the angle of displacement to be small and equal to θ (see Fig. 1). Since the weight of the vessel is constant the volumetric displacement must be constant and the volume of the wedge CDE must be equal to that of CAF. Also in Fig. 2, the volume C_1C_2DE must equal the volume C_1C_2AF.

Let G_1 and G_2 be the centres of gravity of the volumes C_1C_2AF and C_1C_2DE respectively. The rolling of the vessel moves the mass of water C_1C_2DE to the position C_1C_2AF, i.e. from G_2 to G_1, and the movement causes the centre of gravity of the total fluid displaced to move from B to B_1.

Let Z = horizontal distance from G_1 to G_2 when AD is horizontal

S = the perpendicular distance from B to B_1M

V = total volume displacement

v = volume of wedge

w = weight of unit volume of the fluid.

Then,

$$w.v.Z = w.V.S. = w.V.\,(B.M)\sin\theta$$
$$= w.V.\,(B.M)\,\theta \text{ for very small value of } \theta \ldots (1)$$

The restoring couple is

$$w.V.\,(H.G)$$
$$= w.V.\,(G.M)\sin\theta$$
$$= w.V.\,(G.M)\,\theta \text{ for very small value of } \theta$$
$$= w.V.\,[(B.M) - (B.G)]\,\theta$$
$$= w.v.Z. - w.V.\,(B.G)\,\theta \ldots\ldots (2)$$

$w.v.Z.$ is twice the sum of the moments about their axis C_1C_2 of all the elements such as $abcd$ which make up the wedge C_1C_2DE.

Let $af = x$

$bf = x\theta$ for very small value of θ

$ac = \delta l$

Then volume of element $acbd = \frac{1}{2}\theta x^2 \delta l$.

The $C.G.$ of this element is at $\frac{2}{3}x$ from C_1C_2, so that

$$Z = 2x\tfrac{2}{3}l$$

$$\therefore \quad w.v.Z. = 2w\theta\int_0^l \tfrac{1}{2}x^2\delta l \, x \, \tfrac{2}{3}x$$
$$= 2w\theta\int_0^l \frac{x^3 d\,l}{3} \ldots\ldots (3)$$

$\frac{x^3dl}{3}$ is the second moment of area of the area $acdf$ about C_1C_2.

Hence $2\int_0^l \frac{x^3dl}{3}$ is the second moment of area of the whole fluid plane about C_1C_2

and $w.v.Z. = w.I.\theta.$

From (2) the restoring couple

$$= w.I.\theta - wV\,(B.G)\,\theta$$

and if this expression is positive the equilibrium is stable, if negative, the equilibrium is unstable.

From (1)

$$w.I.\theta. = w.V.(B.M.)\,\theta$$

Therefore $B.M. = I/V$

Forty-Sixth Annual General Meeting

TO BE HELD IN

TORONTO, Ont.

FEBRUARY, 3rd, 4th and 5th, 1932

AERIAL VIEW OF A PORTION OF TORONTO

By courtesy of Toronto Industrial Commission.

A Record Attendance is Expected

Make a Note of the Dates

Plan to Attend

Outline of Programme

(Subject to Minor Change)

Wednesday, February 3rd.

Morning	Registration and Business Session.
Noon	Formal Luncheon.
Afternoon	Business Session. Induction of Incoming President and Council.
	Reception and Tea for Ladies.
Evening	Smoking Concert.
	Entertainment for Ladies.

Thursday, February 4th.

Morning	Technical Sessions.
Noon	Luncheon.
Afternoon	Technical Sessions.
Evening	Annual Dinner of The Institute followed by a Dance.

Friday, February 5th.

Morning	General Session and Debate on the Railway-Highway Problem.
Noon	Luncheon.
Afternoon	Visits to Engineering Works of Interest.
Evening	Free.

A special ladies committee has been appointed to arrange for the entertainment of visiting ladies.

At the technical sessions on Thursday, the 4th, papers will be presented for discussion dealing with topics of a wide range of interest, among which may be mentioned the following:

Hydro-Electric Developments on the Lievre River.
Ice Pressure on Engineering Structures.
Filtration Plant at Niagara Falls, Ont.
Meteorology in its Relation to Engineering Works.
The Utilization of Low Grade Fuels.
Central Heating at the Toronto Terminal and at Winnipeg.
Recent Developments in Carrier-Current Telegraphy.
Power Supply for Radio Transmitters in Aircraft.
The Train-Ferry Steamer "Charlottetown."

The morning of Friday the 5th will be devoted to a discussion on an engineering-economic problem which is just now very pressing in Canada: the co-ordination of our Railway and Highway Transportation systems and the justification for the expenditure which they involve. The subject will be introduced by Mr. S. W. Fairweather of the Canadian National Railways, who will be followed by Mr. R. M. Smith of the Ontario Department of Highways, and other prominent speakers.

THE
ENGINEERING JOURNAL
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OF CANADA

VOLUME XIV DECEMBER 1931 No. 12

Annual General Meeting for 1932

Notice is hereby given that the Forty-sixth Annual General Meeting of The Institute will begin at Headquarters, 2050 Mansfield Street, Montreal, on Thursday, January 14th, 1932, at 8 o'clock p.m. After the reading of the minutes of the last Annual General Meeting, the appointment of scrutineers to count the Officers' Ballot, and the appointment of auditors for the ensuing year, the meeting will be adjourned to reconvene at the Royal York Hotel, Toronto, Ontario, on February 3rd, 4th and 5th, 1932.

R. J. DURLEY,
Secretary.

The Institute and Engineering Education

Among the avowed objects of The Engineering Institute of Canada, the promotion of engineering education takes a prominent place. Those responsible for the framing of our by-laws announced as one of the purposes of The Institute "to collaborate with universities and other educational institutions in the advancement of engineering education," for they believed that in this way The Institute could render the most valuable assistance in the training of young engineers. The Council's interest in engineering education has been shown by the many references to the subject at Council meetings, and by the appointment of what is practically a standing committee on Engineering Education. The annual reports of this committee have given rise to active discussions at our annual meetings, and the topic has been selected on two occasions as the subject for essays in competition for the Past-Presidents' Prize.

The Institute, like the Professional Associations, is concerned with the efficiency of our educational system as a means of raising the professional status of the engineer, and it is for this reason that all of these organizations include definite educational tests in their requirements for admission. The maintenance of such standards for admission is now insured in practically all our professional bodies by insistence on qualifications equivalent to those of a degree from a recognized engineering school, or in default of this, the requirement that the candidate for admission must pass the examinations of The Institute or the Association as the case may be. The mere maintenance of such standards however, is not all. While they must be adequate and reasonably uniform throughout the Dominion, they should be capable of modification from time to time, to keep pace with changing conditions and with the development of the professional courses of our engineering schools. It is for this purpose that the services of our Committee on Engineering Education are available in an advisory capacity.

At the Annual Meeting of 1931, that Committee presented a report suggesting more intimate contact between The Institute and engineering schools throughout the country so that The Institute may become in large measure an active connecting medium between the universities and industry. The Committee also urged the consideration by the universities of a higher matriculation standard for engineering students, or a six-year engineering course, and the desirability of devoting more time to public speaking and literature.

As a result, arrangements have been made to hold a conference on Engineering Education at the forthcoming Annual Meeting in Toronto in February next, at which representatives of the engineering departments of Canadian universities will meet other members of The Institute's Committee with a view to giving practical shape to its proposals. The fact that such a conference is to be held will go far towards fulfilling some of the recommendations quoted.

Those in charge of the engineering courses at our universities have a very difficult course to steer. Critics are numerous, and their criticisms are occasionally more destructive than constructive. The opinion most frequently heard, as recently expressed by the President of Yale University, is "that our engineering schools are not training men who are, as such, fundamentally sound scientists. Young graduates may be alert young fellows, they may have fairly good elementary training in this direction or that, but in general it is alleged that they are not satisfactorily trained in fundamental science, including mathematics. If the engineering school admits any justice in this criticism, it is apt to pass back responsibility for the condition to the poor training given by the preparatory school."

Another point of view which is put forward is that the young engineering graduate lacks general culture and is apt to place undue emphasis on the purely technical side of his college training, forgetting that his technical knowledge, however profound, will be of little service to him unless he is able to think clearly, to express his ideas correctly and to use his own language effectively, and unless he has that familiarity with literature and questions of the day which any well-educated man should possess.

Our engineering schools have to reconcile these ideals with the limitations imposed by lack of time and money, increasing enrollment and by the attitude of the student himself, who too often enters a professional course with the notion that his education merely involves the accumulation of a sufficient number of useful facts and their storage in notebooks for reference as required. Such students fail to realize that an engineer worthy of the name must be something more than a walking pocket-book full of technical data, and in many cases they resist with considerable success all efforts designed to train them in orderly thinking, in the expression of their thoughts, or in non-technical subjects of fundamental importance.

It is unfortunate that frequently the post-graduate professional activities of the young engineer do so little to correct this attitude of mind. As a rule, unlike the young lawyer or medical man, the young engineer in his daily work does not get much of the polish which results from a continual contact with his fellow men, and it is in regard to this aspect of the question that participation in the meetings and activities of a professional body like The Engineering Institute can be of invaluable service to him.

Our Canadian engineering schools are to be congratulated on the progress made in recent years towards better training in fundamental subjects and less specialization, and this in spite of insistent demands for instruction in an ever-increasing number of highly specialized subdivisions of engineering science.

In the past we have had a great deal of discussion and criticism of engineering education and too few actual conferences between those engaged in the business of teaching and laymen who are employers of, or workers with, the young engineer. It is to be hoped that the conference to be held at the Annual General Meeting of 1932 will do much to remove this disadvantage as far as The Institute is concerned and that teachers and outsiders will gain a better mutual comprehension of the way in which they can co-operate.

Proposed Amendment to By-laws

In accordance with Sections 74 and 75 of the By-laws, Council presents for the consideration of corporate members the following proposal for the amendment of Section 37, dealing with arrears of fees. This proposal will in due course be submitted for discussion at the Annual General Meeting on February 3rd, 1932, in Toronto, and will subsequently go out to ballot.

At the recent Plenary Meeting of Council, attention was drawn to the large number of members in arrears of fees for two, three or more years, on whose cases Council was asked to pass judgment. It was noted that in other societies with aims similar to our own, such a condition is not permitted to arise, members in arrears for one year or more being *ipso facto* removed from the list unless relieved from this penalty by resolution of Council.

After discussion it was decided to propose such an amendment to Section 37 of our By-laws as would bring our practice into line with the above policy, so that, in the event of the amendment carrying, the amount of fees outstanding will be reduced and the expense of collecting them greatly lessened.

The section in question as now proposed by Council is given below, new wording being underlined.

Arrears—Exemptions—Life Membership List.

Section 37.—The Secretary shall notify any member whose fees become in arrears. No member shall be considered in arrears for any year until after the thirtieth day of June of that year. <u>A</u> member who is in arrears shall <u>not</u> have the right to vote, <u>he shall not receive the publications of The Institute,</u> nor shall he be eligible for office in The Institute or any of its Branches.

<u>Should his fees still be in arrears on the first day of October, he shall again be notified in form prescribed by the Council, and if still in arrears on the first day of January of the year following, he shall forfeit his connection with The Institute and shall be so notified by the Secretary.</u>

<u>The Council, however, may for cause deemed by it sufficient, extend the time for payment and for the application of these penalties.</u>

<u>Further</u> the Council may for sufficient cause temporarily excuse from payment of annual fees any member who from ill health, advanced age, or other good reason assigned, is unable to pay such fees, and the Council may remit the whole or part of fees in arrears.

The Council, at its discretion, may <u>as a privilege</u> exempt from further payment of annual fees any corporate member who has reached the age of sixty-five, or who has been a corporate member for thirty years, or who has rendered signal service to The Institute. The names of such members shall be placed on a Life Membership List."

Meeting of Council

A meeting of Council was held on Tuesday, November 17th, 1931, at eight o'clock p.m., with Vice-President O. O. Lefebvre, M.E.I.C., in the chair, and five other members of Council present.

The minutes of the Plenary Meeting of Council held on September 21st, 22nd and 23rd, 1931, and of the meeting held on October 16th, 1931, were confirmed.

The membership of the Committee on Development was approved as follows:

Past-President	G. H. Duggan, M.E.I.C.
	J. M. R. Fairbairn, M.E.I.C.
	A. J. Grant, M.E.I.C.
	C. H. Mitchell, M.E.I.C.
	R. A. Ross, M.E.I.C.
	J. C. Smith, M.E.I.C.
	A. Surveyer, M.E.I.C.
	H. H. Vaughan, M.E.I.C.
	George A. Walkem, M.E.I.C.
Vice-President	O. O. Lefebvre, M.E.I.C.
Treasurer	W. C. Adams, M.E.I.C.
Chairman	J. L. Busfield, M.E.I.C.

The chairman pointed out that the committee would have the advantage of the counsel and advice of no less than nine past-presidents, which would be available in dealing with the vital problems to be considered by this committee.

A report from the Legislation Committee was approved, giving the text of the amendment to be proposed to Section 37 of the By-laws dealing with the question of arrears, as decided upon at the Plenary Meeting of Council. It was decided that no action should be taken at the present time with regard to any change in the present arrangements for rebates.

The report of The Institute's examinations held on November 3rd, 1931, was presented and approved, and it was noted that Mr. George Stephenson of Ottawa had passed the examinations under Schedule "C" for admission as an Associate Member, and that S. G. Lochhead, S.E.I.C., had passed those under Schedule "B" making him eligible for transfer to the class of Junior.

A letter was presented from the chairman of The Institute's Membership Committee suggesting that action should now be taken to carry out some of the suggestions in the report of that committee which was presented at the Plenary Meeting of Council. The Secretary was directed to communicate with the Executive committees of all branches drawing attention to the situation, and asking them to co-operate with General Mitchell's committee.

A letter was presented from the secretary of the Institution of Electrical Engineers (Great Britain), approving the draft agreement with that body in regard to the formation of Radio sections of branches of The Engineering Institute of Canada, this being generally along similar lines to the agreement already entered into with the Royal Aeronautical Society, and providing for an interchange of publications and affiliation of local Radio sections with the Institution of Electrical Engineers. This agreement was approved.

A request was received from the City Improvement League for The Institute's support in connection with a petition to the provincial government of Quebec asking for a comprehensive Provincial Town Planning and Zoning Enabling Act. As this is a provincial matter the Council, while generally in favour of the proposal, directed that the question should be referred to each of the branches in the Province of Quebec for their consideration and action.

Five resignations were accepted, four reinstatements were effected, and three 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*	
Associate Member	1	Junior to Assoc. Member	2
Junior	1	Student to Assoc. Member	3
Students admitted	16	Student to Junior	3

The Council rose at eleven fifteen p.m.

Publications of Other Engineering Societies

From time to time announcements have appeared in The Engineering Journal and the E-I-C News 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 $10.00.*

† *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	$ 0.50	$ 1.00
Per year	5.50	10.50
Transactions, per year (cloth binding), (issued quarterly)	5.00	10.00
Pamphlets	.25	.50
American Society of Mechanical Engineers		
Mechanical Engineering, single copies	$ 0.50	$ 0.60
Per year	4.00	5.00
Transactions, new, bound, fourteen sections, complete (over 300 papers)	12.50	25.00
(Other publications, same rate to E.I.C. members as to A.S.M.E. members.)		
American Institute of Mining and Metallurgical Engineers		
Mining and Metallurgy, single copies	....	$ 0.50
Per year	....	3.00
(Plus $1.00 for foreign postage.)		
Transactions, per volume	....	5.00
(Plus $.40 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
(Plus $1.00 for foreign postage.)		

No special rates for members of The Engineering Institute of Canada.

OBITUARIES

Edward Fleming Bateman, A.M.E.I.C.

The death of Edward Fleming Bateman, A.M.E.I.C., occurred at Saskatoon, Sask., on October 21st, 1931.

Mr. Bateman was born at Mirfield, Yorkshire, England, on August 1st, 1854, and received his education at Victoria College, Jersey, the training ship "Worcester" at Erith, Kent, and the Engineering School of Kings' College, London.

Mr. Bateman was a pupil with the late J. F. Latrobe Bateman, past-president of the Institution of Civil Engineers, and was later engaged for three and a half years with Messrs. Jas. Watt and Company, Birmingham. For two years Mr. Bateman was with the Lambeth Engineering Company, London, as draughtsman and manager, and in 1883 entered private practice. Following this, he was for nearly ten years chief mechanical draughtsman to the Commissioners of Irish Lights, during which time he had varied experience on important lighthouse works around the coast. Coming to Canada in 1910, Mr. Bateman settled in Saskatoon, Sask., where he carried out many works of importance, including the erection of the structural steel and bunkers at the new power house, the reconstruction of the pumping station, the laying of sidewalks, etc., for the city. At the time of his death, Mr. Bateman was practising as a civil and mechanical engineer.

Mr. Bateman joined The Institute as an Associate Member on October 22nd, 1918.

Orville Frank Bryant, M.E.I.C.

Members will learn with regret of the death of Orville Frank Bryant, M.E.I.C., which occurred suddenly at Montreal on October 27th, 1931.

Mr. Bryant was born at Meredith, N.H., on August 27th, 1887, and graduated from the University of New Hampshire in 1910 with the degree of B.S. in chemical engineering.

From 1911 to 1914, Mr. Bryant was chemical engineer with the Nekoosa-Edwards Paper Company at Port Edwards, Wis., and then became chief of the Forest Products Laboratories of Canada, in Montreal, which position he held until 1918. Being desirous of extending his technical knowledge of the paper-making industry, Mr. Bryant became technical advisor to Bennett Ltd., Chambly Canton, and later chemical engineer to the Laurentide Company at Grand'Mere, where he remained from 1920 to 1927. From there, Mr. Bryant went to Saint John, N.B., as manager of the Nashwaak Pulp and Paper Company, where he remained until 1930. He served with the representatives of the government and the universities on the administrative committee which brought about the establishment of the Pulp and Paper Research Institute, and was largely instrumental in its development, and in 1930 he was appointed as technical adviser to the association, which office he held at the time of his death.

Mr. Bryant joined The Institute as a Member on May 7th, 1929.

Harold Elmer McLellan, A.M.E.I.C.

Regret is expressed in recording the death of Harold Elmer McLellan, A.M.E.I.C., on September 24th, 1931.

Mr. McLellan was born at Souris, P.E.I., on June 24th, 1893, and received his education at Charlottetown, P.E.I., and McGill University, graduating from the latter institution in 1919 with the degree of B.Sc.

From 1920 to 1923, Mr. McLellan was with the Canadian National Railways as inspector and transitman under the harbour engineer, the work mainly consisting of repairs to piers and breakwaters and dredging at Car Ferry Terminals at Port Borden, P.E.I., and Cape Tormentine, N.B. In 1923-1925, Mr. McLellan was engineer in charge of the laboratory of the Dominion Fire Prevention Association, and following that period was for one year demonstrator at McGill University. During the period 1926-1930, he was assistant engineer with the Laurentide Construction Company, in charge of structural design and estimating. Later Mr. McLellan was concrete designer with the Lucerne-in-Quebec Community Association, and in 1930-1931 was structural designer with United Engineers and Constructors of Canada, Ltd., Montreal.

Mr. McLellan joined The Institute as an Associate Member on March 25th, 1925.

Eugene Washington Stern, M.E.I.C.

It is with deep regret that we record the death of Eugene Washington Stern, M.E.I.C., on November 9th, 1931.

Mr. Stern was born at Toronto, on August 20th, 1865, and in 1884 graduated in civil engineering from the School of Practical Science, University of Toronto. Following graduation, until 1891 he was engaged on railroad surveys and construction, and on structural work including the Washington bridge over the Harlem river. During this period he was for one year Fellow in engineering at the School of Practical Science. In 1892 he became chief engineer in charge of the design and supervision of construction of buildings and bridges with the Koken Iron Works, St. Louis, Mo. In 1902 he entered private practice as a consulting engineer, making a specialty of buildings and foundations. Mr. Stern designed and was in charge of the constructive features of many important buildings such as the D. L. and W. Railway terminal, Hoboken, N.J., the 20-storey addition to R. H. Macy and Company, the New York Evening Post building, the Guaranty Trust Company building, the nurses home of Mount Sinai hospital and the Temple Emanu-El. In 1915-1917 he was chief engineer of highways for Manhattan. During the Great War, Mr. Stern served as a major of engineers in the American Expeditionary Force. He was with the 8th French Army from November, 1917, to December, 1918. Later he became chief road officer, Base Section No. 2, and was recommended for promotion to the rank of lieutenant colonel. In 1919 he returned to private practice.

Mr. Stern was a member of the American Society of Civil Engineers, the American Institute of Construction Engineers, the American Construction Institute, the Society of American Military Engineers, the American Legion, and the Military Order of the World War.

Mr. Stern joined The Engineering Institute of Canada (then the Canadian Society of Civil Engineers) as a Member on April 17th, 1909.

Henri Etienne Vautelet, M.E.I.C.

By the death of Henri Etienne Vautelet, M.E.I.C., at Montreal, on November 13th, 1931, The Institute loses one of its senior members who was a distinguished representative of the engineering profession in Canada.

Mr. Vautelet was born at Sedan, France, on February 25th, 1856, and was educated at the Sorbonne and the Ecole des Mines, Paris, graduating from the former school in 1873 and from the latter in 1877.

Coming to Canada in 1884, he engaged in mining work in the Cobalt district, and subsequently became connected with the Colonization Department of the Dominion government. In 1886 Mr. Vautelet entered the service of the Canadian Pacific Railway Company, a connection which was to continue for nearly twenty years. He was soon promoted, becoming principal assistant engineer in 1893, and assistant chief engineer in 1902. Mr. Vautelet's high professional reputation was largely based on his wide experience in bridge design and construction, principally gained in connection with the many bridges necessary to carry the Canadian Pacific Railway across the rivers and canyons along its route. He was responsible for many of these and later for a number of other important structures, among which may be mentioned the moveable dam at St. Andrews, near Winnipeg, and some of the earliest grain elevators to be constructed in this country.

Severing his connection with the Canadian Pacific Railway in 1903, he entered partnership with the late Percival W. St. George, founding the firm of St. George and Vautelet, consulting engineers. In 1908 he was ap-

HENRI ETIENNE VAUTELET, M.E.I.C.

pointed chairman of the Commission appointed to deal with the reconstruction of the Quebec bridge following its first collapse, and was engaged on this project until 1911, when he retired from active professional life.

Mr. Vautelet's eminence as an engineer may be traced to the thoroughness of his scientific and mathematical training, his wide professional experience and an originality of idea and treatment which has led to the wide adoption of many of his methods and details of construction.

Personally popular, his outlook was consistently optimistic and he will be greatly missed by those who were privileged to be his associates.

Mr. Vautelet joined The Institute (then the Canadian Society of Civil Engineers) as a Member on January 9th, 1888, and was the first recipient of the Gzowski Medal on its establishment in 1890.

Mr. Vautelet is survived by his widow, one daughter, a son, a brother in Brazil and a sister.

PERSONALS

Chas. W. Deans, S.E.I.C., is graduate assistant in civil engineering at Iowa State College, Ames, Iowa. Mr. Deans graduated from the University of British Columbia with the degree of B.A.Sc. in 1930.

G. W. E. Nicholson, A.M.E.I.C., is now connected with the Southern Kraft Corporation, at Mobile, Ala. Mr. Nicholson, who is a graduate of the Chalmers Technical Institute, was for a time with the Bogalusa Pulp and Paper Company, Inc., at Bogalusa, La., and more recently lived in Montreal.

J. C. Higbee, Jr.E.I.C., is now resident engineer at Vermilion Bay, Ont., for the Department of Northern Development, Kenora District. Mr. Higbee was formerly located at Newcastle, Ont.

Charles W. Crossland, S.E.I.C., who graduated from McGill University this year, is now located in Cambridge, Mass., where he is taking a post-graduate course in aeronautical engineering at the Massachusetts Institute of Technology.

H. R. Bissell, A.M.E.I.C., of the Grout Engineering Company, Ltd., has been transferred from Fergus, Ont., to Toronto. Before joining the Grout Engineering Company, Mr. Bissell was manager of the Sterling Mine, at Sterling, N.S., and in 1927 he was mine superintendent at the Tetreault mine of the British Metal Corporation (Canada) Ltd., Montauban, Que. Mr. Bissel graduated from McGill University with the degrees of B.Sc. and M.Sc. in mining in 1922 and 1923 respectively.

Geo. R. Pratt, A.M.E.I.C., has re-established himself in Winnipeg, Man., in private practice as consulting steam power and combustion engineer. He has recently completed a two year engagement with the United Engineers and Constructors, Montreal, as assistant designing engineer on the Glace Bay, N.S., plant of the Dominion Coal and Steel Company, and a similar power plant erected at Minto, N.B., for the New Brunswick Power Commission. For a number of years, Mr. Pratt was in charge of the Alberta government campaign for marketing the coals of the province.

A. S. Williams, A.M.E.I.C., formerly electrical designer with the Northwestern Power Company, Ltd., is now chief operator of the company's plant at Seven Sisters Falls. Mr. Williams graduated from the University of Manitoba in 1921 with the degree of B.Sc., and following graduation was demonstrator in physics at that university. In 1922-1923 he was with the Canadian General Electric Company at Peterborough, Ont., and in 1923-1924 was draughtsman on electrical layouts with the Hydro-Electric Power Commission of Ontario. From 1924 to 1929 Mr. Williams was with the Manitoba Power Company, Ltd., as chief operator at the Great Falls generating station of that company.

Some Observations on the Engineering Profession

S. G. Porter, M.E.I.C.,
President of The Engineering Institute of Canada.

Following the Plenary Meeting of Council held in September, S. G. Porter, M.E.I.C., President of The Institute, visited and addressed the following branches in the Maritime Provinces, Quebec and Ontario: Halifax, Moncton, Saint John, Chicoutimi, Quebec, St. Maurice Valley, Montreal, Ottawa and Toronto. More recently he has addressed the Lethbridge and Saskatchewan branches of The Institute, his subject being: "Some Observations on The Engineering Profession."

The following is a summary of his remarks:—

It is worthwhile occasionally to stop and consider what are the duties and obligations which rest upon us as members of the engineering profession, and whether or not we are meeting them in a worthy manner.

We have first an obligation to ourselves. We are in the profession because we like the work and we have chosen it as a means of making our livelihood. It is our duty then to avail ourselves of whatever advantages are offered for our personal advancement.

One means of advancing our own interests is to join with others who are similarly interested in order to benefit from an interchange of professional knowledge and experience. Prompted primarily by selfish motives, we soon find that this interchange cannot persist as a "one-way traffic," and that an obligation rests on us to contribute our share to the common good. And thus we come to a recognition of our duty to our profession.

It was with these aims of mutual benefit in mind that our Institute was formed for the purpose of advancing engineering and scientific education; developing high standards of practice; and for advancing the professional, social and economic welfare of the members of the profession.

These are objects which we cannot successfully accomplish working as independent individuals. They require the organized efforts of the profession as a whole, and it is only through the success of the organized efforts of the profession to better its own position that the benefits are reflected in the improved welfare of the individual members. For whatever benefits the profession benefits the members of the profession.

In stating that one of the objects of The Institute is the advancement of engineering and scientific education, I think we should go one step further and say that we stand for higher educational and technical qualifications to entitle one to use the title and practise the profession of engineering. Our educational facilities, especially for engineering education, are far superior to what they were a generation or so ago. Likewise, the thoroughness of the scientific and engineering investigations which are necessary in order to meet the exacting requirements of modern construction and industry, makes it essential that the engineer have a high degree of educational and technical training as well as practical experience before he is entrusted with such professional responsibility.

I believe that the day is past when the instrumentman or the construction foreman, having acquired a smattering of knowledge of engineering practice without knowing the why or the wherefore of it, is entitled to pass into the ranks of professional men and call himself an engineer. I would not disparage the so-called self-educated engineer. He is to be highly commended. Nor would I specify that every engineer must have a college degree. But I would require that he have the equivalent of an engineering course before he be accepted as a professional engineer. Now that registration is becoming compulsory throughout the country before one can practise engineering, entrance into the profession will soon be entirely through the channel of registration. And since this must precede the practice of the profession, the result will be that the young engineer will prepare himself for meeting the educational and technical requirements and will not expect to be admitted into the profession without having them. This will not work a hardship on the young engineer, for he will know what the requirements are and can prepare himself accordingly, just as he would have to do to enter any other profession. While we are passing through the transition period, due consideration needs to be given to the older engineers who did not have the benefit of a technical education, but they are rapidly passing off the stage, and the profession is being more and more confined to the scientifically educated engineer, and entrance into the profession more and more restricted to such. This in itself gives engineers a higher professional status, and should tend to the solidarity of the profession.

The next object is to develop high standards of practice. The engineering profession enjoys a high reputation for the observance of professional ethics, for honesty and good faith in the performance of duty. There is occasion, however, for careful consideration of the methods and ethics of some semi-engineering activities—some industries or sales organizations in which engineers are engaged or which they partially or fully control. There is no objection to the engineer being a manufacturer, or a salesman, or a promoter. But instead of permitting himself to accept some of the doubtful practices he occasionally encounters, he might render a service both to his profession and to the business interests he represents, by using his influence for the abolishing of objectionable practices. It is his duty to call upon his fellow engineers to support him in any such effort, and the duty of his fellow engineers to give him their support. There is where our organized effort would be effective.

A further object of our Institute is to advance the professional, social and economic welfare of the members of the profession.

We owe a duty to our profession. The engineer who selfishly sticks to his own narrow job, without regard to the welfare of his fellow engineers, is not meeting his full responsibility. He should be as keenly interested in the development of high ethical standards and of professional pride and loyalty as in his personal success. A greater unity and solidarity in the profession are outstanding needs of the engineers of Canada today. How can we expect our voice to be heard and heeded unless it has behind it the force that can only come out of unity and solidarity? If all the engineers of Canada, working in harmony and professional loyalty, could provide a Dominion-wide medium for expressing the viewpoint of the engineering profession, they would exert an influence otherwise unattainable, both on public opinion and on legislation which affects, not merely the welfare of engineers themselves, but the safety and welfare of the public where the construction, operation or control of engineering works and public service utilities are governed by legislative enactment. Such a condition would also result in greater public recognition and more favourable publicity, and would create greater confidence in Canadian engineers and enable them to compete more successfully with outside engineers. All this would result in a reflex influence on the profession itself in creating a stronger professional consciousness and *esprit de corps* among engineers, comparable to that existing in the other professions.

Those are the things that an engineering organization should aim to achieve for the professional, social and economic welfare of its members.

There remains another important duty, and that is our obligation to the public.

There is an obligation resting on each member of our profession, as well as on the profession as a whole, to contribute to the solution of society's problems. The engineer should remember that he is a member of society and not merely a technician. From the nature of his training, co-ordination and co-operation should be instinctive in him, and he should be ready to apply them in his relations to society as well as to his machines. And yet one of his failings is likely to be that he is so engrossed with the immediate task of his own work that he fails to give thought to the problem of how his task meshes with that of his brother engineer, and how the tasks of the two of them mesh with those of still others, and so with all organized society.

The engineer's place in our social structure is particularly important because of the newness of our country and the vastness of its resources. The engineer is by nature a pioneer. He makes ready the way for civilization. He it is that combines the forces of nature and the discoveries of science, and applies them to the needs of luxury-loving civilization. Although many of the principles of mathematics, physics and mechanics were known thousands of years ago, greater advances in their application to industry and the needs of a highly organized social structure have been made within the lifetime of the men of this audience than in all preceding time combined.

This very condition presents a great opportunity, and at the same time imposes a great responsibility on the engineer. You occasionally hear the complaint voiced by engineers that they do not receive the recognition they are entitled to from the public. This is no doubt true. Civilization's debt to the engineer is indeed beyond measure. And he is human and vain enough to want some recognition and credit for what he has done. But after all, is it not largely his own fault? Is he assuming his due share of the responsibility of shaping public policies and bearing the burdens of citizenship in his community? If his training fits him pre-eminently for the task of supplying to the public the utilities and the industrial facilities which it demands, does it not also qualify him for a voice in formulating the policies and directing the course of the activities of those bodies which govern and control us? The obligations of citizenship demand that we capitalize our engineering skill and the influence of our personality for the benefit of the community of which we are members.

One particular field of opportunity lies in the influence which we may exert in the development of our natural resources. Our training as engineers should enable us to appreciate more keenly than others the necessity of a wise public policy in the development and utilization of our natural resources. That fact imposes on us the duty of giving leadership to our governments and to public opinion in formulating wise policies and guiding them in their execution. We have a higher obligation than merely doing well the professional job we are hired to do in exploiting the resources of a new and rich country. The people of the next generation and the next will praise or condemn our generation according to whether we wisely conserve or selfishly exploit the wealth that has been given us by a generous Providence. We are its trustees. If we fail in our trusteeship, the engineering profession must bear a large share of the blame.

The same reasoning applies to many of the complex problems that are troubling industry and governments today. The solution of a problem consists in determining the value and influence of the several factors of which it is made up. Where could you find a better mode of approach to the complex problems that are troubling industry, commerce, economics and politics today than those used by the engineer in studying the problems involved in his own special field. I do not wish to imply that the engineer has some mystic or superior power which will enable him to set right the times that are so badly out of joint, but if he will apply the sound principles of engineering analysis to them he will enhance the value of his citizenship and perform a patriotic service to his country of a much higher order than the haphazard policy of the average politician.

Engineering is the link between science and industry. Its function is the "application of scientific methods to the utilization of the resources of nature." There are no sharp lines of division separating its activities from those of science on the one side, and from industry on the other. The tendency during the past few decades has been to extend the activities of the engineer further and further in both directions. The engineer and the scientist work hand in hand in the research laboratories. The nature of their work is often very nearly identical. It is impossible to say whether the scientist is an engineer, or the engineer is a scientist. In fact, either statement is true, and there need be no jealousy on either side, for their professions are equally worthy.

So on the other hand, in the direction of industry, engineers have been brought into more and more intimate contact with manufacturing and industrial processes. Whereas a few decades ago the engineer only designed and built the machines and factories, he now plays a prominent part in operating and managing them. An outstanding example of the recognition of the value of technical training for executive and administrative positions is seen in the fact that practically all the major executives in the electrical manufacturing industries, and of electric utilities, are technically trained engineers. The same tendency is seen, though not to so marked a degree, in other industries, in railway administration, in public utilities and particularly in city management.

The industrial engineer has been so successful in the application of his technical abilities to methods of production that production has run ahead of the means of distribution, and the ability of the community to absorb his products. Improved methods of production and efficiency of management have brought about an increase of more than forty per cent in the past decade in the per capita production in the United States and Canada. That is, seven men now produce as much as ten did only one decade ago. That ratio applies to industry. In agriculture the increase in per capita production has been still more pronounced. This has brought about our present problem of maladjustment. Is it not possible for the engineer to assist the economist in applying similar methods to this new problem, and bring about a new relationship that will result in a more equitable control of all the elements which enter into the production, distribution and utilization of all manufactured articles? This must include the human element as well as materials. It must likewise include the equitable distribution of the burdens and benefits of labour. He must, furthermore, join with the sociologist and the educationalist in creating a proper distribution of the time element—its division between labour and leisure.

There is an abundance of wealth, an abundance of goods, in the world. There should also be an abundance of work. An inventory of labour is needed. How much have we available? How much is required to do the world's work? How much should be allotted to each worker?

These are difficult problems. Their difficulty arises out of the fact that the human element is involved. If they involved machines only, we could solve them. But since they are human, are we to give them up?

I am not proposing a remedy for unemployment and the other problems that attend it. I do suggest, however, that there is a fertile field for scientific and engineering investigation into the problem of the proper distribution of labour so that all will share more equitably both in its burden and its reward. In saying this, I am not advocating the principles of communism. Far from it. On the contrary, if we are not able, by the application of scientific and engineering methods, to bring about a material improvement in the haphazard system of the distribution of labour that now prevails, the forces of communism will continue to grow at an alarming rate, and will threaten the very foundations of our national existence. I repeat that I am not competent to offer a solution, but if I can arouse the engineers of Canada to become more alive to their responsibilities of citizenship, and become more aggressive and constructive in their efforts to render assistance in the solution of Canada's problems, I shall have performed a duty to my profession and to my country.

BOOK REVIEWS

American Civil Engineers' Handbook, 5th Edition

Thaddeus Merriman, editor-in-chief. Wiley & Sons, New York, 1930, 4½ x 7¼ in., 2,263 pp., figs., charts, tables.
In one volume (atholeather) $8.00. In two volumes (real leather) $10.00.

The practising engineer uses a handbook or pocket book if he can obtain from it facts, formulae or methods more readily than from original papers or text-books. He often desires also some compendium which will give him a concise account of recent progress in subjects allied to his own special field. For example, a civil engineer engaged on bridge work, while not himself an authority on highway construction or electrical illumination or tunnelling, should have available some work from which he can ascertain the effect on his own work of standard practice or recent development in these or other subsidiary divisions of his work.

The new edition of Merriman well fulfills these purposes as regards civil engineering practice on this side of the Atlantic. Its twenty-two sections have all been prepared by well-known authorities working under Thaddeus Merriman as editor-in-chief, and they strike the happy medium as regards the selection of practical information and mathematical formulae.

The book is well illustrated and the diagrams are clear, although some are necessarily small in scale and others attempt to include too much detail. The index occupies 198 pages and accompanies each volume in the two-volume edition. In future issues it might be well to indicate the beginning of each section by thumbtabs, so as to facilitate ready reference. The book is so favourably known from its previous editions as to need little or no recommendation from a reviewer. It is an authoritative book of American practice in the wide field it covers.

The Automobile Engineer's Pocket Book of Rules, Tables and Data

By H. Kerr Thomas. E. and F. N. Spon, Ltd., London, 1931, cloth, 3¾ x 6¼ in., 126 pp., figs., tables, 6/-.

Essentially a book for the drawing office, this is intended for the designer, not the operator, and collects for his reference a series of formulae systematically arranged to be employed in chassis and engine calculations. Where descriptions or discussions are given they are necessarily of the briefest.

Due attention has been given to methods for determining frame stresses and to the subject of suspension and spring design. The information on tooth gearing takes account of modern methods. In addition to its utility to the designer, the book will be found of value to anyone who desires to study the many detailed calculations needed in proportioning modern automobiles.

To those accustomed to stating weights or forces in pounds, it seems strange that such units as tons and cwt. are still employed in a book of this kind. On page 78 we even find a pressure stated in cwt. per square inch.

Molesworth's Pocket Book of Engineering Formulae, 30th edition

By Sir Guilford L. Molesworth. E. & F. N. Spon, Ltd., London, 1931, cloth, 3 x 5 in., 935 pp., figs., tables, 6/-.

First issued in 1862, "Molesworth" still goes on from edition to edition and keeps up with the times. For a man who must carry in his pocket his technical library of reference for all branches of engineering, there is no handbook so concise and comprehensive, although in the limited compass of nearly nine hundred small pages of text it is of course impossible to give the detailed information available in larger pocket books. The new 30th edition includes much new matter on topics of recent interest and the book has been thoroughly revised.

Spons' Electrical Pocket Book, 4th edition

By W. H. Molesworth. E. and F. N. Spon, Ltd., London, 1931, cloth, 3¾ x 6¼ in., 401 pp., figs., tables, 6/-.

In size and form this is really a pocket book. Like "Molesworth" it is much condensed and gives little theory but many tables and much explanatory matter. The additional material included in the edition now issued deals briefly with such subjects as electric welding, radiation, wireless transmission, and television. The methods and standards referred to naturally follow British rather than trans-Atlantic practice. The book can be recommended for use where more elaborate handbooks are not available.

Mechanical Engineers' Handbook, 3rd edition

Lionel S. Marks, editor-in-chief. McGraw-Hill, New York, 1930, cloth, 4½ x 7 in., 2,264 pp., figs., charts, tables, $7.00.

A glance over the pages of a book like this gives a striking impression of the extent of the field which must be covered by a man who is competent even in one of the many divisions of the art of mechanical engineering. Recent development has been rapid in many branches and it is necessary to take account of researches and theories which even ten years ago were conveniently ignored, but which now urgently require the engineer's attention, since pressures, speeds, temperatures and rates of operation are constantly being pushed to higher limits.

The third edition of this well-known handbook fully maintains the reputation of previous issues and the various special fields of rising importance are well covered. For example, reference is made to the work of Ricardo on detonation in internal engines; that of Timoshenko on vibration problems, and so on. It would not be possible for any one individual to deal with a mass of technical material, which even when presented in the excellently condensed form of this handbook occupies 2,180 closely printed pages. In preparing this new edition, Professor Marks enlisted the aid of groups or individual engineers for the revision of existing sections or the contribution of new material, and the result justifies this policy.

The book is of convenient size and typography; the diagrams are legible; it opens easily and, best of all, it is adequately indexed. It can be recommended as an indispensable book of reference for the mechanical engineer.

Erratum

In the paper on "Riveted Tension Members" by Professor T. R. Loudon, M.E.I.C., in the November, 1931, issue of The Engineering Journal, page 557, first column, line 15, *for* Fig. 7 *read* Fig. 6.

RECENT ADDITIONS TO THE LIBRARY

Proceedings, Transactions, etc.

Thirteenth International Housing and Town Planning Congress, Berlin, 1931: [Proceedings], Part 3: Report.
The Institution of Civil Engineers of Ireland: Transactions, Vol. 56, 1929-30.
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Reports, etc.

DEPT. OF MINES, MINES BRANCH, CANADA:
Occurrences of Pitchblende and Silver Ores at Great Bear Lake, N.W.T.
Investigations in Ceramics and Road Materials, 1928-29.
DEPT. OF THE INTERIOR, TOPOGRAPHICAL SURVEY, CANADA:
[Map of] Quetico, Ontario, 1931.
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Tide Tables for the Pacific Coast of Canada for the year 1932.
QUEBEC STREAMS COMMISSION:
Nineteenth Report, 1930.
AIR MINISTRY, AERONAUTICAL RESEARCH COMMITTEE, GREAT BRITAIN:
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1396: Break-away of Boundary Layer on a Cylinder and an Aerofoil.
1397: Air-screws at Negative Torque.
1398: A Method of Testing the Strength of Aircraft Hulls.
1399: Range of Aircraft with Air-Cooled Radial Engine Using Altitude Control.
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Special Pub'n No. 68: Elements of Map Projection with Applications to Map and Chart Construction, 3rd ed., rev., May 1, 1931
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Reports of Radio Researches and Works in Japan, Vol. 1, nos. 1 and 2, June and August, 1931.

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PRESENTED BY A. L. MUDGE, M.E.I.C.:
Partial Bibliography of Welland Ship Canal and Earlier Welland Canals, Sept. 1931, compiled by A. L. Mudge.
PRESENTED BY ERNEST GRUENIG, A.M.E.I.C.:
The Fixed Point Method Simplified for Building and Bridge Design, Vol. 1, 1931, by Ernest Gruenig.
PRESENTED BY MCGRAW-HILL BOOK COMPANY, INC.:
Materials Handbook, 2nd ed., 1931, by George S. Brady.
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Economic Control of Quality of Manufactured Product, 1931, by A. W. Shewhart.
PRESENTED BY GALE & POLDEN LIMITED:
An Introduction to Aeronautical Engineering, Vol. 2: Structures, by J. D. Haddon, 1931.
PRESENTED BY NEW YORK COMMISSION ON VENTILATION:
School Ventilation, Principles and Practices, 1931.

PRESENTED BY COMBUSTION ENGINEERING CORPORATION:
X-Ray Examination of Welded Pressure Vessel Seams [7 pp.]—Reprinted from "Combustion," September, 1931.

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Determination of Olefin and Aromatic Hydrocarbons [21 pp.]—Reprinted from "Industrial and Engineering Chemistry," Jan. 15, 1930.
Direct Cracking of Crude Gives More Gasoline of Higher Octane Number [17 pp.]—Reprinted from "Oil and Gas Journal," July 16, 1931.

PRESENTED BY NATIONAL RESEARCH COUNCIL, DIVISION OF ENGINEERING AND INDUSTRIAL RESEARCH, [UNITED STATES]:
A Directory of Research on Heat Transmission in the Educational Institutions of the United States and Canada, 2nd ed., rev., Nov. 25, 1929.

PRESENTED BY AMERICAN SOCIETY FOR TESTING MATERIALS:
Tentative Standards, 1931.

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Pub'n No. 28: Sur la Structure des Formules et la Synthèse des Lois de Similitude en Physique (191 pp.].

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Bell Telephone System. Technical Publications. Monographs B551-2, B558-583. Index of Monographs, Sept. 1931.

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Compressed Air Plant, 5th ed., 1930, by Robert Peele, published by Wiley & Sons.
National Electrical Code, effective Nov. 1, 1931, (American Standard), published by National Board of Fire Underwriters [United States].

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Bulletin No. 208-A: Split-stage Low Temperature Refrigeration. [8 pp.].

CORK INSULATION COMPANY (CANADA) LTD.:
Corinco Cork Products [39 pp.].

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GILL & GREEN, LONDON, ENG.:
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Bulletin HV, 1931: Kingsbury Thrust Bearings, Horizontal and Vertical. [39 pp.].

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The Negretti & Zambra Automatic Temperature Regulator [7 pp.].
" " " " Flow Operated Cut-Out [2 pp.].
" " " " Instruments for Fuel Economy [8 pp.].
Cambridge Instruments for Panel Mounting [folder].

THE RAINES COMPANY OF CANADA:
The Korfund Vibro-Damper [4 pp.].
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EASTMAN KODAK COMPANY:
Applied Photography, Nov. 1931. [32 pp.].

STOKER MANUFACTURERS ASSOCIATION:
The Condensed Catalogue of Mechanical Stokers, 3rd ed. [39 pp.]

THE NORTHERN BOLT, SCREW AND WIRE CO. LTD.:
Catalogue, 1928 [46 pp.].

ELECTIONS AND TRANSFERS

At the meeting of Council held on November 17th, 1931, the following elections and transfers were effected:

Associate Members

SCHWING, Hans J., (Swiss Federal Coll., Zurich,) engr., Beauharnois Power Corporation, Montreal, Que.

*STEPHENSON, George, E. B. Eddy Co. Ltd., Hull, Que.

Junior

COWIE, Norman Claude, B.A.Sc., (Univ. of Toronto), elect'l. engr., Algoma District Power Company and the Great Lakes Power Company, Sault Ste Marie, Ont.

Transferred from the class of Junior to that of Associate Member

BARNETT, Harold E., B.Sc., (Univ. of N.B.), designing engineer, Dominion Construction Corporation, Fraserdale, Ont.

JOY, Clyde Barber, B.A.Sc., (Univ. of Toronto), 124 High Park Ave., Toronto, Ont.

Transferred from the class of Student to that of Associate Member

BULLER, Francis H., B.Sc., (McGill Univ.), M.S. in E.E., (Union Coll., Schenectady), asst. engr., cable section, central station dept., General Electric Company, Schenectady, N.Y.

FOY, Albert Joseph Bernard, B.Sc., (McGill Univ.), inspr., sprinkler risk dept., Canadian Fire Underwriters Association, Montreal, Que.

HALPENNY, Merle B., B.Sc., (McGill Univ.), estimator, Dominion Bridge Company, Limited, Montreal, Que.

Transferred from the class of Student to that of Junior

*LOCHHEAD, Stuart George, (McGill Univ.), junior engr., City of Westmount, 309 Brock Avenue North, Montreal West, Que.

MORGAN, James Clarence, B.A.Sc., (Univ. of Toronto), graduate student and demonstrator in electrochemistry, University of Toronto, Toronto, Ont.

NORMAN, Douglas, B.Sc., (Univ. of Man.), engr., transformer engrg. dept., Canadian General Electric Co. Ltd., Toronto, Ont.

RACEY, Herbert John, B.Sc., (Queen's Univ.), concrete inspr., Shawinigan Engineering Company, Ltd.; Montreal, Que.

Students admitted

BELYEA, Harry A., (Univ. of Tor.), 64 Pacific Ave., Toronto, Ont.

BUTLER, John Arthur Tweed, (McGill Univ.), 5037 Grosvenor Ave., Montreal, Que.

COLE, Alfred Herman Purkis, (McGill Univ.), 314 Broadway, Lachine, Que.

CUMMING, John Elliott, (McGill Univ.), 3483 Peel St., Montreal, Que.

DONOHOE, Gordon Miller, B.Sc. (E.E.), (Univ. of N.B.), 199 Market Place, Saint John West, N.B.

DWYER, John Norman, (McGill Univ.), 371 St. Joseph Blvd. West, Montreal, Que.

GIRDWOOD, Arthur J., (Univ. of Tor.), 328 Huron St., Toronto 5, Ont.

HOWARD, Albert Warren, (Univ. of Tor.), 89 Charles St. West, Toronto 5, Ont.

LAWRASON, William Murray, (Hamilton Tech. School), asst'g. engr., Hamilton Hydro Electric System, Hamilton, Ont.

LAZORKA, Demetrius, (Univ. of Sask.), P.O. Box 1260, Saskatoon, Sask.

LICHTY, Lyall J., (Univ. of Tor.), 8 Ellen St. East, Kitchener, Ont.

LOVE, Edwin Reginald, (Univ. of Man.), 184 Good St., Winnipeg, Man.

OUIMET, Joseph Alphonse, (McGill Univ.), 448 Outremont Ave., Outremont, Que.

PHILLIPS, Robert Weston, (McGill Univ.), P.O. Box 31, Chambly Canton, Que.

RANSOM, Rosmore, (McGill Univ.), 57 Somerville Ave., Westmount, Que.

SANDILANDS, Adam, Jr., (Univ. of Man.), 609 Goulding St., Winnipeg, Man.

**Has passed the examinations of The Institute.*

The British Grid Crosses the Thames

The height of the "Grid" towers which cross the Clyde at Renfrew is 275 and 283 feet. The crossing of the Forth calls for higher towers than these; they reach a height of 340 feet and the conductors have a span length of 3,050 feet—over half a mile.

Special towers are to be erected at Crossness where the Board's Barking-Swanscombe 132-kv. transmission line crosses the River Thames. The towers will carry six line conductors and an earth conductor. These conductors are of aluminum bronze with a cadmium copper core. Each conductor will consist of nineteen 0.102 inch cadmium copper wires and forty-two 0.102 inch aluminum bronze wires, giving an overall diameter of 0.918 inch. The span length will be approximately 3,060 feet, giving a clearance of 250 feet at the centre.

The earth conductor will be electrically connected to the towers and the towers will be earthed by means of cast iron earth pipes with bonded connections to each leg.

The base width of the towers will be approximately 120 feet. The towers will be constructed of rolled steel sections, and the cross-arms and tower tops down to approximately 20 feet below the bottom cross-arm will be galvanized and bolted, whilst below this point the steelwork will be ungalvanized, riveted and painted.

Each cross-arm, of which there will be three in all, having lengths of 30, 32 and 44 feet, will be provided with a rail from end to end outside the tower framework, designed to carry a travelling chair suspended from a set of grooved wheels, to be used for maintenance facilities. and platforms will be provided approximately 8 feet below each cross-arm. Railed steel ladders will run from ground level to the inside of the tower peak, broken by railed platforms approximately 50 feet apart.

Provision is made for the future accommodation of a lift running up the centre of the tower to the level of the bottom cross-arm should it be found advisable to provide lift access.—*The Electrical Times.*

Address given before the Hamilton Branch of The Institute, September 17th, 1931, by E. P. Muntz, M.E.I.C., Branch Chairman*

I trust you will bear with me for about fifteen minutes while I read some thoughts which I have jotted down since I dare not trust myself to speak extemporaneously. I hope most sincerely this will be of more than passing interest to all members since it is an attempt to help protect our future welfare as a professional institution.

Everywhere we go we hear such remarks as these: "What has The Institute done for me?" or "What can I tell a prospective member The Institute can do for him?" "Why should I join The Institute?" "The whole show is run from Montreal. You'll never get anywhere with anything no matter how sound if they don't want it."

My general answer to all of these and like questions is that the individual only benefits according to his own interest and endeavour, and that by the act of trying to do something to the best of one's ability, the individual is always more than repaid.

I am also sure we can all find plenty of instances in our own experience which bear out my detailed answers to the above questions. Anyone who attends Institute meetings with an open mind, and constructively tries to co-operate, is bound to benefit very materially.

I have questioned a number of the older members, and I find that some of the outstanding points of their lives have hinged on some point developed, or paper read, or person met at Institute meetings, or through The Institute.

I know this is true in my own case, not once but many times,—the most recent instance being in connection with one of the most important economic subjects of the present time. This I have tried to study somewhat this summer. I became interested because of a suggestion made at our first executive meeting in June. We were discussing material for papers. Your Vice-Chairman, H. B. Stuart, A.M.E.I.C., suggested a meeting devoted to Hamilton transportation problems. "Why had radials died? Why could Hamilton no longer be advertised as the hub of a fine radial system? Why did we have to go to Toronto to go to Owen Sound by rail? Why did it take from three to four days to ship by rail to Toronto, etc." It caught my interest, and I have since been drawn in a minor way into the greatest problem facing the railways of this continent today, namely, how to carry on in face of truck, bus, motor car, and other competition. The subject is very large, but like all subjects, the solution can and will be found. The discussions it has been my privilege to have with a number of railroad executives and others have been remarkably interesting, and very valuable to me personally. Some tangible results will come before long. The subject is closely allied to many phases of engineering, and it is worthy of note that this subject is directly of interest to about one-sixth of the total population of the United States and Canada, since their bread and butter are somewhat at stake.

My personal thanks are due to Mr. Stuart for his "thoughts out loud" as he expressed them today and I hope the meeting he suggested will be as successful as the subject warrants, and I have to thank The Institute again for enabling me to meet a number of very influential people and possible clients on their own ground.

What can Rotary, Kiwanis, or any other organization or club tell or do for their prospective members? They get them. We can tell them the same things which they can tell, and in addition we have a well established professional organization, a good channel of professional communication in The Journal, a reasonably common bond in training and avocations, and undoubtedly we have prestige to bestow professionally and no one who has attended an annual meeting in recent years had to go away empty.

As far as Montreal is concerned, Montreal will continue to rule, and more power to them, just as long as the rest of us are willing to do little or nothing about it. Our representatives on Council now make a personal sacrifice which should in our own interest be reduced. This sacrifice is both of time and money for so far they have paid their own way except to the Plenary Meeting once a year. There is now a committee reporting on more adequate Branch representation and after the Plenary Meeting of Council, certainly at the Annual Meeting, we expect to have an answer. Let us adopt the attitude in the meantime no matter what our present private opinions may be that Montreal has accomplished much. We hope they will now freely let us co-operate with them to accomplish more.

I hope these answers may appeal to a number of those who have not been favouring the Branch with their active support, and that also in them a sufficiently virile germ may be found which all members, and particularly the membership committee, may be able to nourish into arguments sufficiently strong and forceful to win over "doubting Thomases" both within the membership and outside. Our membership is barely 50 per cent of the potential in this district. I firmly believe The Engineering Institute can and will do more than any of us expect, if we are each and everyone willing to take a constructive part.

*President, E. P. Muntz, Limited, Toronto, Ont.

Now let us consider for a few minutes what is wrong or what is giving rise to these questions.

As we all know, the railroads are in a bad way,—looking longingly for a solution. The railroads in the past have been considered fine, upstanding, solid examples of progress and this until quite recently. Transportation, however, has changed radically, and continues to change, and the railroads have not done more on land than move goods from point to point by rail as they did when they first started. And by this rather caustic comment, I have no intention of detracting in any way from the marvels of engineering both mechanical, electrical and civil developed by these same roads.

Our Engineering Institute is exactly like the railroads, a fine, solid, old institution, as we look on the age of anything these days. As a matter of fact, it has grown up with the railroads, but like the railroad's special trouble—the motor vehicle—along now have come the professional associations, supplying a cheaper vehicle to professional respectability. The Institute is temporarily embarrassed, and like the railroad industry will be glad to see some definite working arrangement consummated. A committee is working now on The Institute's problems, just as there are a hundred committees or more working on the railroad's problems. If I might presume to offer a suggestion to all these committees (The Institute's included) it would be to forget the past, and not try to mould the present into the past, but let us have some radically new, workable and worth while functions to fill performed by new organizations, if necessary.

The railroad man must forget that the prime things in life are to move railroad trains from here to there on time. If he is merely a railroad man, and nothing more, that may be all he can do, but his place is now being taken by the forwarder who moves goods from the farm, the woods, the seacoast, the minehead, the city house, or warehouse, with or without railroad sidings, in the cheapest way and in the shortest time,—no matter if he uses truck, bus, rail, water, or air, or any combination of them. In this chain the railroad is only a part. Incidentally it should be an important part, but it will not be if the roads do not give what every shipper wants, that is, complete pickup and delivery service, one responsibility supplying all types of transportation to serve the best interests of the shipper.

The Institute, on the other hand, we all know, has got to develop some interlocking working arrangement with the professional societies. That we hope is now being worked out. The Institute has also got to realize that there are a very great number of people with engineering training employed in industry and all kinds of commercial activity. These people on the whole are anxious to keep up their engineering affiliations. Many of them would like to be associated with The Institute. They realize, possibly more than some of us, the extent to which engineers have filtered into the whole industrial and commercial fabric.

You may not know that this whole question is also being studied by a committee and again we expect some definite recommendation for the annual meeting. There are also the men with very special training and qualifications along some one line—but who could not qualify for membership under present standards. They must be cared for in some way. Our professional group or association is not yet by any means complete.

The question of fees is another important one. Due to the good work of preceding executives the Branch has a substantial surplus. Headquarters on the other hand are inadequately financed.

The affairs of The Engineering Institute, as I see it, can not be kept anything like as separate as those of a medical institute from the body politic. We, therefore, have to offer something much broader and bigger than purely technical discussions and qualifications. Like the railroads, The Institute is only fulfilling a part of a chain of functions which it should fulfill.

Preceding executives of this Branch are more than deserving of the thanks of all of us for not only the surplus but for the excellent spade work which they have done in working out sound answers to both classification and fee problems. These I hope to see written up shortly and placed in your hands. I believe two recommendations of your former executives provide *ipso facto* the answers to most of our troubles. Your present executives will more than welcome criticism and advice from those who have already gone a long way on the road to the solution of our problems.

Now each Branch, like all the individual railroads, has its own problems. We right now are confronted with doing our best to meet conditions as we see them. We, in Hamilton, have a lot to do no matter whether the millenium for the major difficulties comes this year or later. Therefore finally let us consider why we are banded together and why we are here now as members of The Engineering Institute. Let us also consider some comments indicating lines on which we might proceed.

The "avowed" purposes of The Institute (whether we entirely agree or not) are (A) "to facilitate the acquirement and interchange of professional knowledge among its members," (B) "to promote their professional interests," (C) "to encourage original research," (D) "to develop and maintain high standards in the Engineering Profession," and (E) "to enhance the usefulness of the Profession to the Public."

These purposes are very wide, and we, as a Branch, of course, subscribe to them.

The objects of the Branch according to Section 1 of the Branch by-laws are:

(*a*) To promote the interests and objects of The Institute;
(*b*) To raise the prestige of The Institute and the profession in the community;
(*c*) To unite the members for their mutual improvement.

It is presumed we facilitate (A) "the acquirement and interchange or professional knowledge among our members" by getting good papers by men of high standing and by arrangements to attend meetings elsewhere, etc. This is covered by Branch by-laws, Section 1A.

(B) "to promote their professional interests" seems to me to require the lively support of the Ontario Association of Professional Engineers, so that more definite legislation may be obtained among other desirable ends. At the same time a very much more distinct connection should exist between this Institute and the Ontario Association, than the indefinite relation now existing. This really amounts to nothing more than the fact that a large number of one belong to the other. I understand there is a committee working on this now and feel we should develop a policy on this subject as quickly as possible. The relations are not at all satisfactory at present, and there appears to be a great danger of one usurping the functions of the other; whereas one should assist the other.

(C) "to encourage original research." This is probably the most interesting branch of The Institute's "avowed" purposes. In some form or another original research is possible and open to every member of the profession and for that matter to the majority of human beings. It might have been written "to encourage original thinking." The meaning of "original research" which I understand is the original work done to obtain a new result, or an old one by a new process, with the assistance of the sciences or the correlation of information and deduction therefrom. Whether the research has to do with new methods of obtaining a result which we are now obtaining in our usual occupations or some new discovery or invention, I believe does not matter. It is important to stimulate original thinking to the point where everyone of us is every now and then producing the tangible and preferably beneficial results or thoughts of original endeavour on the part of the author. While we are probably primarily interested in engineering research, original research or thinking of any kind is worthy of attention.

The next item in the "avowed" purposes is to develop and maintain high standards in the engineering profession. Can not this best be done through the Professional Engineering Association and by seeing to it that we each maintain a high standard of ethical conduct and behaviour.

The last "purpose" and one of the utmost importance is "to enhance the usefulness of the profession to the public." I do not see quite why we should consider the altruistic side only. Unquestionably by the interchange of knowledge and original research and all the rest we are enhancing our usefulness to the public. I do not know who really benefits but the public by the average engineering research and the general improvement in engineering knowledge, methods, legislation protecting the owner against unqualified practitioners, *et al.* My conception of this clause is that it is a redundancy unless conceived as requiring that we "sell" the public on the usefulness of the profession.

We can not put paid advertisements in the newspapers. If we are going to sell anybody anything we must, however, have some means of definite contact on which or through which to work. There is little use in making ourselves invaluable to the public (as we no doubt are) if the public does not know wherein that value lies, so they can make full use of it.

Employers usually know where they can get engineering brains. If those brains are in the possession of a member of a really live organization which is a potent factor in the community, if the organization stands high in the opinion of employer and public alike, aren't those brains liable to be worth quite a lot more? Unless I know where I can purchase service or commodities it is little use to me if such service and commodities, as I may be able to use profitably from time to time, exist but are unknown to me. If the purveyors of these services or commodities did not "register" with me in some way I would not know of their use nor be in a position to secure them when opportunities arose. I believe the public is in the same relation to our Engineering Institute. If we do not make it possible for the public to recognize us we can not expect to be recognized. I do not think "recognize" is too strong a word in this connection.

Unquestionably The Institute already has prestige of a vague, indefinite kind in the minds of the public and of a very definite kind in certain particular channels like railroad executives and some government departments.

There is no reason why The Institute can not be before the country and the people of this district continually and sell themselves to the people and various public bodies by the soundness of their professional advice on a variety of questions arising in any community growing the way Hamilton and Canada will for some years, or for that matter in the country which undoubtedly has the brightest future in the world.

I am not proposing to become involved in politics in any way, but I believe we can endorse this project or object to that one, even though we may tread on the toes of some. When we have a speaker or subject of interest to the public let us make sure the public comes. If all this results in some paid assistance to the Secretary, as it surely will, let us get it. We will certainly find that action and reaction are equal and opposite and that if properly managed such propaganda with some amplification is bound to result in our opinion, collectively and individually, having a much higher value in the community.

I believe it possible and essential to send a notice of motion and possibly a copy of the actual proposed resolution covering such questions to members before a meeting. This only has to be done three or four times a year on sufficiently live subjects to obtain a large part of the contact which I feel should be fostered.

The Ontario fruit situation is now receiving considerable attention from some of our members. A paper on fruit marketing to which a great many people might be invited and to which they would be glad to come, followed by suitable if more or less prearranged discussion and resolutions and subsequent publicity in the press, might result in Hamilton getting that cold storage fruit warehouse which appears held up temporarily at least in Toronto. If not that, maybe another.

We are a centre for iron and steel, electrical manufacturing and a host of mechanical and other lines. I am sure in our membership there is a direct contact possible in many lines which will be of benefit to all of us and to the community, if it were made known by the means I have indicated.

We will find from time to time that there may be some feeling against this or that, particularly when it comes to patting someone on the back. There may be objections, but I believe a gracious act on our part would be a resolution appreciating the high quality of the recent advertising being done by the Pigott Construction Company.

I mentioned that there would be criticism, but my point is that if we are not ready to pat the other fellow on the back when he does something a little better and on a little higher plane, we will not find the other fellow ready to co-operate and help along some idea we are very anxious to foster.

With dignity but at the same time fearlessly we should make ourselves known to all men. First by co-operation and assistance and then by leadership, and not by insularism nor professional "high hattedness," can this be brought about.

I am sure the large manufacturing concerns we have as well as the railroads, the hospitals, parks and other boards all have the occasional problem which, if laid before us, would benefit by our endorsation or the discussion which would disclose reasons for withholding endorsation. I am sure we would benefit greatly by such work. I would curb promiscuous and idle subjects by making it a rule that we as a body could only act upon a request for endorsation accompanied by full, written particulars from some other properly constituted body or upon a paper prepared by one of our own members with resolutions made and seconded in writing. In either case, our Executive committee would pass upon it and circularize the members with their comments and stating the question would be discussed and the resolution voted upon at the next or some definite subsequent meeting.

The first two objects of the Branch as defined in the Branch by-laws are clearly covered by The Institute's "avowed" purposes. The third object "to unite the members for their mutual improvement" is sufficiently broad to embrace almost any activity and I certainly feel that this object can cover within reason all parts of what I believe is still called a liberal education.

We can without overburdening ourselves or building up too much machinery go a long way to obtain the objective which a number of our members, I am sure, think desirable.

Without doubt it is in your power to obtain just as much benefit from The Institute as your own ambition desires. Action and reaction as usual and as previously referred to are still equal and opposite and you must be prepared to give if you are to partake. Do not expect to partake too quickly,—but be ready to give *co-operation, considered constructive criticism, regular attendance* and *above all a certain amount of tolerance.* If you are willing to thus spread your bread on the waters, and I am sure you will, I am also sure you will be more than repaid.

In these remarks, I hope there is sufficient meat to bring out many constructive suggestions. Let me say most emphatically it is also in your power to make this professional organization outstanding in this community,—one to which anyone will be proud to belong, before which anyone will be proud to speak.

Natcoflor, a new product of the National Fire Proofing Company of Canada, Ltd., was subjected to exhaustive tests at the company's plant at Aldershot, Ont., on October 30th last. The main test, carried out under the supervision of the Canadian Inspection and Testing Company Ltd., was designed to show the load-bearing properties of Natcoflor. The panel was tested until the total live load was 468 square feet without failure. Natcoflor is a new type of structural clay tile used in combination with concrete joists to form a one-way system of composite floor construction. A number of members of The Institute were present at the test, among the more prominent being: Brig. General C. H. Mitchell, C.B., C.M.G., D.S.O., D.Eng., M.E.I.C., a past-president of The Institute, and Dean of the Faculty of Applied Science of the University of Toronto; J. P. Hynes, A.M.E.I.C., of Toronto; A. E. Beck, A.M.E.I.C., of the Petrol Oil and Gas Company, Toronto; A. H. Harkness, M.E.I.C., of the firm of Harkness and Hertzberg, Toronto, and C. S. L. Hertzberg, M.E.I.C., of the same firm, and J. Morrow Oxley, M.E.I.C., a member of the firm of Chapman and Oxley, of Toronto.

BRANCH NEWS

Calgary Branch

A. W. P. Lowrie, A.M.E.I.C., Secretary-Treasurer.
W. H. Broughton, A.M.E.I.C., Branch News Editor.

On the afternoon of Saturday, September 26th, a very enjoyable and instructive visit of inspection was paid to the Glenmore water storage reservoir and dam now almost completed on the Elbow river south-west of Calgary.

The party of about forty members and friends was divided into small groups with an official guide in charge of each, this by courtesy of N. G. McDonald, A.M.E.I.C., resident representative of Messrs. Gore, Storrie and Naismith, engineers of the project, and the contractors, Messrs. Bennett and White of Calgary.

The dam will impound about 3,600,000,000 gallons of water in a natural basin west of the city, or sufficient to supply a population of about 200,000 people for three months. As the present population is less than one-half this number the project will cover the city's demands for many years to come.

The whole project, which consists of the reservoir and its dam, hydro-electric pumping plant, mains to supply adequate pressure to all parts of the city, and a sedimentation, filtering and chlorination plant will cost about $3,770,000 and will eliminate the very strenuous and just complaints which have recurred about June every year, of the quality of the water supply. During its construction it has provided work for many otherwise unemployed; part of the work being done exclusively by rotating gangs of unemployed under the supervision of the engineers and a few permanent employes as experts in the various trades.

The visitors were first conducted around both sides of the dam and the cushion basin designed to allow any large overflow to swing into the natural channel of the Elbow river without shock or erosion of the banks. While the dam rests on a solid sandstone and shale foundation, pipes were provided every 8 or 10 feet for grouting after the superstructure is finished by means of air pressure at 100 pounds per square inch. It was found that not a great deal of grouting was necessary and in some cases the grout was forced up through adjacent pipes.

The dam is of concrete construction throughout. An overhead mixer was installed on one side of the river and the concrete distributed by means of a cable way with a tower on each side of the river and dumped by drop bottom skips.

The party was then conducted over and into the purification plant designed for a capacity of 27,000,000 Imperial gallons per day and which consists essentially of three portions providing for coagulation, sedimentation and filtration. Each of the three settling tanks has four coagulating tanks and eight filter beds through which the water flows in series at a very low velocity, taking about three hours for the complete circuit.

The pipes are all of concrete construction, manufactured locally, with a patented lead joint, reinforced with a steel cylinder and wire mesh which is bonded at the joints and then grouted in. Manholes are provided at convenient intervals for internal inspection. The delivery main forms a ring around the city which is tied in to the existing distributing system at convenient places.

Regular tests are being conducted on samples of each of the three grades of concrete used, the contractors being bound to very close limits of aggregate, water content, and physical strength in each case.

The project is believed to be the largest of its kind in the west and those present spent a very enjoyable afternoon.

The thanks of the members are due to the engineers and the contractors for the arrangements made for the visit.

Golf Tournament

By courtesy of the Earl Grey Golf Club, to which many of our local members belong, the Calgary Branch of The Engineering Institute held its annual golf tournament on the afternoon of Saturday, August 28th, in ideal golfing weather. The ladies of the party served tea in the club house.

The prize-list was as follows:

Best net score (18 holes):
First: R. C. Harris, M.E.I.C. (chairman).
Second: R. S. Stockton, M.E.I.C.
G. H. Patrick, A.M.E.I.C. (tie).

Best gross score (18 holes):
First: G. P. F. Boese, A.M.E.I.C.
Second: H. J. McEwen, A.M.E.I.C.

Best net score (1st nine):
W. Anderson, A.M.E.I.C.

Best net score (2nd nine):
G. H. Morton, A.M.E.I.C.

Hidden Hole (Handicap):
R. McKay, A.M.E.I.C.

Putting:
Men: E. N. Ridley, M.E.I.C.
Ladies: Mrs. F. G. Bird.

Hamilton Branch

J. R. Dunbar, A.M.E.I.C., Secretary-Treasurer.
J. A. M. Galilee, Affil.E.I.C., Branch News Editor.

Joint Meeting with Ontario Section A.S.M.E.

A joint meeting of the branch with the Ontario section A.S.M.E. was held in Hamilton on Friday, October 30th. E. P. Muntz, M.E.I.C., occupied the chair and opened the meeting by welcoming the Toronto visitors. He called on Mr. S. L. Fear, chairman of the Ontario Section A.S.M.E., to introduce the speaker. In his remarks Mr. Fear referred to the desirability of having joint meetings of the different engineering organizations.

The speaker for the evening was Professor J. W. Bain, of the University of Toronto, who spoke on "Mechanical Industries and the Chemical Engineer."

Mechanical Industries and the Chemical Engineer

(Reported by V. S. Thompson, A.M.E.I.C.)

The speaker in his opening remarks gave a definition of a mechanical engineer as one primarily interested in mechanisms and drew the distinction between the mechanical engineer and the chemical engineer, the latter being interested in matter or material. Thus the two are complementary and he proceeded to relate a number of examples, as for instance how a young Scotch mechanical engineer named McArthur had revolutionized the gold mining industry by his improvement of existing filter presses.

The filter press at that time used by chemical engineers was only for liquids containing a small amount of solid material which was pumped in and allowed to drain out leaving the solid inside. McArthur reversed this process by making a frame covered with filter cloth which was slipped into the solution and suction applied from the inside. This was cleaned by applying air pressure instead of suction, the cake dropping off the outside of the filter cloth.

Up until 1912 the total ammonia production (about four million tons) was obtained from coal. The German, Haber, conceived the idea of making Nitrogen and Hydrogen unite under pressure using a catalyst. He passed SO_2 and O_2 through a tube at 120 degrees without result until platinum was tried as a catalyst, when sulphur trioxide was obtained, ($2SO_2 + O_2 = 2SO_3$). The amount of SO_3 obtained is increased with increase in pressure and this requires extremely carefully designed mechanical equipment.

Incidentally this process was a very important incentive for the development of special alloy steels. Many alloys will sustain fairly high tensile stresses but keep on stretching under load at high temperatures. At 800 degrees C. ordinary carbon steel will sustain 1,000 pounds per square inch for 107 hours before failure.

The British practice maintains that a specimen must not expand more than 1/100,000th inch per day while American practice requires not more than 1 per cent extension in 10,000 hours.

A good example of modern alloy is made in England to-day (18 per cent chromium, 8 per cent nickel) which will sustain 2½ tons per square inch indefinitely at 800 degrees C., or five times as strong as ordinary carbon steel.

These steels made synthetic ammonia possible and now tubes are made 40 feet long, 30 inches diameter with a wall thickness of 5 inches to 7 inches to carry loads up to 300 atmospheres at 500 or 600 degrees C.

Similarly the speaker cited the development of synthetic methyl or wood alcohol used in the manufacture of dyes. Hydrogen and carbon monoxide are combined synthetically using zinc oxide as a catalyst. This process has completely killed the old wood distillation method within the last eight years.

Professor Bain then described special electric furnaces with electrodes 2 feet square for the manufacture of carbide and showed a chart giving a long list of products obtained from it, Acetic Acid, Ethyl Acetate, Ethyl Lactate and Carbon Black among others.

It was discovered that ordinary cotton dipped into Nitric Acid and washed undergoes a profound chemical change by becoming soluble in alcohol and ether, and dries leaving an elastic film; duPont thickened this film by concentrating the liquid and applied it by means of a spray giving a hard lustrous finish, which he called "Duco" (Nitro Cellulose Lacquer).

A Frenchman called Chardounet dissolved cellulose and squirted through minute holes so that the solvent evaporated leaving a fine thread. Two Englishmen, Cross and Bevan, elaborated this process and founded the modern Rayon or Artificial silk industry.

Synthetic resins have been common since about 1910 and many of these are used in the manufacture of varnishes, but it was left for a Belgian inventor to perfect a substance which is used in hundreds of different forms to-day. This is Bakelite, a resinous product made from carbolic acid and formaldehyde, which when heated thickens up and sets.

In closing, Professor Bain paid tribute to the success of the mechanical engineer and metallurgist in keeping up with the demands of modern chemistry and without whose aid very few of these developments could have progressed to the commercial stage.

Lethbridge Branch

Wm. Meldrum, A.M.E.I.C., Secretary-Treasurer.
G. W. Rowe, Jr.E.I.C., Branch News Editor.

The Lethbridge Branch of The Engineering Institute of Canada held its first meeting of a series of bi-monthly dinner meetings.

Among the guests of the Branch on this occasion were several representatives of the teaching profession.

A splendid dinner was served during which the orchestra conducted by George Brown rendered an excellent musical programme. A short period of community singing followed with vocal solos by Bob Lawrence, A.M.E.I.C., and Miss J. McIlvena.

"The Mid-North"

Dr. W. G. Carpenter, B.A., LL.D., principal of the Institute of Technology and Art, Calgary, was the speaker and took for his subject "The Mid-North."

W. Meldrum, A.M.E.I.C., presided and introduced the speaker in the unavoidable absence of the branch chairman, N. Marshal, M.E.I.C.

The vast resources of this mid-north country, aside from its agricultural possibilities as illustrated by what has been done in the Peace River country, are almost unbelievable, according to the speaker, who told of the tar sand deposits, salt and the indications of radium bearing ore found at Great Bear lake.

Numerous facts and figures were presented to illustrate the country and its possibilities and of these perhaps the most striking was the statement that the average summer and winter temperatures were comparable to those in the southern part of Saskatchewan.

Mention was also made of other natural resources of the province such as coal, gas and oil, for which, while perhaps at the present time the outlook was none too favourable, nevertheless would in their time play a big part in the development of the province.

It is impossible to predict just what the development of these natural resources will lead to, concluded the speaker. They are a challenge to the youth of today, a gleam of optimism at a time when so much pessimism is prevalent.

Following the motion pictures, N. H. Bradley, A.M.E.I.C., moved a hearty vote of thanks to the speaker.

On October 31st, 1931, the Lethbridge branch of The Engineering Institute of Canada held the second of their regular bi-monthly dinner meetings in the club dining-room of the Marquis hotel.

Grain Handling

The speaker was C. D. Howe, M.E.I.C., consulting engineer of Port Arthur, Ontario, who addressed the branch on the subject of "Grain Handling," illustrating his remarks by a series of slides.

Mr. Howe is internationally regarded as a leading authority on this subject, having designed and supervised the construction of grain elevators in all parts of this country from Prescott and Buffalo in the east to Vancouver and Victoria in the west, the most recent undertakings being the interior terminal elevator at Lethbridge and the first elevator at Churchill on Hudson's Bay.

Mr. Howe recently returned from a trip to the Argentine and in his address gave a brief account of the grain handling methods of that country.

In opening his subject, Mr. Howe told of the enormous increase in the production of wheat in Canada during the last twenty years. While the crop in 1909 was only some 100,000,000 bushels this steadily increased until it reached the peak in 1928. During that year 550,000,000 bushels were grown in this country.

Discussing the economic factors which have so depressed the wheat market during the last two years, the speaker commented on the enormous wheat crop of the Argentine in 1928 and the return of Russia as a wheat exporting country for the first time since the world war.

However, the events of the past two weeks, continued the speaker, are such as to entertain every hope that the grain business in the not too distant future will return to normal.

Continuing, Mr. Howe explained the function of the 5,000 country elevators scattered throughout the west and the part they play in rushing the grain to the outlet ports. He also discussed briefly the construction and equipment of this type of elevator.

Turning from the country elevator to the interior terminal such as the one located at Lethbridge, Mr. Howe spoke of the various problems involving the design and construction of these large reinforced concrete structures.

Mr. Howe devoted the concluding part of his address to the Churchill elevator. This elevator has a capacity of 2,500,000 bushels of grain. Future possibilities however have been carefully kept in mind and it can be extended to hold 10,000,000 bushels later on if necessary.

The speaker mentioned the recent arrival at Royal Victoria dock of the "Farnsworth" with its cargo of 227,000 bushels of grain.

Particular attention was drawn to the fact that while insurance rates on this shipment were twenty-two times greater than via Montreal it had still been able to show a profit to the western farmer of 1½ cents over the lake and rail route, the bay being readily navigable from the 1st of July until the middle of November.

Following the address, J. B. deHart, M.E.I.C., moved a hearty vote of thanks to the speaker for his highly interesting and enlightening address.

W. Meldrum, A.M.E.I.C., occupied the chair, and the speaker was introduced by Mr. W. N. Chater, resident engineer for C. D. Howe and Company on the Lethbridge elevator.

During the afternoon, through the courtesy of Mr. J. Pickering, acting superintendent, and Mr. J. Taylor, acting foreman, government elevator officials, the members inspected the new Lethbridge interior terminal elevator. The grain inspection department proved particularly interesting to many, and thanks are due to Mr. Herb. Goddard, chief grain inspector, for his explanation of this part of the work.

During the dinner the orchestra under the direction of George Brown rendered an excellent programme of high class music. This was followed by a period of community singing interspersed with two solos by Mr. Fred Teague, which were greatly appreciated.

Ottawa Branch

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

The Coming Total Solar Eclipse

At the luncheon meeting of the Ottawa Branch of The Engineering Institute of Canada, on Thursday, October 22, the guest speaker was Mr. R. Meldrum Stewart, Director of the Dominion Observatory, who spoke on the subject "The Coming Total Solar Eclipse." In addition to the speaker and G. J. Desbarats, C.M.G., M.E.I.C., the chairman of the local branch, the other guests at the head table included Hon. T. G. Murphy, Minister of the Interior; H. H. Rowatt, Deputy Minister of the Interior; Dr. Charles Camsell, M.E.I.C., Deputy Minister of Mines; John Murphy, M.E.I.C.; F. H. Peters, M.E.I.C., Surveyor General; Louis H. Berger, W. M. Tobey, M.E.I.C., Commander C. P. Edwards, A.M.E.I.C., H. Ewart and Noulan Cauchon, A.M.E.I.C.

Mr. Stewart stated that eclipses may be predicted very closely, but sometimes slight discrepancies in their times occur. As these discrepancies are due to some cause, they are, therefore, of the greatest interest to astronomers, for from them these causes may possibly be deduced. There will be a total eclipse on August 31, 1932, visible in a portion of Quebec, and it was in this connection Mr. Stewart mentioned some of the problems involved in making observations of it for scientific purposes.

There are a number of problems which accurate observations of eclipses can help solve. An eclipse party measures the time of the eclipse as accurately as possible and also endeavours to measure the limits of the shadow cast on the earth. For data concerning the path of the eclipse, the public can very materially assist by advising the officials of the Observatory of their observations. If sufficient observers would do this, the limits of the shadow could be plotted fairly accurately.

The theory of relativity can be checked at the time of a total eclipse by photographing the stars around the sun and comparing the photograph with one taken during normal conditions.

Another study at the time of the eclipse is that of the sun's corona. When it is realized that only one or two minutes per year is all the time that is available for the study of the corona, it is easily realized that there is a good deal yet to be learned about it.

The sun's atmosphere also may be studied at the time of the eclipse, as a careful record is kept of the spectra observed as the sun passes into the shadow.

Terrestrial magnetism is also believed to be affected by the sun and interesting observations may be made of the effect of cutting off the sun's light. A study of the sun's effect on wireless reception may also be studied at such a time.

This path of totality of the coming eclipse will travel from the Arctic coast to a point on the international boundary in southern Quebec. The width of the shadow zone in southern Quebec is approximately 100 miles: the western edge passes through Montreal and the eastern about 25 miles east of Three Rivers. The maximum period of totality at any one site will be in the neighbourhood of one hundred seconds. The party will therefore be occupying the site of the observation several weeks before the date of the eclipse, erecting instruments and rehearsing the procedure to be followed.

In studying the meteorological records for the possible location of the site, the speaker stated that a station in southern Quebec would have about a fifty-fifty chance of having favourable weather for the observation. In locating the site, various local conditions would have to be taken into account, such as keeping away from towns or cities to avoid smoke, avoiding high hills on account of the possibility of clouds collecting over them, accessibility, etc.

The previous total eclipse visible in Canada occurred in 1925, the next will be in 1954, so every precaution for next year's observation will be taken.

Visit to Dominion Observatory

At the above luncheon meeting, the invitation was extended to the members of the Branch to visit the Dominion Observatory on the following Saturday evening, October 24. A large attendance was present to avail themselves of this opportunity, despite the adverse weather conditions.

Everything had been done to make the visit of an interesting nature, and every instrument and apparatus in use at the Observatory was on display for their examination. At the conclusion of their visit members of The Institute expressed their thanks to Mr. Stewart.

The Ottawa branch, at their noon luncheon on November 12th, had as their guest speakers Walter Lambert, M.E.I.C., M.I.N.A., senior partner of the firm of Lambert and German, consulting naval architects, Montreal, and J. W. Hughes, electrical engineer for the Eastern Lines of the Canadian Pacific Railway. G. J. Desbarats, C.M.G., M.E.I.C., chairman of the branch, presided at the meeting, other guests at the head table being C. P. Edwards, A.M.E.I.C., E. Hawken, J. G. Parmalee, R. F. Howard, M.E.I.C., and C. S. Morse.

Mr. Lambert's firm was responsible for the design and constructional supervision of the "Prescotont-Ogdensburg" unit, operating to ferry the railway traffic of the New York Central Railroad and the Canadian Pacific Railway across the St. Lawrence river between Prescott, Ontario, and Ogdensburg, New York. This unit consists of the tug "Prescotont" and the car float "Ogdensburg," in which are embodied certain radical features which constitute possibly the first commercial development of the conception of what might be termed "more remote control." Mr. Hughes co-operated with the naval architects in supervising the manufacturers' tests, and the installation of the electrical equipment of the tug "Prescotont."

The addresses, which were most interesting, were supplemented by lantern slides, which served more readily to illustrate the novel features of the design.

Peterborough Branch

W. F. Auld, Jr.E.I.C., Secretary.

Arthur R. Jones, Jr.E.I.C., Branch News Editor

The annual dinner of the Peterborough Branch of The Institute, which was held at the Empress hotel on November 17th, was a most successful function, being attended by over one hundred members and guests. The meeting was presided over by A. B. Gates, A.M.E.I.C., chairman of the Branch, and among the prominent guests present were: Brig. General C. H. Mitchell, C.B., C.M.G., D.S.O., D.Eng., M.E.I.C., past-president of The Institute, and the principal speaker, J. L. Busfield, M.E.I.C., chairman of the Finance committee of The Institute; C. S. L. Hertzberg, M.E.I.C., chairman of the Toronto Branch of The Institute; J. Roy Cockburn, M.E.I.C., vice-chairman of the Toronto Branch; E. A. Peck, M.P., and J. F. Strickland, M.P.P.; city solicitor J. R. Corkery, representing the legal profession; A. S. Zavitz (of the Collegiate staff), representing the teaching profession; Dr. N. H. Sutton, district officer of health, representing the medical profession, and the Rev. A. H. Going, secretary of the Peterborough Ministerial Association.

W. E. Ross, A.M.E.I.C., a past-chairman of the Branch, who is leaving Peterborough for Toronto, was the recipient of a small gift.

Following the toast to "The King" and after Mayor Denne had voiced an official welcome to the visiting engineers, a toast to "The Engineering Institute of Canada" was proposed by Ross L. Dobbin, M.E.I.C. Mr. Dobbin pointed out that The Institute now has twenty-five branches reaching from coast to coast and with an approximate total membership of five thousand. Not the least of these branches, said Mr. Dobbin, was the Peterborough Branch, with a membership of one hundred and twenty-five. The toast was responded to by Mr. Busfield and J. F. Plow, A.M.E.I.C., who both had interesting observations to make regarding the work of The Institute among the engineers of Canada.

Brig. General Mitchell, who also spoke in reply to the toast, said in part:

The members of the engineering profession possessed a curious ability to size up the affairs of a country. They held the same relationship to the country as a whole as did a staff officer in the war as against an officer of the line. The staff officer was able to view a much wider horizon than the officer of the line whose knowledge was confined to a particular sector of his front.

"We have been going through a difficult period. Far be it from me to speak in gloomy terms. I would ask you, are these times so difficult as we have been led to think. There has been a good deal of talk. What's the matter with the country? But I would ask. 'What's the matter with ourselves?'"

The trouble, he was convinced, consisted a great deal in wrong thinking along pessimistic channels. And a great deal of that trouble was, he said, "due to our playing about with extravagances and not practising economy—economy in our personal life, in business life, and in civic life."

"Do we suit our demands to what we need or to what we want," the speaker challenged. "We have extravagances and they have been increasing. Can we not practise some limit to our wants and luxuries."

Uttering a word of warning, General Mitchell said, "we should not fool ourselves with dreams of the future or of profits on paper."

Striking off to another thought which conveyed a wealth of optimism and hope, General Mitchell invited his deeply absorbed audience "to look across the seas to Great Britain and the Great Empire.

"Empire trade is at this very hour being discussed and plans are being formulated for trade arrangements for the Empire alone. That is an influence that has come about by reason of our hanging together as an Empire people."

There was another influence—that of the United States—which he also referred to. "We living close to the United States have a natural tendency and inducement to spend on things we don't need in 'keeping up with the Jones,' and quite naturally we are induced to buy from them."

He noted a very pleasing feature in this connection, however, which he thought was an indication that Canada was waking up. "During the month of October," he said "our trade balance with the States turned from an unfavourable to a favourable balance."

Viewing for a moment the things which Canada has not only in her shop window but the goods which she has packed away in the basement not yet opened, the speaker dealt with the country's agricultural potentialities.

It was true that the west had been and still was facing a period of depression, but he said, "we must also remember that only four years ago the west produced a wheat crop of five hundred million bushels, three million bushels of which were shipped overseas. And a good price was obtained for it."

The speaker mentioned also Canada's pulp and mineral resources. The fact that this country ranks first in the production of nickel, second in gold, fourth in copper, and third in silver.

Canada's water power resources also provided for turbine capacity of six million horse power—over six-tenths horse power per inhabitant in the country.

"Let me also point this out to you that as we have and are developing this country in various directions which I have indicated, Canada's direction geographically is turning northwards. A few years ago Canada was a narrow strip of territory running for three thousand miles east and west. Can't you imagine what is going to happen when the breadth of that strip is doubled?"

But it was not in possession of huge natural resources that Canada's future prosperity and success lay, General Mitchell said in closing. It was not in her great rivers and lakes, her vast mineral regions and wheatlands. Such things alone did not make a country. That could only come about by the right people going out to develop those resources and co-operating in harmony. Out of that combination a great and prosperous nation could not help but evolve.

"It is not walls or ships devoid of crews, but men who make a city," he said quoting from the saying of a Greek historian.

"Our men with all their initiative, fortitude and courage are going to make this country and help develop her unbounded natural resources."

"The Branches" was the toast proposed by A. L. Killaly, A.M.E.I.C., and was responded to by Messrs. C. S. Hertzberg,, M.E.I.C., N. E. D. Sheppard, A.M.E.I.C., and J. R. Cockburn, M.E.I.C.

The final toast on the list, that to "Sister Professions and Other Guests," was proposed by W. M. Cruthers, A.M.E.I.C., and replies were made by the various representatives of the sister professions.

Quebec Branch

M. Boyer, S.E.I.C., Secretary-Treasurer.

Dinner to Alexandre Lariviere, A.M.E.I.C.

On the evening of October 26th the Quebec Branch feted its vice-chairman, Alexandre Larivière, A.M.E.I.C., on the occasion of his recent appointment as a member of the Quebec Public Service Commission.

The celebration took place in the Riverview dining-room of the Chateau Frontenac, with an attendance of over seventy guests, among whom were several members of the engineering profession from Montreal, Three Rivers, Chicoutimi and Rimouski.

Following the dinner, Hector Cimon, M.E.I.C., chairman of the Quebec Branch, expressed his keen satisfaction in presiding over such an enthusiastic gathering, and said that the Quebec Branch of our nation-wide professional association, The Engineering Institute of Canada, which had been working in the interests of engineers for the past forty-five years and knew how to appreciate the success of its members, had naturally taken the lead in promoting this manifestation in honour of its devoted vice-chairman, Mr. Alexandre Larivière.

Many letters and telegrams had been received from prominent citizens and engineers who expressed their regret at being unable to attend, among whom he might mention the Honourable L. A. Taschereau, Prime Minister; the Honourable J. N. Francoeur, Minister of Public Works; Ivan E. Vallée, A.M.E.I.C., Deputy Minister of Public Works and Labour; Mr. Noel Belleau, K.C., Bâtonnier of the Quebec Bar Association; Chief Magistrate Ferdinand Roy, a substitute member of the Public Service Commission, and Messrs. Aurelien Boyer, A.M.E.I.C., Principal of the Ecole Polytechnique de Montréal; Prof. A. Mailhiot, B.A.Sc., E. A. Evans, M.E.I.C., Henri Kieffer, B.A.Sc., F.E., J. A. Duchastel de Montrouge, M.E.I.C., and J. E. Gibault, B.A.Sc.

On behalf of all, Mr. Cimon sincerely congratulated Mr. Larivière upon his recent appointment as Commissioner, and expressed feelings of gratitude to the Provincial government and the officers of the Quebec Public Service Commission for their judicious choice of Mr. Larivière as an able successor to the late and esteemed François-Charles Laberge, M.E.I.C., who had been a member of this Commission since its creation.

L. C. Dupuis, A.M.E.I.C., division engineer for the Canadian National Railways, proposed the toast to the hero of the evening, which was seconded by James Ruddick, M.E.I.C., consulting engineer, and by Mr. Edouard Hamel, chief engineer of the city of Quebec, and the former partner of Mr. Larivière at the time they were both engaged in private practice as consulting engineers.

The toast was followed by the singing of "Il a gagné ses épaulettes" and, after prolonged applause, Mr. Larivière addressed the meeting as follows:

Monsieur le Président,

Mes chers amis,

Je suis profondément touché de la démonstration à la fois sympathique et enthousiaste que vous me faites, ce soir, à l'occasion de ma récente nomination comme membre de la Commission des Services Publics de Québec.

A en juger par les paroles de ceux qui m'ont précédé, j'ai bien des mérites et des qualités que je ne me connaissais pas. Je suis porté à croire qu'elles ont été inspirées à ceux qui les ont prononcées plutôt par les bons sentiments dont ils sont animés à mon égard que par mes mérites réels.

Quoiqu'il en soit, je dois maintenant faire appel à votre indulgence car je me sens tout à fait incompétent pour répondre convenablement aux flots d'éloquence et d'éloges qui viennent de déborder à mon sujet, d'autant plus qu'en ce moment, l'émotion qui m'étreint l'emporte sur tous mes autres sentiments.

J'aurai donc recours, pour exprimer toute ma reconnaissance, à un seul mot que l'on retrouve sur les lèvres de quiconque reçoit une faveur, sur celles du pauvre ou du riche, du plus humble ou du plus puissant, de l'illettré ou de l'érudit, c'est le mot: merci.

Pour combler la vacance créée par le décès du regretté M. Laberge, le Premier Ministre et ses collègues ont bien voulu considérer les années de service de votre humble serviteur et choisir un employé du service civil; permettez que je leur exprime d'abord, ainsi qu'à ceux qui m'ont recommandé, ma vive gratitude pour le grand honneur qu'ils m'ont fait et la confiance qu'ils m'ont témoignée. Je puis les assurer que dans l'exercice de mes nouvelles fonctions, tout mon dévouement, mon énergie et mes connaissances seront mises au service de la justice.

C'est avec plaisir que je constate la présence ici ce soir de mes collègues, messieurs Beaudry et Macalister et de mon ancien Commissaire, Sir Georges Garneau. Cette courtoisie de leur part ne me surprend pas et je les en remercie sincèrement. Les membres de la Commission ont été pour moi non seulement des supérieurs doués d'une extrême bonté, des conseillers précieux et même des amis, mais, mon association à leur œuvre m'a procuré les plus beaux exemples d'honnêteté, de droiture, d'esprit de travail, du sens de la justice et du devoir.

Depuis que j'ai été nommé commissaire, j'ai souvent ressenti, en montant sur le banc, une profonde émotion en songeant aux nombreuses qualités du cœur et de l'esprit dont était doué celui que j'ai été appelé à remplacer, en songeant à sa haute compétence en matière technique, à sa conception profonde de la justice et à son jugement sain et profond.

Sur la tombe à peine fermée de M. Laberge, je dépose l'hommage de mon admiration, de mon respect et de mon meilleur souvenir.

En cette circonstance où on a fait allusion à ma formation technique, il n'est que juste de signaler que je la dois à l'Ecole Polytechnique et à ses professeurs. Ces derniers n'ont peut-être pas réussi à faire de moi tout ce qu'ils auraient voulu, mais ma dette de reconnaissance envers eux et envers l'Ecole est bien grande, car mes succès sont, en grande partie, attribuables à leur enseignement, à leur dévouement et à l'intérêt qu'ils m'ont porté même après ma sortie de l'Ecole.

Je m'en voudrais de ne pas mentionner les quelques années que j'ai passées avec mon ancien associé, Edouard Hamel, maintenant ingénieur en chef de la Cité de Québec et président de la Section de Québec de l'Association des Anciens de Polytechnique. Il était mon aîné et, à son contact, j'ai acquis, dans le domaine des travaux municipaux, une expérience qui me fut fort précieuse dans l'exercice de mes fonctions d'ingénieur de la Commission.

Enfin, je vous remercie, mes chers amis de l'Engineering Institute of Canada, de la Corporation des Ingénieurs Professionnels, de l'Association des Anciens Elèves de l'Ecole Polytechnique, pour vos bons souhaits et pour le témoignage d'estime que vous avez bien voulu me donner en ce jour, soit en participant à l'organisation de cette fête, soit en y prenant part.

It is not my intention to repeat in English all that I said in French, as most of you understand both languages, but I wish to convey my deep appreciation of your presence at this gathering and my most sincere thanks for your good wishes as expressed so eloquently by your "spokesman," Mr. James Ruddick.

The courtesy that you have shown in participating in this banquet and the friendship that it signifies are very pleasing to me and I wish to assure you that I shall always keep the happiest remembrance of tonight's celebration.

Sir Georges Garneau, B.A.Sc., President of the National Battlefields Commission and a former member of the Public Service Commission, paid an eloquent tribute to the new Commissioner, whose character and services as engineer of the Public Service Commission he had truly appreciated when acting as a Commissioner.

The next speaker, Mr. Adrien Beaudry, K.C., President of the Quebec Public Service Commission, offered flattering comments on the career of Mr. Larivière, and Dr. A. R. Decary, M.E.I.C., President of the Corporation of Professional Engineers of Quebec, added a brief but eloquent contribution of best wishes and congratulations to the new Commissioner.

Dr. Augustin Frigon, M.E.I.C., Director of the Ecole Polytechnique de Montréal, took pride in recalling the days when, as his pupil, the guest of honour had followed a post graduate course in electrical engineering.

Olivier Lefebvre, D.Sc., M.E.I.C., one of the vice-presidents of The Institute, and chief engineer of the Quebec Streams Commission, spoke on behalf of the Council of The Engineering Institute, and delivered messages of friendship and congratulation from the out-of-town engineers.

Alderman Wilfrid Lacroix, B.A.A., architect, a graduate of the Ecole Polytechnique de Montréal, referred to the many occasions on which the Quebec city council had sought Mr. Larivière's technical opinion and advice, which had been greatly valued, and the last speech was from Mr. Ludger Gagnon, assistant engineer for the city of Quebec, who, as spokesman for the younger engineers, offered to the new Commissioner most sincere wishes for a long career.

The meeting was brought to a close to the cheering tune of "For he's a Jolly Good Fellow."

We wish that the promotion of our friends always brought about such merry and unforgotten moments of rejoicing!

Saint John Branch

G. H. Thurber, A.M.E.I.C., Secretary-Treasurer.
C. Gordon Clark, S.E.I.C., Branch News Editor.

The Saint John Branch of The Engineering Institute of Canada held a meeting on November 5th, 1931, in the Georgian ballroom of the Admiral Beatty hotel. This took the form of a cabaret dinner, dance and bridge and was the first social event sponsored by the Branch in some years. It was well attended by members and friends. John N. Flood, A.M.E.I.C., chairman of the Branch, presided.

Dinner music and the dance programme of the evening were provided by Bruce Holder and his orchestra.

This marked the opening of Branch activities for the 1931-32 season. One of the chief objects of this social gathering was to give the numerous outside engineers employed on the reconstruction of the Saint John harbour an opportunity of meeting local engineers.

The arrangements for the meeting were in charge of J. N. Flood, A.M.E.I.C., and G. G. Murdoch, M.E.I.C., chairman of the Entertainment committee. They were assisted by a committee composed of Messrs. A. A. Turnbull, A.M.E.I.C., G. H. Thurber, A.M.E.I.C., V. S. Chestnut, A.M.E.I.C., C. G. Clark, S.E.I.C., J. P. Mooney, A.M.E.I.C., F. M. Barnes, A.M.E.I.C., and W. J. Johnson, A.M.E.I.C.

Saskatchewan Branch

Stewart Young, A.M.E.I.C., Acting Secretary.

The first regular meeting of the Saskatchewan Branch of The Engineering Institute of Canada for the season, was held in the Kitchener hotel on Tuesday evening, October 27th, 1931, being preceded by a dinner at which there were thirty-six guests.

Immediately after dinner E. E. Poole, Affil.E.I.C., presented a moving picture of scenes taken on a recent trip to Churchill. The reel shown included views of the Flin Flon and Sherritt-Gordon mines, views of the harbour at Churchill, the old Hudson's Bay fort and the new storage elevators.

Before proceeding with the regular business of the evening, E. R. Jenkins of the engineering staff of the Department of Telephones favoured the meeting with two songs.

The speaker of the evening, S. G. Porter, M.E.I.C., President of The Engineering Institute of Canada, was then introduced by the Chairman, D. A. R. McCannell, M.E.I.C.

Mr. Porter, before proceeding with his address on "Some Observations on the Engineering Profession," reviewed briefly certain Institute activities, calling attention in particular to the fact that the ultimate value of The Institute to its membership depended largely on the proper functioning of the Branches and that these, in turn, depended upon the efforts of the individual membership. He stated that in its final analysis the value of The Institute to each member depended on his personal interest in Institute affairs. He receives benefit only to the extent to which he renders assistance to The Institute.

As a means towards better attendance at meetings Mr. Porter suggested:

(1) Organized discussion;
(2) Obtaining the interest and support of the younger members;
(3) The use of films on subjects of general interest, these being available from government departments, corporations and industrial organizations;
(4) Occasional addresses on subjects of general or popular interest, rather than purely technical or engineering subjects;
(5) Mixed gatherings, including a Ladies Night;
(6) An Attendance Committee.

In concluding his remarks in this connection Mr. Porter stressed particularly the necessity for the Branch keeping up its contact with the individual membership.

Sault Ste. Marie Branch

A. A. Rose, A.M.E.I.C., Secretary-Treasurer.

The regular monthly meeting of the Sault Ste. Marie Branch was held in the Windsor hotel following the regular dinner.

The speaker of the evening, Mr. C. F. Layne, was introduced by the Chairman, A. H. Russell, A.M.E.I.C.

Deep Well Pumps and Well Drilling

Mr. Layne had taken as his subject, "Deep Well Pumps and Well Drilling."

In his introductory remarks, Mr. Layne said that while wells were known from very early times as shown by Biblical history, many improvements in drilling have recently been made.

He described his own method of drilling as follows: First, test holes are sunk to determine the nature of the formation before selecting a location. Second, a large casing is sunk to the water bearing formation. Third, a second casing with a screen on the end is set inside the first casing so that the screen is in the water bearing formation and it is there surrounded with gravel to above the level of that formation.

Next by pumping out the inner casing the sand is gradually taken out and the gravel sinks down in its place. The gravel may extend back from the screen as far as fifteen feet, forming a good filter for the water.

The pump is a vertical centrifugal type, the shaft being enclosed in tubing with bronze bearings every five feet. It discharges underground to the main to prevent freezing. The pumphouse contains the electric equipment and the vertical hollow shaft motor. The capacity varies from 20 to 5,000 gallons per minute. With the exception of the motor, the entire pump is made in Sault Ste. Marie by the Northern Foundry and Machine Company.

The discussion which followed brought out many interesting points on the subject.

On motion of Messrs. J. H. Jenkinson, A.M.E.I.C., and H. F. Bennett, A.M.E.I.C., a very hearty vote of thanks was tendered Mr. Layne for his interesting talk.

W. S. Wilson, A.M.E.I.C., showed a number of slides obtained from the Department of Interior, National Development Bureau, illustrating "The New Commercial Canada." Mr. Wilson reported that the November meeting would be addressed by Mr. L. Hollingsworth, on the subject, "Lumbering in Canada."

Toronto Branch

W. S. Wilson, A.M.E.I.C., Secretary-Treasurer.

Astronomical Telescopes

Some eighty odd members of the Toronto Branch of The Institute listened with much interest to Professor C. A. Chant, M.A., PhD., who described the general construction and use of astronomical telescopes, and Professor R. K. Young, B.A., Ph.D., who described the construction of a new telescope for the University of Toronto.

"The general use of a telescope is to enlarge the image of distant objects so that they may be carefully studied and photographed," stated Dr. Chant, who described further the types of telescopes in the world today. Two general types are used, first, the type which employs large lenses to obtain suitable images, and second, the type that uses large curved mirrors to reflect the light to the desired images.

It is necessary to build telescopes of large diameter to allow sufficient light to be collected to form the image; yet, they are limited in size because, if too large, strains in the lenses or mirrors may cause errors in images. In Mount Wilson observatory there exists a telescope with a mirror 100 inches in diameter, the largest in the world. One at Victoria, B.C., is 72 inches in diameter and has produced excellent results. The new telescope now being built for Toronto will be 74 inches in diameter and of the mirror type. It is being constructed by Sir Howard Grubb, Parsons and Company, at Newcastle-on-Tyne, England, and is about half completed. It will be finished in 1933. It is being provided by Mrs. David A. Dunlop as a memorial to her late husband, and will be presented to the University of Toronto. It will be the second largest in the world.

Professor Chant then explained some slides taken from photos of celestial bodies. One remarkable photograph of a nebula clearly indicated the wonderful results obtained by astronomers with some modern large instruments. "This nebula," stated Professor Chant, "is probably 900,000 light years away." When the speed of light is estimated to be about 186,000 miles per second, or 11,160,000 miles per minute, the distance is difficult for most of us to comprehend. It is roughly estimated that this nebula rotates about once in 160,000 years. It is probably an aggregation of stars much like our Milky Way.

Another interesting slide was that of a globular star cluster. Of such, some 86 star clusters have been discovered and there are as many as 50,000 stars in some of the clusters.

The chairman then called on Dr. Young to tell the meeting about the new telescope. Dr. Young has used the Lick refractor and the Victoria reflector which are two of the world's finest telescopes and he went to England to assist in designing the new one.

"There are two main difficulties in designing and building a telescope," stated Dr. Young, "one being the minute accuracy of the parts involved and the other the enormous weight which has to be moved so slowly, once in twenty-four hours." He explained the equatorial mounting of the telescope which allows the instrument to be pointed in any direction and to follow the motion of the stars—due to the earth's rotation.

The clock drive is made with extraordinary precision and tolerances rarely exceed 1/20,000 inch; even with this accuracy errors are compensated for in fitting parts. When the slowness of rotation is considered and the weight involved, in this case about fifty tons, it can readily be seen that there must be no drag or loss, because clockwork would have to overcome inertia. Some telescopes were floated on mercury to obtain a smooth bearing but the accuracy of ball bearings now make it possible to dispense with this.

The speaker then showed several interesting slides showing and explaining the process of manufacture of the 74-inch telescope. He stated that even the fixture holding the mirrors for grinding must be especially constructed in order that the process of grinding and testing can be done together.

In the discussion which followed, one question caused considerable interest. Dr. Young had explained that the large steel dome which housed the telescope was so constructed that it could be moved to allow the aperture to be always over the telescope. The question was asked: Would not vibration be caused by this movement? The speaker explained that the walls of the observatory are on a separate foundation to the telescope and that vibration is not transmitted.

A. H. Harkness, M.E.I.C., moved a fitting vote of thanks, which was conveyed by the chairman to the speaker and heartily endorsed by all present.

C. S. L. Hertzberg, M.E.I.C., occupied the chair and thanked the members for their increasing attendance at the meetings. "Your executive have chosen subjects of general important interest to all technical divisions and it is a source of gratification to find an increasing interest."

Vancouver Branch

W. O. Scott, Jr.E.I.C., Secretary-Treasurer.

Students' Section

E. J. Merrett, S.E.I.C., Secretary.

October 7th, 1931

The first meeting of the year was held on October 7th., A. S. Gentles, M.E.I.C., vice-president, and E. A. Wheatley, A.M.E.I.C., registrar of the Association of Professional Engineers of British Columbia, respectively addressed the members and many Applied Science men. A very clear description was given of the work of the Association of Professional Engineers in British Columbia. The speakers were most emphatic in urging co-operation between the Association and The Engineering Institute.

October 14th, 1931—History of Town Planning in Vancouver

Mr. J. Alexander Walker, of the Town Planning Commission, gave a talk on the "History of Town Planning in Vancouver." He traced the history of the City from the date it was founded in 1792 to when it was incorporated on May 26th, 1886.

Mr. Walker outlined the city's growth and estimated a population of 500,000 in 1940 and 1,000,000 in 1950. To cope with increasing population existing streets will have to be widened and new thoroughfares made. There are 225 miles of major streets in Vancouver of which 101 miles will require widening and 19 miles of new connections are projected.

The commission has plans for filling in of False Creek, leaving a 600-foot water-way and turning basin, and reclaiming many acres of what will be valuable property as the city continues to grow.

October 21st, 1931—The Science of Geology

Outlining the science of geology in various divisions, and the part it plays in modern engineering, Dr. J. A. Walker, of the Geological Survey of Canada, delivered an address before the Applied Science E.I.C. members on Wednesday, October 21st, 1931.

Reviewing briefly the various theories that had existed regarding the origin of the earth and the planets, the speaker said that the one which is accepted by the majority of modern scientists is the solar theory. He explained that according to this theory the planets were originally part of the sun and had been separated from the latter by the impact of another heavenly body.

He went on to deal with the crust and interior of the earth. "The geologist's work covers only the thin outer shell of the earth," he pointed out. He continued that the interior of the earth had physical properties like those of a fluid, but that its exact properties are unknown. He revealed that if an earthquake shock is recorded more than 1,000 kilometers from its origin, two shocks are recorded, one travelling directly through the earth, the other over the surface.

He then spoke of the history of the earth's formation, showing how the gradual cooling of the earth caused its crust to buckle and thus form mountains.

Proceeding to a discussion of geology as a science, the speaker referred to its two main divisions, Palaeontology, concerned with the study of fossils, and general Geology, which includes the study of the structure of rocks. "By studying the structure of the surface rocks, a geologist can determine the exact nature of their formation in a given area."

In conclusion, he expressed the belief that in the future the young geologist would be used more than ever. "The old time prospector has done all he can in some districts," he said, "but I believe that the vicinities of the old mining camps are still rich in hidden ore and with the aid of the geologist this buried wealth can be uncovered."

Preliminary Notice

of Applications for Admission and for Transfer

November 20th, 1931

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, 1932.

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—HAROLD CECIL TRAYNER, of 3126 Maplewood Ave., Montreal, Que., Born at Penang, Straits Settlements, July 6th, 1901; B.A., 1925, M.A., 1928, (Mechanical Sciences), Cambridge University; 1925 to 1927, pupil to W. T. Halcrow, M.Inst.C.E., of Messrs. C. S. Meik & Halcrow, London, England; 1927-29, asst. to the res. engr. on constrn. of Lochaber Water Power, Fort William, Scotland (approx. value of work $15,000,000); 1929-31, on designing staff of Power Corporation of Canada Ltd., Montreal, Que. (Stud.Inst.C.E., 1927. Assoc. Member Inst.C.E., 1931.)

References: H. S. Grove, V. R. Davies, J. F. Roberts, J. H. Trimingham, G. E. Booker.

ERIKSEN—GUDMUND, of Port Arthur, Ont., Born at Haugesund, Norway, Mar. 10th, 1899; Educ., Diploma, Oslo (Kristiana) Technical College. Day course, 1922-25; 1925-26, inspr. in charge of bldg. constrn., J. T. Munch, engr., Oslo, Norway; 1926-30, with C. D. Howe & Co., Port Arthur, Ont.; at present, city engr.'s dept., Port Arthur, Ont. Work since 1926 has included design without assistance, except general instruction, Grand Trunk Pacific Welfare Bldg., Fort William, (reinforced concrete steel and wood); Canadian Govt. Elevator Office Bldg., Port Arthur, (reinforced concrete steel and brick); structural designing and supervising, Port Arthur Technical School, (reinforced concrete and brick); layout design and supervision, addition to St. Joseph's Hospital, Port Arthur, (reinforced concrete and brick); elevator work-design steel and concrete, and check mfrs. drawing; new city plan of Port Arthur; small addition to waterworks pumping station.

References: J. Antonisen, W. H. Souba, R. B. Chandler, F. C. Graham, J. M. Fleming.

LABERGE—CHARLES RENE, of Quebec, Que., Born at Montreal, Oct. 4th, 1906; Educ., B.A.Sc., Ecole Polytechnique, Montreal, 1931; 1926-30, summer work with St. Regis Pulp & Paper Co., Port Alfred Pulp & Paper Co., and Montreal Branch, Public Works of Canada; May 1931 to date, designing engr., Dept. of Public Works, Province of Quebec, Quebec, Que.

References: A. Larivière, A. Frigon, O. Desjardins, J. G. O'Donnell, A. B. Normandin, I. E. Vallee.

LEFEBVRE—PAUL, of 97 Grande Allee, Quebec, Que., Born at St. Hyacinthe, Que., Feb. 21st, 1904; Educ., B.A.Sc., Ecole Polytechnique, Montreal, 1930; 1926-30 (summers), field work, Topog'l. Survey of Canada; 1930 to date, engr., Prov. Fire Commnr.'s Office, Dept. Public Works, Prov. of Quebec, Quebec, Que.

References: A. Frigon, E. S. T. Lavigne, A. B. Normandin, I. E. Vallee, A. Duperron.

LYNCH—JOHN FRANKLIN, of 201 Northumberland St., Fredericton, N.B., Born at Fredericton, N.B., Sept. 25th, 1906; Educ., B.Sc. (Elec.), Univ. of N.B., 1929; 1928 (May-Sept.), student helper, Can. Gen. Elec. Co., Peterborough, Ont.; 1929-31, telephone engr. (dial), Northern Electric Company, Ltd., Montreal, Que.

References: J. Clancy, W. N. McGuinness, W. H. Jarand, H. Miller, B. B. Shier.

MARCOTTE—PACIFIQUE, of 81 Manrese Ave., Quebec, Que., Born at Ste Monique, Que., Nov. 21st, 1900; Educ., B.A.Sc., Ecole Polytechnique, Montreal, 1929; 1925-26 (summers), Quebec Streams Commission; 1927-28 (summers), Topog'l. Survey of Canada; 1929-30, dftsman., Dominion Bridge Company, Montreal; 1930 to date, designing engr., highway bridges, Dept. Public Works, Prov. of Quebec, Quebec, Que.

References: J. G. O'Donnell, O. Desjardins, A. B. Normandin, A. Larivière, I. E. Vallee.

MARTIN—LUCIEN, of 14 Fraser St., Quebec, Que., Born at Montreal, Oct. 8th, 1902; B.A., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1931; 1927-31 (summers), geology for Dept. of Mines, Quebec, Que.; Fall of 1931 to date, bridge design, Dept. Public Works, Prov. of Quebec, Quebec, Que.

References: I. E. Vallee, O. Desjardins, A. Lariviere, A Frigon, T. M. Dechene, A. B. Normandin.

REEVELY—FREDERICK RICHARD, of 1441 Drummond St., Montreal, Que., Born at Bolton, Ont., May 28th, 1903; B.A., (Hons. Chem., Minerol. and Geology), Univ. of Toronto, 1929; 2 years engrg. drawing course, Sir George Williams College, Montreal; 1928 (4 mos.), field party leader, on geol. survey for Old Colony Mines, Millertown, Nfld.; 1929 to date, development engineer, on mfg. methods, Northern Electric Co. Ltd., Montreal, Que.

References: W. H. Eastlake, S. R. McDougall, H. Miller, N. L. Morgan, E. Baty.

REYNOLDS—PHILIP, of 18 Castleview Ave., Toronto, Ont., Born at Swindon, Wilts., England, Jan. 29th, 1878; Educ., Swindon Technical School. Private tuition; 1895-1900, pupil, mech'l. engrg., Great Western Rly., England; 1901-03, marine engr., C.P.R., Vancouver; 1904-15, mech'l. dept., C.P.R.; 1915-16, Munitions Branch; 1916-20, supt., L. M. Lymburner Ltd.; 1921-23, chief dftsman., St. Lawrence Welding & Engrg. Co., Montreal; 1923 to date, chief engr., The Shell Oil Co. of Canada, Ltd., Toronto, Ont.

References: H. H. Vaughan, C. H. Scheman, E. P. Muntz, H. C. Karn, J. T. Farmer.

FOR TRANSFER FROM THE CLASS OF JUNIOR TO A HIGHER CLASS

BROWN—THOMAS ALAN, of 293 Holmwood Ave., Ottawa, Ont., Born at Stratford, Ont., March 10th, 1898; Educ., B.Sc., Queen's Univ., 1923; 1921-22 (summers), Geod. Survey of Canada; 1923-26, asst. engr., Hull Electric Rly. Co.; 1926-27, asst. engr., 1927 to date, mgr., Eastern Distribution District, Gatineau Power Company, Ottawa, Ont. (*Jr. 1925.*)

References: G. G. Gale, J. S. Parker, W. E. Blue, S. S. Scovil, W. P. Wilgar, W. L. Malcolm.

MEWS—JOHN COURTENAY, of Buchans, Nfld., Born at St. John's, Nfld., June 30th, 1896; Educ., Public School and home study; 1913, helper, 1913-15, transitman on survey party; 1915-16, Royal Navy; 1916-19, B.E.F. France; 1919-27, in charge of mine survey party and dfting office, N.S. Steel & Coal Co., Nfld.; 1927 to date, with Buchans Mining Co. Ltd., Buchans, Nfld., 1927-29, instr'man. and asst. to the chief engr. on constrn. of 500 ton mill, and from 1929 to date, in charge of surface and transportation dept., including operation of 30 mile branch rld., gen. plant constrn. and mtce., town constrn. and mtce. (*Jr. 1921.*)

References: J. B. Gilliatt, C. B. Archibald, J. B. Petrie, A. R. Chambers, F. W. Angel.

RAMSEY—KENNETH MACPHERSON, of Montreal, Que., Born at Quebec, Que., Sept. 2nd, 1898; Educ., B.Sc., McGill Univ., 1922; (2 years overseas); 1919-20-21 (summers), mach. shop and gen. mach. mtce., Citadel Brick Ltd., Quebec; 1922 (6 mos.), instr'man and dftsman., Hamel & Lariviere, Quebec; 1922-23, production engr., on St. Lawrence pulp and paper job, Thompson Starrett, contractors; 1923 to date, with Citadel Brick Ltd., as follows: 1923-24, constrn. supt. on plant extension and improvements. Made all plans and estimates. Capacity of plant doubled; 1925-26, asst. plant supt. and consltg. engr. to company; 1927, moved to Montreal in charge of new sales office, but retained as consltg. engr. to date. Checking and approval of all proposed improvements to plants. All important work directly supervised. Acted as consltg. engr. on several brick plant extensions and renovations in Ontario. (*S. 1921, Jr. 1926.*)

References: F. H. Pitcher, E. Brown, W. G. Mitchell, C. M. McKergow, L. H. D. Sutherland.

WEBB—HARRY RANDALL, of Edmonton, Alta., Born at Lucan, Ont., Jan. 13th, 1900; Educ., B.Sc. (Civil), 1921, M.Sc. (Civil), 1922, Univ. of Alta.; 1922-28, lecturer, and 1928 to date, asst. professor of civil engrg., University of Alberta. Summer work; 1919, rodman, drainage dept., Govt. of Prov. of Alta; 1919, dftsman., 1920, instr'man., irrigation branch, Dept. Interior, Calgary; 1921-22, rodman and instr'man., land surveys dept., C.N.R., Winnipeg; 1924-25, dftsman., American Bridge Co., Ambridge, Pa.; 1926, commercial testing, Univ. of Alta.; 1927, research on design and constrn. of experimental grain dryer for Scientific and Industrial Research Council of Alberta; 1928, associated with Prof. I. F. Morrison in study of materials and design and control of concrete for Ghost dam of Calgary Power Co.; 1929, instr'man. and field engr. for same company on water power reconnaissance; 1930-31, commercial testing. (*S 1919, Jr. 1927.*)

References: R. S. L. Wilson, H. J. MacLeod, R. W. Ross, A. I. Payne, R. J. Gibb, A. W. Haddow, E. Stansfield.

FOR TRANSFER FROM THE CLASS OF STUDENT TO A HIGHER CLASS

BURPEE—LAWRENCE HANINGTON, of Beauharnois, Que., Born at Ottawa, Ont., Dec. 10th, 1902; Educ., Grad., Royal Naval Coll. of Canada, 1921; B.A.Sc., Univ. of Toronto, 1925; Summer work: 1921, rodman, Chippawa-Queenston Power Canal; 1922, dftsman., Dominion Topog'l. Surveys; 1923, rodman, St. Maurice Power Co., La Gabelle, Que.; 1924, operation and mtce, St. Lawrence River Power Co.; 1925-27, engrg. ap'tice, H.E.P.C. of Ontario; 1927-29, designer, Gatineau Power Company; 1929 to date designer, Beauharnois Construction Company, Beauharnois, Que. (*S.1924.*)

References: T. H. Hogg, F. H. Cothran, M. V. Sauer, J. A. Knight, G. G. Gale, W. E. Blue, C. R. Young, R. E. Heartz.

CHENEY—WAYNE PUTNAM, of Kerrobert, Sask., Born at Lyleton, Man., Oct. 14th, 1904; Educ., B.Sc. (E.E.), Univ. of Man., 1928; 1927-29, rodman, Manitoba Good Roads Board; 1928, instr'man., i/c party, 1928-29, asst. to res. engr. i/c of party on constrn., Manitoba Good Roads Board; 1929-30, junior engr., distribution dept., City of Winnipeg Hydro Electric System; May 1930 to date, asst. eng. on highway constrn., Sask. Dept. of Highways, Kerrobert, Sask. (*S. 1926.*)

References: J. C. Irving, H. R. MacKenzie, W. W. Perrie, E. China.

GORDON—ARTHUR I. E., of 531 W. 10th Ave., Vancouver, B.C., Born at Ferguson, B.C., April 13th, 1904; Educ., B.A.Sc. (Civil), Univ. of B.C., 1927; 1921-22-23, (total of 10 mos.), rodman and sounder, and 1924-25 (total of 10 mos.), current observer, Hydrographic Survey of Canada; 1926 (5 mos.), and 1927 (5 mos.), instr'man on precise levelling, Geod. Survey of Canada; 1927 (2 mos.), surveys asst., Greater Vancouver Water District; 1928 (1 mo.), mine sampler, Britannia Mining & Smelting Co.; 1928 (5 mos.), transitman, rly. mtce., C.P.R., Vancouver; 1928 (5 mos.), location and constrn. of 18 mile power ditch for Yukon Cons. Gold Corpn., Dawson, Y.T.; 1929 (2 mos.), shop timekpr., Dominion Bridge Company, Vancouver; April 1929 to date, asst. engr., Vancouver and Districts Joint Sewerage and Drainage Board, Vancouver, B.C. (*S. 1927.*)

References: J. M. Begg, T. E. Price, W. H. Powell, E. A. Cleveland, J. R. Grant.

LEBLANC—JULES, of 3817 St. Hubert St., Montreal, Que., Born at Sherbrooke, Que., Dec. 4th, 1903; Educ., B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1928. B.Sc. (Elec.), Mass. Inst. Tech., 1929; 1928 (summer), surveying, asst. to city engr., Sherbrooke; 1930 (Jan.-Sept.), valuations, estimates and design of elect'l. distribution, etc., Arthur Surveyer & Co., Montreal; 1930 to date, with B.B. Electric Co. Ltd., Montreal, design of electric system (power lighting and communication), for the new University of Montreal bldgs., design of switchboards and transformer rooms. (*S. 1928.*)

References: A. Frigon, A. Surveyer, E. Nenniger, H. Massue, A. Cousineau, A. Duperron, T. J. Lafreniere.

Caustic Embrittlement of Steel

Some Waters Weaken Boiler Plate

Greater size, higher pressure, more elevated temperatures for steam boilers demand greater precaution and more knowledge of materials and of operating conditions.

Within recent years a phenomenon of somewhat frequent occurrence has been distinguished from other kinds of cracking of steel plates in boilers. It was termed "embrittlement" because the fracture resembled that of brittle metal, although it is now known that the steel does not truly become brittle. The cracks are formed between the crystals of the steel and not across the crystals as are always cracks due to stresses of various kinds and to "fatigue" so-called.

An investigation begun in 1895 by the University of Illinois defined an area nearby within which the water from tube wells used in many boilers was of unusual mineral composition. Almost no sulphates were present. The water underwent unexpected chemical changes in the process of steam making, producing caustic soda. Carbon dioxide was separated and removed with the steam. As the explanation of this was not disclosed the investigation ceased with filing of the notebooks in 1900.

In 1912, boiler distresses at the University began to develop in a serious manner and revived the question whether the method of construction, the material, or chemical action was at fault. The fact was brought to the surface again that the particular water used would become caustic in the boiler, and, since similar distresses were known to develop where strong caustic solutions were handled in chemical industries, there was sufficient evidence to call for investigation along chemical lines.

Coincident with these studies, boilers installed in 1911 began to show signs of weakness and by 1915 were so badly cracked as to require replacement. Neighbouring regions in Illinois were being discovered where this kind of water was used. Within these zones, up to 1912, there had occurred four boiler explosions and thirteen replacements of drums, due to cracking. There was presumptive evidence, at least, that the cause lay in the caustic condition attained by the water under steaming conditions.

On this theory, to protect new boilers at the University, there was added to the water, before admission to the boiler, sufficient magnesium sulphate to neutralize three-fourths of the causticity. This treatment was shortly altered to the addition of crude sulphuric acid in amount sufficient to neutralize all but twenty-five per cent of the sodium alkalinity.

In connection with new studies begun in 1925, a method was developed for producing this cracking phenomenon at will, making it possible to investigate all conditions, such as kind and concentration of solutions, inhibitive agents, effect of stresses on test pieces, and kind of steel that might be used in boilers. Approximately five hundred tests were made. It was shown that the original treatment was a fortunate guess. The boilers where that regime was adopted were, after twelve years, in perfect condition. In all the field studies no boiler distress was met where this ratio of sulphate to carbonate was maintained. Conversely, all cracking has been accompanied by an excessive ratio of caustic to sulphate.

Guided by the data thus assembled, the Boiler Code committee of The American Society of Mechanical Engineers adopted the requirement that this ratio of three parts of sulphate to one of alkalinity, be maintained in practice.

Fortunately, the signs of caustic embrittlement are in evidence before a dangerous weakness develops, so that actual explosion from this cause is the exception.

The cracks develop as a result of two factors, strain and concentration of the caustic solution, not under either condition alone.

The quantity of caustic required for cracking, equivalent to not less than 100 grams per litre of water, is easily accounted for by the natural concentration that occurs in capillary spaces between plates, connected at some point with the main volume of water in the boiler. The strains in the metal are readily accounted for by processes of construction and operation. The cracks occur in the riveted areas under lap joints and butt straps or similar parts where strain and capillary spaces occur.—*From Research Narratives of the Engineering Foundation.*

Fifty Years of Canada's Development

Canada is but a new country, and its engineering progress is measured only by decades. It cannot be said that its engineering dates back for a hundred years; rather, is it more nearly fifty or seventy-five. Canada's first people, coming originally from France three hundred years ago, and Great Britain a hundred and fifty years later, occupied only the regions around the Atlantic coast and Great Lakes. It was but seventy-five years ago that the expansion began, and it is not more than fifty or sixty years since the definite movement of population commenced to the prairie regions westward of the Great Lakes, and to the Pacific coast. The present widely-scattered districts of population and development are confined to a belt across the continent from the Atlantic to the Pacific, which may be said to be 3,500 miles long, varying in width roughly from 300 to 400 miles. Economically, however, the Dominion forms a much larger figure. Its developable area, now being disclosed as containing the most valuable of natural resources and largely capable of sustaining population, may be viewed as nearly three times this size. In other words, the belt can, and undoubtedly will in time, be expanded to a region from 800 miles to a 1,000 miles wide.

Canadian development activities were accelerated thirty years to fifty years ago, when they rapidly moved westward, and it was within that period that the marked growing time was most pronounced. In the decade before the war, the westward growth was continuing, but rather in the nature of consolidation than in wider expansion.

To-day, Canada's development is, by contrast, definitely moving northward. The new north of Canada is now beginning to be realized, for, within the past few years, especially since the war, there has been a distinct northward movement of population and development as the more adventurous and enterprising of the Canadians have reached out to these new regions further afield.

It is easily understood that such a young country as Canada should have had a very active life during this growing period of the past fifty years. The history of its material development where engineering was required, does not date much further back than seventy-five years. That early period was the age of road building and of rail and water communication, when steam application was in its infancy, and when most of the manufactured articles of use were imported from the United States or Great Britain. The country then was necessarily agricultural, with such industry as was required to supply domestic wants, and with export trade only in lumber.—Brig.-General C. H. Mitchell, CB., C.M.G., D.S.O., D.Eng., M.E.I.C., in *Engineering.*

EMPLOYMENT SERVICE BUREAU

This Service is operated for the benefit of members of the Engineering Profession and 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

All notices intended for publication must be received not later than the Tuesday of the week preceding the date of the issue in which they are to be inserted.

Situations Wanted

ELECTRICAL ENGINEER, graduate 1924, experienced home and foreign in electrical design and construction, surveys, reports, etc., capable of taking charge of same, desires any opening in engineering work. Age 32, married. Location immaterial, including foreign countries. Apply to Box No. 7-W.

ELECTRICAL AND RADIO ENGINEER, B.Sc. '28. Experience in the design and testing of broadcast radio receivers, including latest superheterodyne practice, and capable of constructing apparatus for testing same. Also familiar with telephone and telephone repeater engineering. Thorough experience in design, construction and inspection of municipal conduits. Apply to Box No. 12-W.

ELECTRICAL ENGINEER, graduate '25. G.E. test; switchgear engrg. dept., relay engineer, public utility. First-class record. R.P.E., B.C. Apply to Box No. 68-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.

MECHANICAL ENGINEER, B.Sc. McGill 1919, A.M.E.I.C., married. Eleven years experience, including structural, reinforced concrete, piping and high pressure boiler and furnace design, heating and ventilating, hydraulic and boiler plant operating problems. Apply to Box No. 265-W.

CIVIL ENGINEER, B.Sc. and C.E., age 26. Thirty months engineering experience, including testing laboratory work, instrument and inspection work on hydro power plant construction, location and field engineering on transmission line job, plane table contour work, triangulation and ground control for aerial photography. Applicant now open for employment, preferably on construction work with a reliable company in North America. Apply to Box No. 431-W.

CIVIL ENGINEER, B.A.Sc., C.E., A.M.E.I.C., age 29, married. Experience over nine years includes railway location and construction as resident engineer. Hydro-electric report on estimates and investigation, also design, construction and teaching on hydraulic structures, bridge foundations and caissons. Location immaterial. Apply to Box No. 447-W.

DESIGNING ENGINEER, A.M.E.I.C., P.E.Q., with extensive experience in design and construction of power plants, industrial buildings and hydraulic structures, desires position as designing engineer or resident engineer on construction. Apply to Box No. 492-W.

MECHANICAL ENGINEER, B.Sc., Jr.E.I.C., '26. Ten months experience in pulp and paper steam control. Four years experience in detail and design, in pulp and paper mill, industrial plant and hydro-electric development work. Age 27. Married. Location immaterial. Apply to Box No. 521-W.

Situations Wanted

ELECTRICAL ENGINEER, married, graduate of McGill University, desires position in Ottawa, Montreal or Toronto. Experience includes four summers with a building concern as instrumentman and assistant engineer, two and one-half years with the Canadian Westinghouse Co., this time being distributed between tests, design and sales. At present employed but available on short notice. Apply to Box No. 533-W.

ELECTRICAL ENGINEER, A.M.E.I.C., university graduate 1924. Experience includes one year test course and five years on design of induction motors with large manufacturer of electrical apparatus. Four summers as instrumentman on highway construction. Several years experience in accounting previous to attending university. Available at reasonable notice. Apply to Box No. 564-W.

CIVIL ENGINEER, B.Sc., McGill University, Jr.E.I.C. Five years experience along the lines of general construction, including structural steel. Available at once. Apply to Box No. 570-W.

MECHANICAL ENGINEER, A.M.E.I.C., with twenty years experience in mechanical and structural design, familiar with shop practices and costs, desires connection. Apply to Box No. 571-W.

YOUNG ENGINEER, Jr.E.I.C., experienced in design, details and erection of steel and concrete structures. Also a good theoretical and practical knowledge of steam, hydraulic and I.C. engine power plant. Good practical mechanical and electrical engineer, able to operate and maintain any type of machinery or power plant. Location immaterial. Apply to Box No. 572-W.

CIVIL ENGINEER, B.A.Sc. Toronto '28. Experience, hydro-electric, building design, bridges and culverts, inspection and testing of materials. Married. Present location Montreal. Apply to Box No. 576-W.

MECHANICAL ENGINEER, S.E.I.C., B.A.Sc. (Univ. of B.C., '30), Undergraduate experience in pulp mill. One year's experience, Canadian General Electric Co., mech. dept. Single. Age 24. Desires position in technical design or sales. Location immaterial. Available on short notice. Apply to Box No. 577-W.

MECHANICAL ENGINEER, S.E.I.C., age 21, four years mechanical engineering, Queen's University, desires permanent employment. Experience in wood work, machine shop work, draughting and surveying. Location immaterial. Available at once. Apply to Box No. 600-W.

MECHANICAL ENGINEER, Canadian, technically trained; eighteen years experience as foreman, superintendent and engineer in manufacturing, repair work of all kinds, maintenance and special machinery building, desires change. Location immaterial. Available on one month's notice. Apply to Box No. 601-W.

Situations Wanted

MECHANICAL ENGINEER, Jr.E.I.C., five years apprenticeship on general mechanical engineering; 10 years experience on heating and ventilating and mechanical equipment of buildings. Design, draughting and production. Desires change. Capable of taking charge of engineering department. Further particulars if required. Apply to Box No. 616-W.

POWER ENGINEER, M.E.I.C., age 42. Married. Thoroughly conversant with electrical, steam, mechanical and industrial engineering, desires executive position with large industrial, power or financial corporation. Best of references as to ability and positions held. Apply to Box No. 617-W.

CIVIL ENGINEER, Jr.E.I.C., B.A.Sc., '24, age 35, married. Five years designer and estimator with well-known firm of industrial builders; two years detailing, designing and estimating structural steel for bridges and buildings, also survey and municipal experience. Open for position immediately, will go anywhere. Apply to Box No. 618-W.

CIVIL ENGINEER, A.M.E.I.C., graduate '23, married, eight years municipal engineering experience. Sewerage and sewage disposal, water works, street pavement, etc. Also some experience highway construction. For the past three years engaged by firm of consulting municipal engineers. Desires permanent position. Location immaterial. Available immediately. References. Apply to Box No. 624-W.

CIVIL AND MECHANICAL ENGINEER, experienced in design, layout, installation and selling. Sixteen years association with largest Canadian industries manufacturing equipment particularly relating to pulp, paper and lumber and five years design and construction of sulphite mill, including electrolytic bleachmaking from salt. Apply to Box No. 633-W.

ELECTRICAL ENGINEER, B.Sc. '26, Jr.E.I.C. Age 31. Experience includes on year operation and maintenance work in hydro-electric power plant. Three years on power plant construction work, consisting mostly of relay, meter, and remote control wiring. One year out-door sub-station construction, as assistant engineer. Also geologival survey and highway construction experience. Desires position of any kind. Available at once. Apply to Box No. 636-W.

ELECTRICAL ENGINEER, B.Sc., N.S. Tech. Coll., '31. Experience includes geological survey work in Rouyn mining area and hydro-electric power plant construction, both civil and electrical work. Available at once. Apply to Box No. 639-W.

ELECTRICAL GRADUATE, McGill '30, S.E.I.C., with thirteen months experience on General Electric test course, twelve months draughting and five months as instrumentman on power plant construction. Location immaterial. Apply to Box No. 644-W.

CIVIL ENGINEER, A.M.E.I.C., R.P.E. (Ont.), extensive experience as executive and in charge of construction of complete water power developments, including transmission lines, harbour developments, including hydraulic, dredging and land reclamation, industrial plants and municipal works. Apply to Box No. 647-W.

OPERATING ENGINEER. Position wanted as operating superintendent or assistant. Age 43. Married. No children. Nineteen years experience operating hydro-electric plants, sub-stations, transmission lines. Available immediately at any reasonable salary and for any location. Apply to Box No. 654-W.

Situations Wanted

ELECTRICAL ENGINEER, Jr.E.I.C., 1926 grad. of English Tech. Coll. Past two years inspector of communication apparatus; three years varied power and sub-station experience, including automatic sub-stations, on comprehensive training scheme. Age 24, single. Location immaterial. Available at once. References. Apply to Box No. 658-W.

ELECTRICAL ENGINEER, B.Sc.E.E., 1931. N.S. Tech. Coll. Experience in armature winding and apparatus repairs, in conduit and cable work. Students' course in elevator manufacture, ship's electrician on tropical run. Good cultural education. Available at once, for Canada or tropics. Apply to Box No. 659-W.

ELECTRICAL ENGINEER, university graduate '28. Experience includes one year with operating department of a large public utility and two years with manufacturer of electrical equipment, work including design, test and correspondence. Available on short notice. Apply to Box No. 660-W.

MECHANICAL ENGINEER, age 26, university graduate. Experience in machine shop and foundry productions and cost control, and considerable experience with arc welding. Interested in sales engineering. First-class references. Available at once for any location. Apply to Box No. 664-W.

ELECTRICAL ENGINEER, B.Sc., S.E.I.C. Experience: Installation staff Can. Gen. Elect.; students test course with the same company, concrete inspection, transmission line surveying and inspection; also some railway construction experience. References. Desires position with electrical concern. Location immaterial. Available at once. Apply to Box No. 665-W.

RADIO ENGINEER, with thorough general experience covering short wave, marine, broadcast, wire communication, and sound picture work. Capable of taking responsibility in engineering, operating, manufacturing or executive fields. University graduate; single; age 27. Apply to Box No. 667-W.

MECHANICAL ENGINEER, desires position with manufacturing or other company offering opportunity in design and draughting. Thorough technical training and four years experience since graduation. Prefer western Canada, but location and salary of secondary importance. Age 29, unmarried, thoroughly reliable and capable of handling junior position of responsibility or taking charge of technical work for small concern. Apply to Box No. 669-W.

ELECTRICAL ENGINEER, B.Sc., McGill Univ. '23, Jr.E.I.C. Eight years experience as sales engineer in all classes of electrical machinery, also switching, mine hoists, steam and hydraulic turbine generator sets, street railway and railroad equipment. Good commercial experience. Highest references. Age 30. Single. Available immediately. Apply to Box No. 670-W.

CIVIL ENGINEER, graduate University of New Brunswick '31, in C.E. Experience consists of three seasons on a survey party. Available October 1st. Desires permanent position. Willing to go anywhere. Apply to Box No. 672-W.

MECHANICAL ENGINEER, A.M.E.I.C., Canadian, technically trained; six years drawing office experience, including general design and plant layout. Also two years general shop work, including machine, pattern and foundry experience, desires position with industrial firm in capacity of production engineer or estimator. Available on short notice. Apply to Box No. 676-W.

CIVIL ENGINEER, graduate, Jr.E.I.C., age 25, single. Experience includes mill construction, design and supervision. Also design of hydraulic structures, bridge foundation, rigid frames and caissons. Will go anywhere. Apply to to Box No. 677-W.

RADIO ENGINEER. Graduate McGill Applied Science '30. Experience includes the design, development and production of broadcast receivers, as well as general radio laboratory practice. Apply to Box No. 680-W.

ELECTRICAL ENGINEER, graduated 1914, desires position with engineering firm or electric utility. Experience in design and layout of power houses and sub-stations, including automatic and supervisory control equipment; design of switchboards and switching equipment; manufacturing, testing, erection and operating of electrical apparatus of all kinds. Anywhere in Canada. Permanent position preferred. Apply to Box No. 681-W.

OPERATING ENGINEER, A.M.E.I.C. Operating superintendent or assistant. Age 44, married. Twenty years experience in industrial manufacturing, steel mills, power plants and quarrying operations, both large and small. Very successful with labour problems, cost accounting, etc. Will take any position with view to betterment. Available immediately in any location. Apply to Box No. 682-W.

ELECTRICAL ENGINEER, B.Sc.E.E., University of Man. 1921, A.M.E.I.C., married. Two years Westinghouse test course, three years sales engineer, five years draughting and electrical design on hydro plants, transmission lines, etc. Apply to Box No. 687-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 on short notice. Apply to Box No. 692-W.

ELECTRICAL ENGINEER, S.E.I.C., B.A.Sc. '31. Age 21. Three months undergraduate experience in electric railway substation. Five and a half months Canadian General Electric test course on induction motors and industrial control apparatus. Available on short notice. Location immaterial. Apply to Box No. 700-W.

AERONAUTICAL ENGINEER, M.Sc. Mass. Inst. of Tech., B.Sc. Mech. Eng. Queen's Univ. '30. Capable of aircraft design work and stress analysis. Experience also in machine design, etc. Canadian, single, available immediately for position anywhere. Apply to Box No. 702-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. At present in Montreal. Apply to Box No. 703-W.

MECHANICAL ENGINEER, Jr.E.I.C. Graduate Inst. Mech. Engrs. Age 25. Nine years practical experience, design and construction, air compressors, Diesel engines, elevating, transporting, stone and woodworking machinery. Three years at pulp and paper mill, design and construction of paper and board machinery, reinforced concrete construction. Available at once. Apply to Box No. 704-W.

ELECTRICAL ENGINEER, B.A.Sc., graduate '28. Test experience D.C. motor and generator design, and industrial electric heating design experience. Single. Location immaterial. Apply to Box No. 709-W.

Stoker Manufacturers Association, Detroit, Mich., have recently published a new forty-page catalogue, illustrating and describing forty-eight different types of mechanical stokers manufactured by the fourteen member companies of the Association. The various stokers are grouped into the following classifications: multiple retort underfeed stokers, single retort underfeed stokers, chain grate stokers and overfeed stokers. The text is limited to engineering descriptions of the various types of machines, and a supplementary section on engineering data relating to modern stoker practice is included. Copies will be sent upon request to W. V. McAllister, Secretary of the Association, Foot of Walker street, Detroit, Mich.

Kingsbury Machine Works, Inc., Philadelphia, Pa., have published Bulletin HV, combining in one 39-page booklet descriptions and illustrations of vertical and horizontal thrust bearings, whose parts are to a large extent interchangeable. Only standard self-aligning, equalizing thrust bearings are covered. Capacities, weights, and principal dimensions are given for the usual forms of these bearings. This bulletin supercedes the company's previous Bulletins D, F and parts of G. Copies may be secured from the company at 4324 Tackawanna street, Frankford, Philadelphia, Pa.

Combustion Engineering Corporation, New York, has recently placed on the market the C-E Electric Stoker Drive. This drive is now available as standard equipment for both the Type E and Type K stokers and is applicable wherever the steam pressure is insufficient for the standard steam drive or where other conditions favour the use of an electric drive.