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Paper to be presented before the General Professional Meeting of the Engineering Institute of Canada, at Hamilton, Ont., on February 7th, 1941.

At the outbreak of war it was natural for engineers to realize that the chemical industries of the country would be greatly expanded but the large expansion which we have seen take place in the last year has been largely dependent on the work of the civil, mechanical and electrical engineers. Large development has taken place in the mechanical and electrical engineering field to provide the necessary plant equipment for war industries.

Up to 18 months ago, all mercury-arc rectifier equipment was imported from Europe or United States, the larger portion being from central Europe. With this source of supply eliminated, the chemical industries looked for their supply of rectifier equipment, which is a necessary adjunct to a number of electro-chemical processes, to the Canadian manufacturer and at the present time there is sufficient capacity in Canada to produce 40,000 kw. of rectifiers a month if the demand requires it.

The mercury-arc rectifier of today is a far cry from the equipment used in 1882 to prove that an arc between carbon and mercury electrodes would only pass currents in the direction from the carbon to the mercury, or from the Cooper-Hewitt rectifier of the late 90's with its large glass bulb, its temperamental starting equipment, and the blue glow which became familiar in the garages as the electric landau achieved popularity. The glass bulb type rectifier has been developed principally in England up to ratings of 500 amperes at 500 volts and is now a very satisfactory piece of equipment up to such ratings.

In 1908, Peter Cooper-Hewitt suggested the enclosure of the mercury-arc rectifier in a metal shell in order that it could have more mechanical strength to withstand the shocks of handling, and to withstand the physical forces in case the rectifier should fail in its valve action or "arc-back."

The first commercial metalclad rectifiers were built in 1910 by Westinghouse and followed the general shape and construction of the glass bulb rectifier in that the electrodes were placed in side arms and there was a large condensing dome in the centre. About the same time in Europe, a design was brought out by the Brown Boveri Company, which might be called the first commercial tank rectifier, in which the tank contained the electrodes and no arms projected from the tank. The rectifier thus took the form with which we are now familiar, in the multi-anode tank. Water cooling was adopted by 1913 and soon rectifiers capable of handling 700 amperes at 2,400 volts were produced. By 1918 the ratings had been pushed to 6,000 amperes per tank.

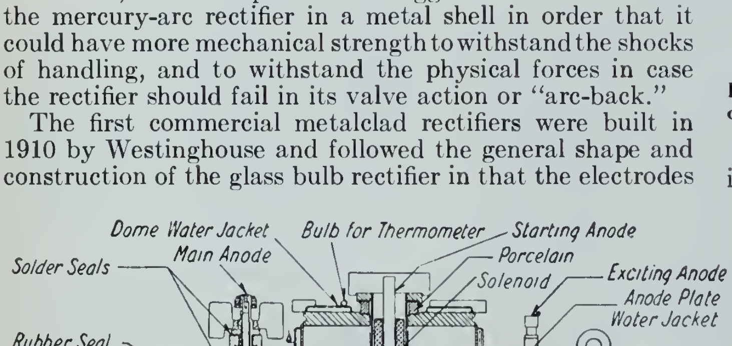

Fig. 1—Cross section of mercury arc rectifier.

Theory

The process of rectification by means of a mercury-arc in vacuum depends on the fact that mercury under certain conditions is a prolific source of electrons, while carbon is an extremely small source of electrons. The mercury pool in the bottom of the rectifier tank proper is known as the cathode and the various carbon electrodes are known as the anodes. The mercury will not emit electrons until a cathode spot has been formed on the surface. This was done in the old Cooper-Hewitt rectifiers by tilting the bulb and drawing an arc from an auxiliary electrode which caused what we call a cathode spot or a source of intense ionization from which electrons are freely emitted under the influence of an electric field. If the anode is made positive at the time when there is a cathode spot on the surface of the mercury, electrons are drawn across to the anode, ionizing the mercury vapour present in the tube and providing a path for the passage of current. In the multi-anode tank or conventional rectifier, there is usually an auxiliary anode or anodes arranged so that there is always one positive anode. It is a property of mercury-carbon arcs that once established they will continue as long as there is a flow of current in the proper direction; that once an arc is started from the cathode to an anode, it is necessary either for the anode to go negative or the voltage to be removed by some external means in order to prevent current flow. In the multi-anode rectifier, the various anodes are so connected to a transformer so that one or more is always positive and the positive anode is the collector of the electrons.

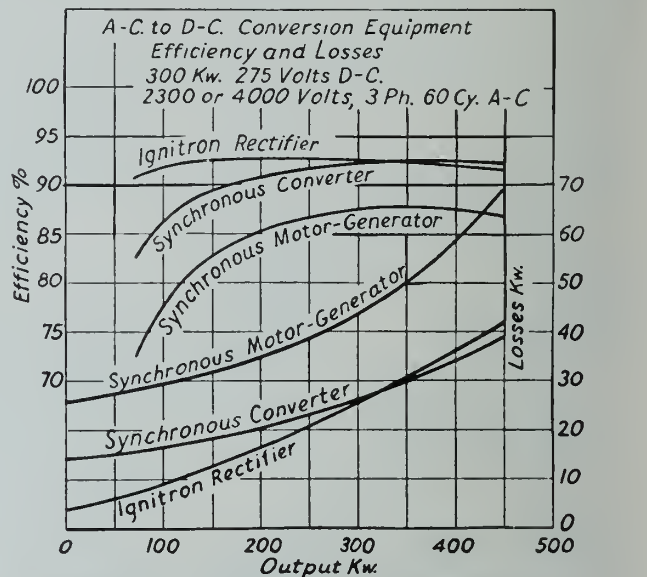

Fig. 2—Typical efficiency curves of the different a-c to d-c conversion units. The curves are for units rated 300 kw., 275 volts.

The process of rectification consists then of allowing the positive half cycles of an alternating current voltage to cause current flow from the anode to the cathode and from the cathode in turn through the external circuit back to the transformer. If the transformer connection is arranged so that it is the centre of a number of centre-tapped transformer windings arranged in various phase positions, the flow of direct current is continuous but not uniform. For instance, if only two anodes are used which are alternately positive, the flow of current is in a series of surges and may actually drop to zero under certain circumstances at the time of transition. If, however, the anodes are connected to a three-phase system, there is a slight overlapping and the current does not go to zero. By increasing the number of phases, the amount of ripples present can be reduced almost to zero. There are now commercial installations in Canada operating on the 36 phase system, and equipment in progress is being built for use on a 60 phase system. This 60 phase system will have less than 1/6 of one per cent ripple which is considerably smoother than that obtained from a commutator type of machine.

It can be readily seen that as the ratings of these multi-anode rectifiers increased, it was necessary to provide larger

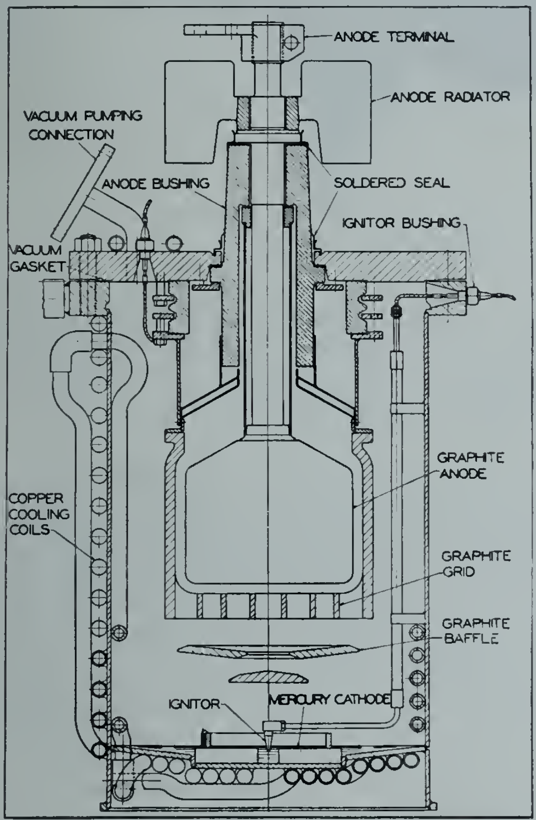

Fig. 3—Cross section of one of the larger ignitrons.

tanks in which to contain the increased number and also the physically larger anodes to carry the larger current. This, in turn, meant that the anode circle was larger and the distance from the anode to the cathode had increased. As the voltage lost in the arc is somewhat proportional to the length, it can be seen that the larger machines were relatively less efficient than the small ones. This is contrary to usual electrical practice and although engineers studied the problem, it seemed as if the arc loss was going to steady down at 28 to 30 volts for the average large size rectifier.

About once in a few million times, one anode would suddenly lose its valve action and become a conductor in the reverse direction. This phenomenon was known as "arc-back" and was accepted in the early rectifiers as part of the trouble with which one had to put up. The demand from operators for more continuous and better service caused manufacturers to seek means of eliminating or reducing the arc-back frequency, various expedients in the form of tortuous paths, stovepipe-like shields and grids were inserted in front of the anode to help de-ionize the path of the arc immediately after conduction should cease. These in turn brought the penalty of higher-arc-drop with resultant lower efficiency.

In 1933, Dr. J. Slepian announced a new method of forming a cathode spot on the mercury pool, which made

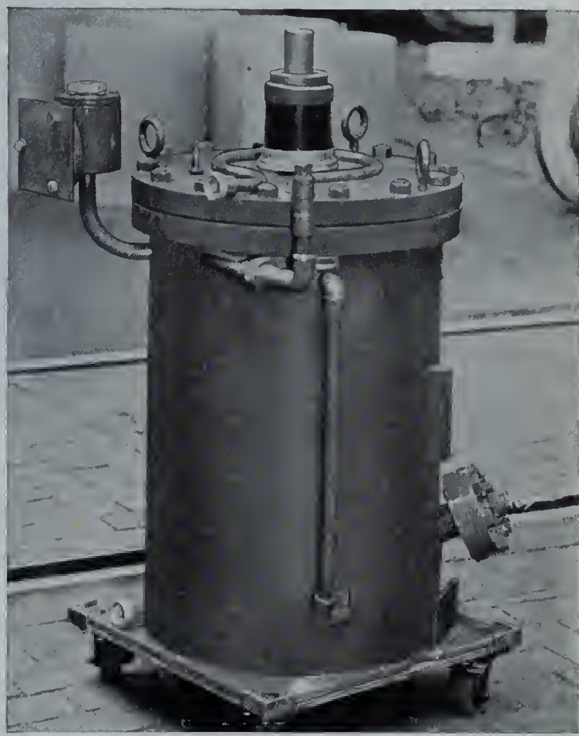

Fig. 4—Shop assembly of ignitron tank ready for mounting in frame.

it practical to put each anode in a single tank with its own cathode, strike the arc when required for conduction and allow the arc to go out naturally during the period when conduction was not required.[1] This allowed the anode to be placed much closer to the mercury pool and the shielding considerably simplified. This invention became known as the ignitron because it was ignited. Dr. Slepian found that by immersing a crystal of carborundum or other such material in the mercury and passing a fairly large current, but of very short duration, through this crystal to the

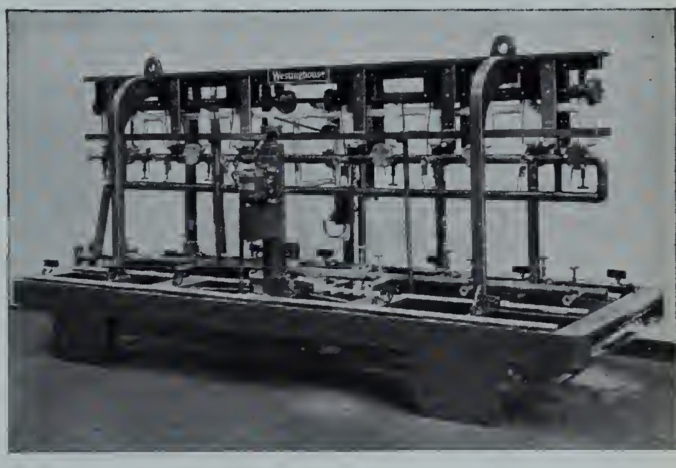

Fig. 5—Frame for 12 ignitrons with water and vacuum manifolds and small wiring in place.

mercury, a cathode spot would be formed on the surface of the mercury. On account of the much simpler arc path and shorter arc distance, he was able to reduce the arc-drop from approximately 30 volts to about 15 volts, thus reducing the rectifier losses by half in one operation. It was quickly

[1] Transactions of *The American Institute of Electrical Engineers*, June, 1933, V. 52, p. 693.

found that the arc-back frequency of this type of rectifier was so good that the shielding previously considered necessary could be largely dispensed with. The ignitron has so established itself as a rectifier that approximately 500,000 kw. of ignitron rectifiers have been sold within the past fifteen months.

Construction

The ignitron rectifier consists essentially of a steel tank formed of mild steel plate, welded vacuum tight, containing a pool of mercury at the bottom, a carbon anode suspended from the top and an igniter rod entering through an insulated bushing at the side. For voltages over 500, an additional electrode called the grid is suspended between the anode and the arc space. This electrode helps in controlling the backfires and it helps in establishing the arc pick-up. in the manufacture of all vacuum apparatus, the utmost cleanliness and absolute purity of the electrode materials are most essential. Foreign matter of any sort is detrimental to the functioning of the rectifier. The tanks are closed by a heavy steel plate top held by 14¾-in. high tensile steel bolts drawing up against aluminum gaskets. The porcelain is fastened to the top by means of a flange, clamping the flange of the porcelain in a recess in the steel top and made vacuum tight by means of solder seals in which the porcelain is actually soldered to the metal. The anode head itself is made of the purest graphite obtainable as experience has shown that no other material is so suitable for withstanding the strains of temperature which occur when a rectifier is operated under intermittent loads. The normal operating temperature of the anode head is approximately 900 deg. C. and very few materials have less electronic emission than carbon under such temperature. The mercury is carefully prepared by four chemical washes and finally by evaporating under vacuum and recondensing. All metals entering into the construction of the tank are sand blasted just before assembly to make sure that all foreign matter is removed. The assembly itself is done in an air conditioned room by operators who wear white cotton smocks and white cotton gloves which are changed at the first sign of soil. After closure, the tank is pumped to approximately 1/1,000,000 of an atmosphere pressure and operated at reduced voltage and up to three times normal current until no further gas can be driven off from the metal and carbon parts. Groups of these tanks are then assembled on a frame to form the requisite number for the capacity required, connected to a common manifold for pumping vacuum and to the necessary water inlet and outlet manifold and the small wiring added to make a complete 6 or 12 phase rectifier. One recent installation in Canada consisted of 48—12-tank rectifiers, each rated at 3,375 kw.

Fig. 7—A compact, convenient and portable arrangement of six ignitrons with control equipment.

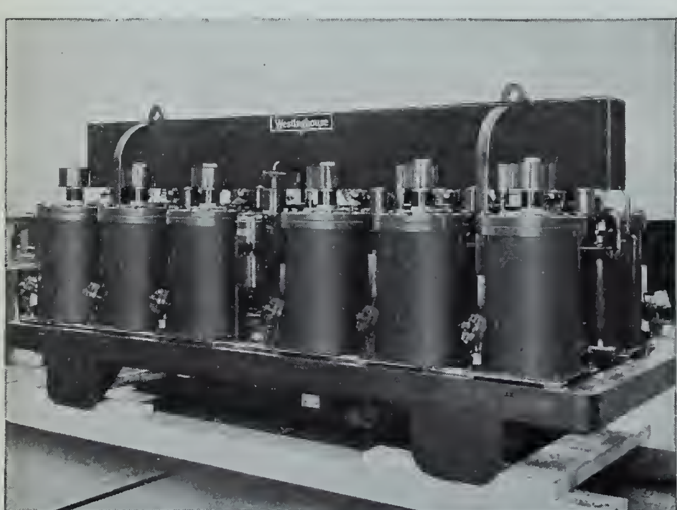

Fig. 6—Complete frame of 12 ignitron tanks rated 3,375 kw.

Ignitrons as Contactors

The ignitron with its peculiar properties of being able to carry current when desired and interrupting the current flow at the end of the first positive half cycle after initiation processes have stopped has become very useful as a contactor where rapid action is required, such as in the spot-welding and seam welding industry. By connecting two ignitrons back to back, they can be arranged to pass alternating currents to the primary of a welding transformer and such an installation has been in service in Hamilton for several years on a spot-welder on critical work in which the record to date has been one defective spot per 468,000 welds. The operation of the igniter control may be made fully automatic so as to cause the current to flow for two cycles on and two cycles off, for instance, or it may be made that it will flow for a predetermined time after the operator initiates the action and then stop completely until the operator takes control again. In the smaller sizes for welding control, the ignitrons are now sealed off and no pumping equipment is required to maintain the necessary vacuum. On account of the extremely large overload capacity available in such equipment, an ignitron rated at 225 amperes continuous is capable of an output of 3,000 amperes for a short time, provided the average is not over 225 amperes. This allows the use of comparatively small ignitrons to take the place of the extremely large contactors and to operate without any moving contacts or fuss. The saving in maintenance on contactors has caused several industries to go over wholly to ignitron contactors and other industries have said that the saving in production more than paid for the installation. It may be noted that the streamline trains made of stainless steel are all welded by the ignitron controlled welding equipment and that every Monel hot water tank sold in Canada has been welded on an ignitron controlled seam welder. The welding operator of a few years ago judged the time to make a spot-weld by the amount

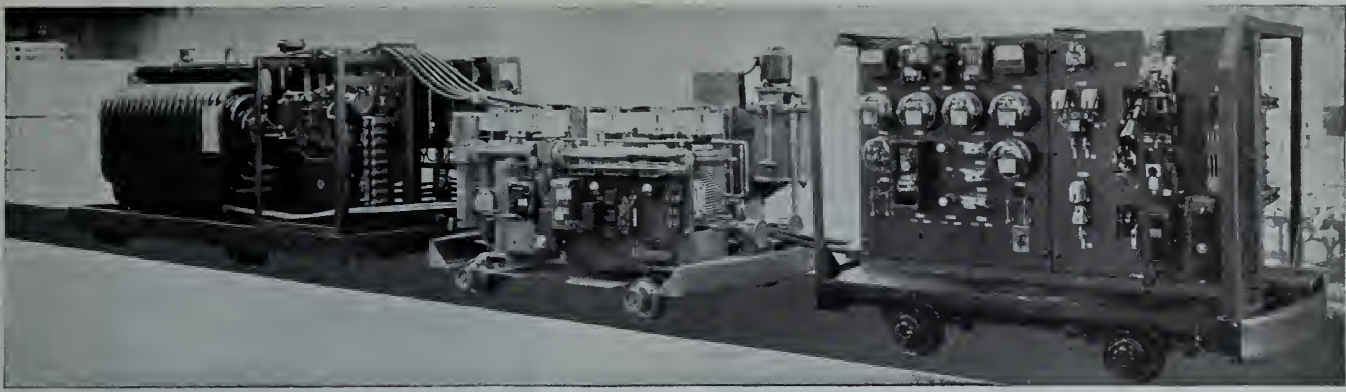

Fig. 8—A typical portable ignitron station for installation in a mine. When this assembly is hauled into place by the mine locomotive it is only necessary to connect to the high voltage feeder and the direct current distribution system, and the d-c substation is ready for operation.

of red that showed under the electrode of the spot-welder. Such a welder would have considerable trouble making welds on sheet lead, but with ignitron control, such welds are entirely practical. There are hardly any metals which cannot be spot-welded by means of ignitron control, whereas manual control can only be used for the few metals which have a large temperature range during which they are weldable.

It is felt that the ignitron is a distinct contribution to Canada's war effort both as a rectifier for the electrochemical industries and as a control device for the metal fabricating industries, and the production in Canada of such a large quantity of new equipment has been a worthwhile achievement.

THE SPIRE OF CHRIST CHURCH CATHEDRAL, MONTREAL

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Chief Engineer, The Foundation Company of Canada, Limited, Montreal, Que.

The original appearance of Christ Church Cathedral, on St. Catherine Street West, in Montreal, has recently been restored by the erection of a new spire.

Construction of the cathedral was started in July, 1856, and was finished in the late fall of 1859. It is built in gothic style of limestone rubble masonry, set in lime mortar. The tower forming the base of the spire is 24 feet square with two buttresses at each corner and it originally extended 22 feet above the ridge of the main roof. The spire was octagonal in plan and was 121 feet high, the top being 226 feet above sidewalk level.

In the interior of the church the tower is supported by masonry arches and columns. The columns rest on irregularly shaped masonry piers, extending from the underside of the main floor to from 4 to 8 feet below basement ground level. The four piers are joined by inverted masonry arches having the intrados of the crown at the ground line.

As determined by borings, the piers rest on a layer of brown sandy clay 4 to 6 feet thick which, in turn, rests on a bed of blue clay 10 to 13 feet thick. The upper half of this blue clay is of a sticky consistency while the lower half is very soft. Below the blue clay, and overlying bedrock, is a layer of hard brown clay and hardpan about 22 feet thick. The bedrock is of limestone and is about 40 feet below the bottom of the piers.

Before the tower was completed, in 1858, it was discovered that the foundations were sinking and that the two south piers were sinking more than the north ones, causing the tower to lean south towards St. Catherine Street. When the spire was completed there was a maximum settlement of about 5 inches. This settlement disturbed and damaged the columns and arches adjacent to the tower to such an extent that it was necessary to make extensive repairs. While most of the settlement took place during construction, subsequent check measurements showed a slight progressive movement and in 1927, when the settlement was 6½ inches and the spire was 2 feet out of plumb, it was decided

Fig. 1—One of the tower arches. This view shows some of the damage caused by settlement before the original spire was completed.

to remove the spire and about 22 feet of the tower to avoid a possible catastrophe.

The total weight of the original spire, tower, piers and inverted arches was 4,329 tons, making an average load of about 7 tons per square foot on the sustaining soil. This excessive loading accounts for the settlement, and the bearing area of the south piers being a little less than that of the north ones accounts for the uneven settlement. By removing the spire and a portion of the tower the total load was reduced by 1,320 tons, leaving a load of 3,009 tons or about 5 tons per square foot on the soil. There was no further settlement under this reduced loading.

In 1939 an anonymous benefactor offered to provide funds for the construction of a new spire on condition only that the original design could be reproduced. After investigating soil conditions and alternative schemes for strengthening the foundations and reconstructing the spire, it was decided that the tower foundations should be underpinned down to the hard clay or hardpan formation; that the tower should be extended to a height of 25 feet in light masonry construction to match the existing stonework, and that the spire should be of light construction consisting of a structural steel frame covered with cast aluminum plates, treated to produce the appearance of stone masonry.

Considering the nature of the soil, the loads to be supported and the weakened condition of the arches in the interior of the church, it was manifest that the underpinning should be carried out with the least possible disturbance of the soil under the piers. To satisfy this condition and to confine the work to the basement only, the pipe pile method was adopted.

The total weight of the spire, tower, piers and inverted arches is now 3,447 tons, including a net additional weight of 438 tons in the new construction. To take care of the load under the piers, 36 twelve-inch pipe piles, nine under each of the four piers, were jacked down to the required depth, to a resistance of 100 to 105 tons per pile, by means of hydraulic jacks.

An examination of the old rubble masonry piers indicated that it would be necessary to reinforce them to take the reaction of the jacks. This was effectively done by building a collar completely around the upper 5 feet of each pier. The collar consists of a vertically reinforced gunite slab supported by two bands of 12-inch I-beams spaced about 3 feet apart. The beams were welded together at the ends and were prestressed, by wedging with steel wedges between the beams and the masonry, before the gunite was applied. To provide an additional margin of safety, the inverted arches were also strengthened with reinforced gunite and the two south piers were shored, temporarily, on the south face, by means of 75-ton jacks placed at an angle of about 60° to the pier, with the head of the jack in a recess in the masonry and the base bearing on a timber mat on the soil.

Fig. 2—The church after the old spire was removed.

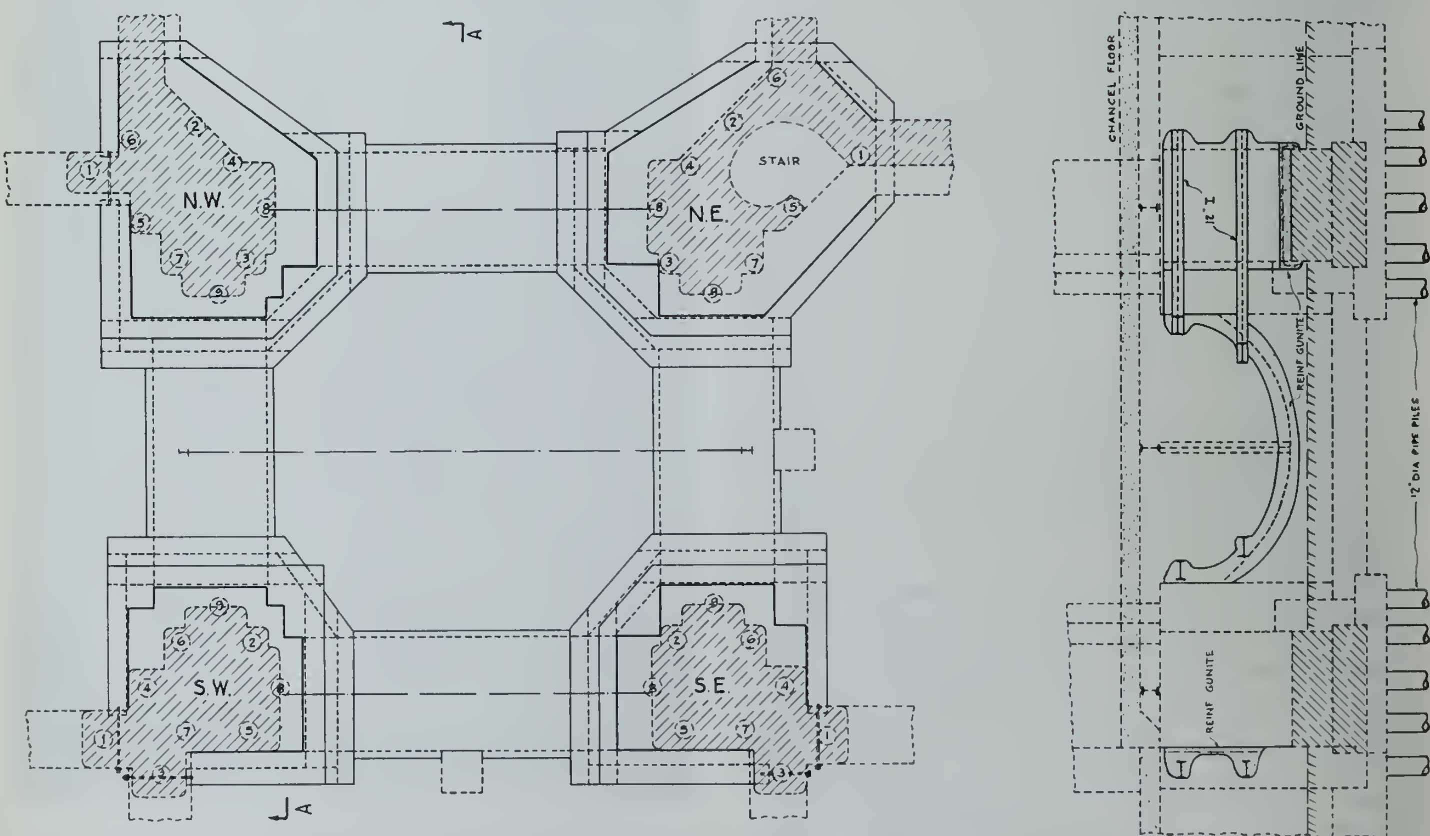

Fig. 3—Plan and section of the foundations. The reinforcing around the piers and over the inverted arches is indicated. The circles show the locations of the piles and the order in which they were placed.

After the gunite had set, recesses were chipped out of the masonry from just below the collar to the bottom of the pier. The recesses were of sufficient depth to allow the piles to be placed directly under the edges of the columns resting on the piers. A concrete pad was then formed at the top of the recess to distribute the load and to provide an even bearing for the head of the jack. The piles were then jacked down, in sections, to the required resistance, as indicated by the gauge on the hydraulic pump. As the maximum extension of the jack was only 8 inches, it was necessary to substitute oak blocks to obtain the required clearance for a new section of pipe. Each pile consisted of a cast iron point and sections of 12-inch standard weight steel pipe 3 feet 4 inches long, with cast iron sleeves between sections. The average length of pile was 18 feet 11½ inches. When the required resistance was reached the top section was carefully burned off to grade near the bottom of the pier and filed to leave an even bearing surface. The pipe was then filled with concrete and, after this had set, a structural steel column was wedged in place between the top of the pile and the concrete pad at the top of the recess. The recess was then filled with gunite. Chipping and jacking were carried on simultaneously at all four piers, one pile at a time at each pier, with the chipping kept in step ahead of the jacking. Preliminary work started on September 26th and the underpinning was completed on December 9th, 1939.

Fig. 4—Underpinning the piers. This view shows a pile being jacked down in the south east pier, which is about four feet deeper than the other.

The new tower forming the base for the spire was started in the spring of 1940. It is 24 feet square and extends 25 feet above the old masonry or ridge of main roof. It consists of a structural steel portal-type frame and four masonry walls with two buttresses at each corner and a louvre in each face. The bottom of the steel frame is attached to a structural steel grillage which is embedded in the masonry walls and on which the new concrete roof slab is supported. There are two rods at each corner, anchoring the grillage to steel beams embedded 10 feet down in the old masonry. The new masonry walls consist of Montreal limestone facing and Indiana limestone trim, with 12 inches of common brick backing. The louvres are of red wood, painted to match the stonework, and are encased in cast stone. The roof slab is insulated with fibre board and sheeted with copper. Two drainage outlets are provided through the walls.

The pyramidal steel frame for the spire is octagonal in cross section. It is 24 feet in diameter at the base and is 118 feet high, the top being at the same elevation as the original spire, about 226 feet above sidewalk level. The base is attached to a structural steel grillage which forms the transition plane between the square tower frame and the octagonal spire frame. The frame consists of 8 tee-section legs tied together at 9 foot intervals with angle diagonals and struts. The tee legs have their webs turned outward to connect to the aluminum corner castings, while additional angles, on the faces of the octagon, support the intermediate castings. Horizontal brace frames, which also serve as landings for the interior ladder system, are provided every 18 feet. The structure is designed to withstand a wind pressure of 30 pounds per square foot of vertical projection.

On account of the spire being situated at the centre of the cruciform church structure, the steel could not be handled in one lift from the ground to the spire. The general contractor's material-handling bridge from the nearby construction tower served as an intermediate landing stage, about 80 feet above ground level. It was raised to this level by means of a gin pole 90 feet long and was then wheeled along the bridge to the tower and hoisted into place by means of a small gin pole attached to the spire frame. This small gin pole was moved up, in turn, with the spire sections. The top section, with cross and finial fastened in place, was erected by means of a pole lashed to an outer face of the frame and cantilevered up to a position slightly above the top of the steel. Main field connections were riveted and other connections were bolted and provided with lock nuts. The steelwork was painted with metalastic black paint, the connections being given an additional coat. The total weight of steel erected was 38 tons.

The facing on the spire consists of cast aluminum plates modelled and treated to produce the appearance of stone masonry similar to that in the original spire. The plates are convex in shape and are made to represent one or more pieces of masonry. The dimensions vary from 16 inches by 8 inches to 16 inches by 84 inches. The plates are designed for their own particular location and are provided with lugs for bolting to the steel frame.

To obtain the desired effect, plaster models were first made of the plates and these were used as patterns for making the castings. The edges of the rough castings were made true by grinding and the surfaces were cleaned by sandblasting. The appearance of weathered masonry was obtained, immediately, by dipping the plates in a solution consisting of black antimony sulphide, sodium cyanide and warm water. It is expected that the coating deposited by this process will, in time, become slightly bleached but the weathered effect will be maintained by the action of the elements in the same manner that stone masonry attains the weathered appearance.

The contrasting effect of mortar joints, between sections representing stones in the plates, was produced by subjecting these joints to a special chemical treatment and, between the plates themselves, by leaving ⅜-inch open joints.

The plates were handled up to the base of the spire by means of the general contractor's material tower and bridge. They were then pulled up and erected from a platform attached to the outside of the spire. This procedure started at the top of the spire and was carried downward, the platform being moved at convenient intervals. All plates fitted exactly into place and all connection holes matched the holes provided in the structural steel, indicating the degree of accuracy used in manufacturing the castings and in fabricating and erecting the structural steel. On account of the inside of the spire being open to the weather, the bolts connecting the plates to the steel frame were given a rust preventative treatment and one coat of red lead paint in the shop, and one coat of metalastic black paint after erection. About 6,500 bolts were used and the total weight of aluminum castings erected was 16.6 tons.

With the exception of the installation of the new clock and the old bell, the spire was completed in November, 1940. It is believed that this is the first time cast aluminum plates have been used, in imitation of stone masonry, on a church spire.

A detailed inspection of the masonry arches in the interior of the church was made prior to the actual underpinning operations. All cracks and defects were carefully recorded and the most prominent ones were marked and photographed. Elevation marks were also established on the columns and piers. Subsequent inspections and level readings indicate that there has been no movement since the start of the new work.

Messrs. Ross and MacDonald were the architects and The Foundation Company of Canada Limited, the general contractors. The structural steel was supplied and erected by the Dominion Bridge Company Limited and the aluminum plates were manufactured and erected by the Robert Mitchell Co. Limited. The cut stone was supplied by Quinlan Cut Stone Limited and the cast stone by Mr. E. J. Ambrose.

Fig. 5—Christ Church Cathedral, Montreal, after completion of the new spire.

THE DESIGN OF SPREAD FOOTINGS

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Foreword

The following paper is an attempt to place the design of spread footings on a rational basis. It is realized that there are numerous short-comings and that it will be easy to offer destructive criticism to many points contained in it. The author will welcome rational discussion both favourable and adverse but at the same time would beg of those—and there will be many—who disagree to bear in mind the philosophy of the "Better 'Ole."

General

In this paper it is proposed to deal with only the simplest type of foundation such as is commonly found under buildings. A laterally uniform soil will be assumed, the water content of which will be supposed to remain essentially constant. We shall be concerned, not with the strength of the footing, but merely with its size and shape in plan.

At the outset it is obvious that the criterion which forms the basis on which the proportionate size of the footings must rest is that of equal settlement; at least, in so far as such is at all possible in any particular case. We shall examine this aspect of the subject but, before proceeding to do so, it is necessary to discuss in a general manner the phenomenon of settlement of a footing and to enquire as to its causes.

Phenomenon and Causes of Settlement

Let us conceive a footing of rectangular shape which supports the interior column of a building. Its sole is, let us say, about one-half the width of the footing below the basement floor level so that the footing rests in the earth rather than on top of it. Due to the load from the column; to the weight of and load on the basement floor; and to the weight of the fill, top block, and footing itself; an average vertical unit pressure, p_o, is applied to the soil. If this pressure be appreciably greater than the original pressure at the same level due to the weight of the soil prior to excavation—and it usually is—then settlement of the footing will take place. Even if it be equal to the original pressure the soil may swell after the excavation has been carried out and subsequent settlement may occur. As to how much settlement will occur, that depends on a number of factors—among which are the physical characteristics of the soil strata to a considerable depth, the pressure applied by the footing to the soil, the size and shape of the footing, the depth of its sole below the surface of the surrounding earth, and also the pressure of other footings in the vicinity of it. It is by no means easy to estimate the combined influences of all of these factors.

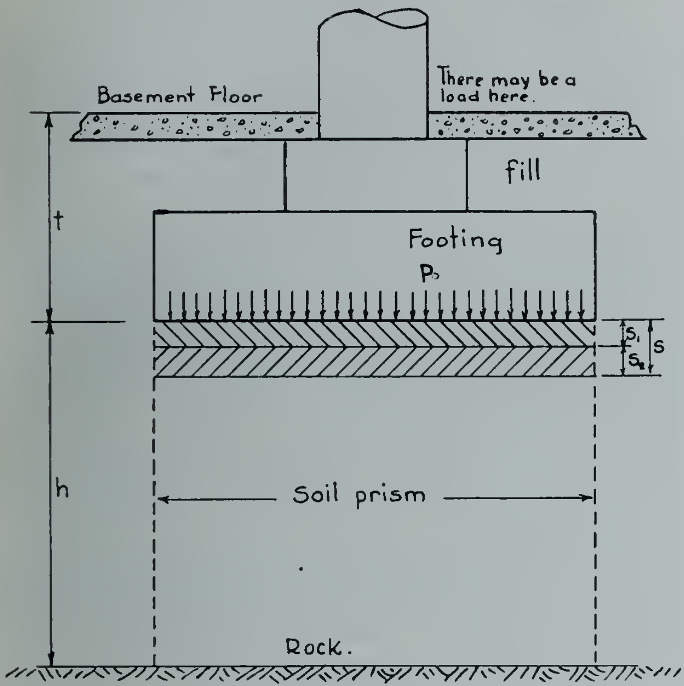

Fig. 1

The sinking of the footing into the ground is the result of two general effects produced by the stresses which result from the application of the pressure p_o to the soil. These effects are: 1: a compression, or consolidation, of the soil directly below the footing; and 2: a lateral movement of the soil from under the footing. The settlement of the footing is the combined result. These items have been the subject of much recent discussion and investigation, and here it is proposed to avoid further detailed consideration. The consolidation of the soil is due to the normal compressive stresses which cause the expulsion of some of the water and compression of the air which occupies the voids in the soil, which results in a change in the unit volume of the soil. Such change of unit volume is for the most part of a permanent character, though there is some elastic deformation as well. The lateral movement is also of an only partially elastic character. We shall find it convenient to assume a direct proportionality relationship between the settlement and the footing pressure, corresponding to the assumption of Hooke's law, i.e., for sole pressures, p_o, not too large, the settlement, s, will be directly proportional to p_o.

In order to make this discourse clear, Fig. 1 shows the footing resting on a prism of soil the cross-section of which is given by the size and shape of the footing in plan. s_1 is the settlement due to the lateral squeezing out of the soil prism and s_2 that due to the consolidation of the soil lying within the prism. The largest part of each of these effects occurs near the top of the soil prism and the total settlement is directly proportional to the change in volume of the soil lying within the prism.

The general shape of the load settlement curve is shown in Fig. 2 by the curve C. The ordinates to this curve are the sums of the respective ordinates to the curves A and B, due to the lateral movement and to the consolidation respectively. From a qualitative point of view, these curves represent the following well known facts: for curve A, as the footing pressure increases, the sinking s_1 increases at an increasing rate. In the early stages, the lateral bulging of the soil prism is elastic in character with some lateral consolidation of the soil which surrounds the soil prism; with increased pressure, due to the shear resistance of the soil being overcome by the shearing stresses, plastic flow outwards and upwards around the footing sets in as indicated by the sudden downward trend of the curve A. For curve B the consolidation increases with p_o at a decreasing rate. Near the origin of co-ordinates, the curve C is approximately straight and it is this fact which forms the basis for the assumption stated above regarding the proportionality of settlement to footing pressure; provided the latter be not too large. As to how large the sole pressure may become without invalidating this simple relationship between load and settlement is a question of the carrying capacity of the soil—a subject of importance, with which, however, we are not concerned at the moment.

At first sight, it would seem that we have in this way succeeded in putting the proportioning of footings on the same basis as the proportioning of, let us say, a concrete column or any other structure composed of materials to which we may feel justified in applying Hooke's law. This does not turn out to be the case, however, because the values of the ordinates to the curves A and B respectively are dependent not only on the properties of the soil, but are also functions of the size and shape of the footing itself and of the depth, h, of the soil layer. A mathematical analysis shows these functions to be extremely complicated and one does not, at present, feel that such refinement should be attempted in practice. It can be shown, however, that the total settlement can be represented by the formula

$$s = \frac{p_o}{E}(kr^n + k'r^{-1}) \qquad (1)$$

in which k and k' are parameters dependent on the shape and size of the footing and the depth of the soil to bedrock.

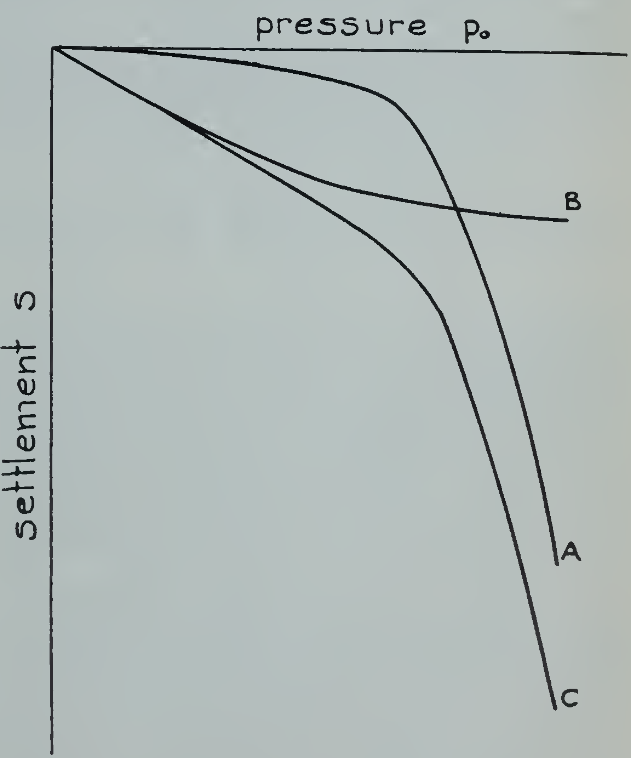

Fig. 2

E is the modulus of compression of the soil, and r is a lateral dimension, such as, for example, one-half of the smallest side of a rectangular footing, or the width of a strip footing, etc. Some attempts have been made to obtain numerical data for k. On the other hand but little is known regarding k' except that it is relatively small for small footing pressures and large footings, and that it may become large and, therefore, predominant, for large pressures and quite small footings. Most footings, in practical design, are sufficiently large that the term $\frac{p_o k'}{Er}$ may be neglected. Thus, we are left with the relatively simple expression $s = \frac{p_o r k}{E}$ (2) for the approximate settlement, in which n has been taken equal to unity as it has approximately that value.

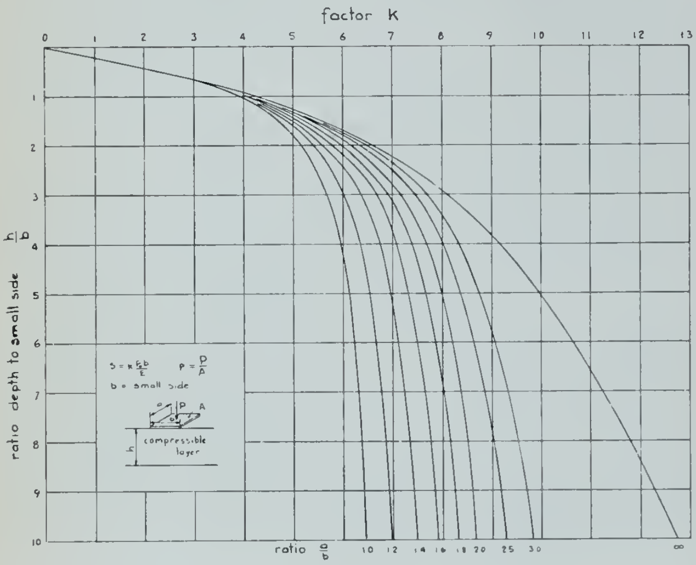

Fig. 3

Several simplified formulae have been given for k but here the discussion will be limited to that given by Steinbrenner* for the estimation of the settlement of rectangular footings.

Proportioning Footings

If, then, for two footings which are to support total loads P_1 and P_2 we are to secure equal settlement, we shall have

$$\frac{P_1 r_1 k_1}{E} = \frac{P_2 r_2 k_2}{E}$$

or, assuming the sole pressure to be uniformly distributed,

$$\frac{P_1 r_1 k_1}{A_1} = \frac{P_2 r_2 k_2}{A_2} \qquad (3)$$

in which A_1 and A_2 are the respective footing areas. The process for the design of footings on this basis may then be stated as follows: After the total loads on the soles of the footings have been determined, the smallest one is selected and with some allowable sole pressure the required area is determined by the usual process. With this data, all of the other footings are proportioned on the basis of equation (3) above. In order to do this, the values of k_1 and k_2 must be known and these may be determined from Steinbrenner's diagram, Fig. 3, by a trial and error process.

At first sight, the above process may appear to lead to larger footings than the older methods and therefore to increased cost. This is not the case, however, when it is realized that higher allowable soil pressures can be used with assurance than were advisable with the previous process. Also, the allowable soil pressure may be governed by other practical details. For example, in the design of a small steel frame building the exterior brickwalls rested on 14-inch concrete basement walls. It did not seem practical to place beneath these walls a footing less than 28 inches wide, though a 24-inch footing could perhaps have been used. From the total load per foot on these footings, the basic soil pressure per square foot was computed and, by using the process suggested above, all of the interior footings were proportioned. The unit sole pressure on the soil varied from 4.8 kips per sq. ft. under the wall footings, to 3.2 kips per sq. ft. under the largest of the interior column footings, which had a design load of 220,000 lbs. The soil was a deep deposit of silt with a natural water content of 19 per cent.

Distribution of Pressure under Footings

It becomes necessary, next, to examine the conditions under which it is possible to attain equal settlement for the footings of a building. Buildings which rest on deep deposits of compressible soil cause a saucer-shaped depression of the horizontal plane surface on which they rest. This is due to the fact that the distribution of stress from the various footings overlaps and thus, taken as a whole, there is more consolidation of the ground at the centre of the building than at its perimeter. Not much can be done about this aspect of settlement except to keep the settlement as a whole, and therefore the differential settlements, to a minimum. This can be done in part at least by deep excavation and by stiff foundation structures. Otherwise the building simply has to conform to the saucer-shape and it may, in certain circumstances, be expedient to choose a flexible type of structure for that purpose.

In order to discuss the overlapping of the stresses, it is first necessary to consider the spreading out of the pressure beneath a footing.

A number of formulae have been devised for the distribution of pressure beneath a spread footing and several useful diagrams and tables for the purpose are to be found in the contemporary literature. Painstaking accuracy,

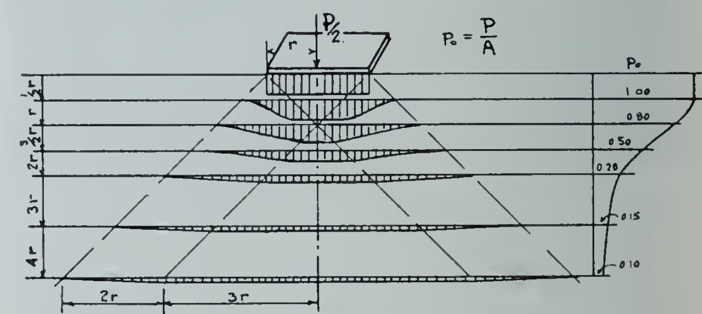

Fig. 4a

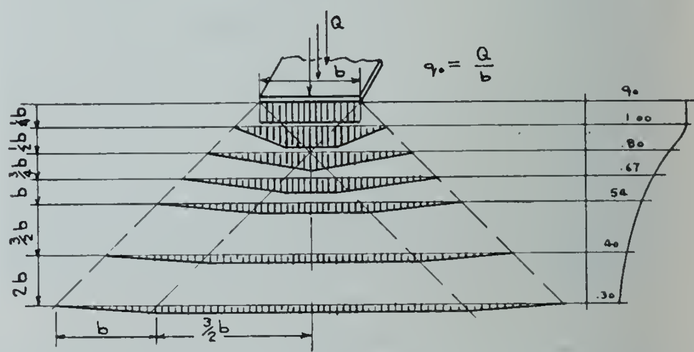

Fig. 4b

however, in this matter is not justified at the present state of knowledge, so that some simplified assumption as regards vertical stress distribution appears to be in order from a practical point of view. Without going into too much detail, we shall assume that the angle of spread of the pressure is at 45 deg. to the vertical. Figures 4a and 4b represent rectangular and strip footings respectively and an assumed vertical stress distribution at different levels is shown which will be adequate for practical purposes. From them, it will be seen that the stresses become rapidly smaller for horizontal planes at depths greater than the width of

(*) Figure 3 has been reproduced and modified from a modified diagram shown in Baugrund und Bauwerk by Kögler and Scheidig, and originally published by Dr. Steinbrenner in *Die Strasse*, 1934.

the footing and that these stresses taper to zero after a certain point away from the centre line is reached.

It is an easy matter to determine the minimum spacing between footings such that no serious overlapping of the stress distribution will occur. As an example, let us assume three equal footings each 8 by 8 ft. and that they rest on a compressible soil which has a depth $h=15$ ft. from the footing soles to bed-rock. What should be the centre to centre

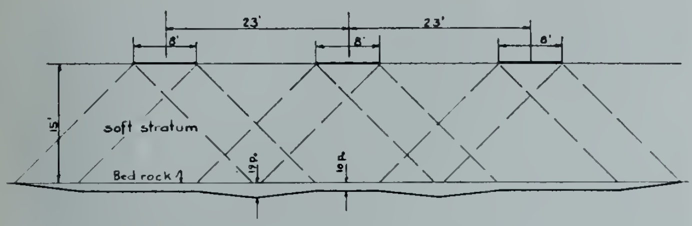

Fig. 5

distance between footings so that equal settlement may be expected ? Figure 5 shows the solution and additional comment seems hardly necessary.

Obviously the theoretical centre to centre distance between equal rectangular footings resting on a compressible stratum of thickness h is $d=h+b$, in which b is the least lateral width. If the footings be unequal in size, such, for example, as a small footing lying between two equal large footings, the distance between centres should be determined by the same process.

In case a soft stratum lies below a hard stratum in which the footings rest, the stresses—intensity and distribution—should be computed at the top and bottom of the soft stratum. From this information one can determine whether there will be unequal settlement—which is often the case—and an estimate of the amount can be made if the pressure-voids ratio curve has been obtained or if the E-value has been determined by test in the field. Simple preliminary studies of this sort may be an important factor in the choice of type of superstructure as well as the general arrangement of column spacing.

Total Settlement of a Structure

A second aspect of footing design is concerned with the amount of settlement of the structure as a whole. Several methods for such computations have been given, based both on the pressure–voids ratio relationship and on the E-value. Equation (2) affords one method for such computation and it becomes necessary to determine the E-value for the stratum (or strata) lying below the footings. The best method is to determine this value by direct test but in so doing a deep boring or open pit is necessary with suitable samples for the purpose of determination of the character of the supporting soil. Soils are not usually uniform for any great depth and consequently the E-value of the various strata must be taken into account by means of separate tests at suitable levels.

Loading Tests

The interpretation of soil loading tests and the determination of the E-value from them is by no means a simple matter. In order to properly interpret a soil loading test it is necessary to bear in mind the two terms which go to make up the settlement as given in equation (1). For tests on small areas the second term becomes perhaps more important than the first and often predominant. Figure 6 shows the relationship between size of footing, or test area, and the settlement for a constant unit pressure.

The curves A and B represent the first and second terms of equation (1) respectively and C the resultant of the two. The general shape of the curve C has been confirmed by numerous tests and also in theoretical analysis so that it appears to be well established. For areas of approximately 1 sq. ft. the settlement is a minimum for pressures not too large. For smaller areas the settlement increases very rapidly and for larger areas the increase is much slower. It is obvious that areas larger than one square foot are necessary for bearing tests if the useful part of the C curve is to be obtained. Several such curves (determined for different unit pressures) will enable one to determine the E-value for the soil immediately below the test footing. Concrete footing blocks having areas of 2 sq. ft. and 4 sq. ft. are suggested as practical sizes, though up to 10 sq. ft. would be desirable if the cost be not prohibitive.

If the substratum be not uniform, then other methods for the determination of the E-value at various levels must be employed. These, however, will not be described in this paper. Some attempts have been made to develop satisfactory tests on the strata *in situ* but much along this line still remains to be done.

A rough idea of the E-values for various kinds of soil may be obtained from the following table drawn from a similar table given by Kögler-Scheidig ([1].) It should be used only as a general guide in the absence of more reliable information.

Table I

Soil Type	E-Value (Tons per sq. ft.)
Gravel (dense)	1000—2000
Sand (dense)	500— 800
Sand (loose)	100— 200
Clay (hard)	80— 150
Clay (medium)	40— 80
Clay (soft)	15— 40
Clay (very soft)	5— 30

The E-value for the silt on the river flats at Edmonton is approximately 44 tons per sq. ft. This soil is known to be quite compressible.

In the determination of the E-value from a soil bearing test, Steinbrenner's diagram can be used to advantage provided of course the limitations as to size of bearing plate and magnitude of soil pressure are kept in mind. As an example, a bearing plate of 4 sq. ft. area showed a settlement of 1.1 in. due to a load of 4 tons per sq. ft. The soil was a yellow clay of considerable depth having a natural water content of 26 per cent. From this test the E-value is:

$$E=\frac{.65 \times 4 \times 2 \times 12}{1.1}=60 \text{ tons per sq. ft.}$$

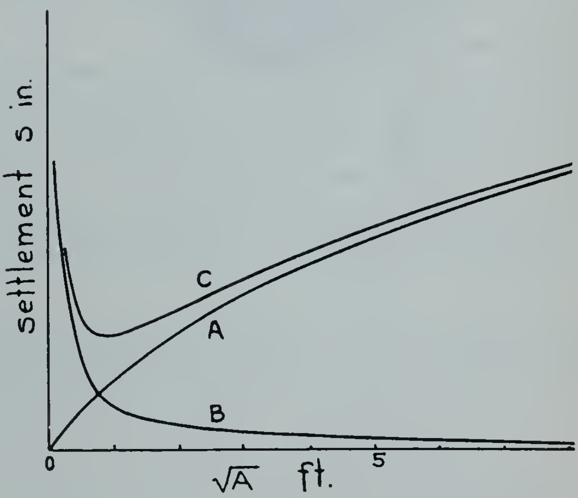

Fig. 6

Bearing Capacity

In the preceding remarks it has been assumed that the bearing capacity of the soil has not been exceeded. The designers should make sure that this will not happen. The best way to determine the bearing capacity of a soil is by actual test in the field provided the test be properly interpreted. Moreover, the character of the soil must be taken

(1) Baugrund und Bauwerk, Wilhelm Ernst & Sohn.

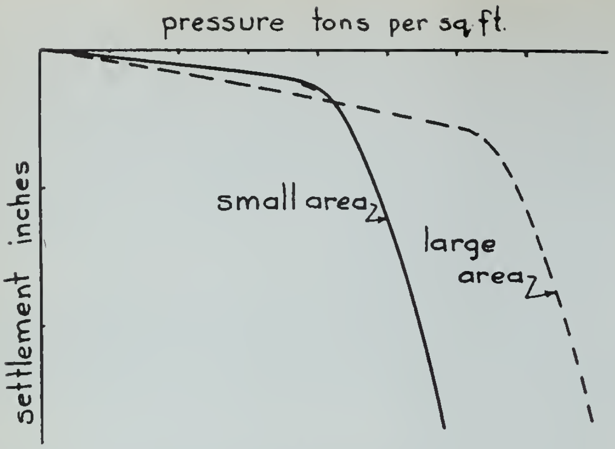

Fig. 7

into account. Figure 7 shows the typical loading test graph (full line) for a cohesionless soil, let us say carried out on an area of 4 sq. ft. We shall interpret this test as indicating that the bearing capacity of the soil is 4 tons per sq. ft. A second test on a larger bearing area will give a graph according to the dotted line. The correct conclusion is that for larger areas the bearing capacity of this soil is more than 4 tons per sq. ft., so that for such soil when we speak of the bearing capacity we must also have in mind the area of the footing.

Figure 8 shows a similar test on a cohesive soil. Here it will be noted that the bearing capacity is perhaps 3.5 tons per sq. ft. and that it is not as sharply defined as in the case of the non-cohesive soil. Also, it will be noted that the bearing capacity of this type does not increase with an increase in size of footing but remains substantially the same (dashed line). Many soils in nature will lie between these extreme cases and it becomes necessary to use judgment not only in interpreting the results of a soil test but in selecting from it a safe value for the maximum permissible soil pressure in any given case.

Failure—somewhat indefinitely defined as that point which is reached on the curve where for a small increment of load there is a large increment of settlement—is brought about by the lateral flow of the soil which in turn is dependent on the depth *t* of the sole of the footing below the surface of the soil which surrounds it. The bearing capacity increases with this depth and in fact does so quite rapidly, especially for cohesionless soils.

On the basis of the field tests shown by Figs. 7 and 8 respectively, one can safely adopt 4 or more tons per sq. ft. in the one case and perhaps but 1½ tons per sq. ft. in the other. One must remember, however, that such field tests exhibit the properties of the soil only to a comparatively small depth and that underlying soft strata in the case of Fig. 7 may have an appreciable influence on the design of the footing but not so much from the point of view of failure of the soil as from that of excessive settlement.

Loads on Footings

An important part of correct footing design lies in a proper estimate of the column loads for which the footings should be proportioned. Clay soils compress slowly and loads of short duration have little effect on the amount of settlement over a prolonged period. Sandy soils and silts, which compress relatively quickly, are affected by loads of short duration. For example, there is no point in allowing for impact loads on the foundations for the piers of a railroad bridge where the soil is a dense clay.

The column and wall loads in a building depend on three items. These are: the dead load of the structure, which may be accurately estimated; the permanent superimposed loads, which may remain in place for long periods; and the intermittent superimposed loads. Of these, the first is always present, the others may or may not be present in certain cases. The author believes that the footings should be proportioned in general only for the first and second, though there are obvious exceptional cases. It is difficult to estimate the amount of the second item. It is seldom equivalent to the floor and column design loads. For example, in the case of a warehouse which may be heavily loaded on all floors for long periods, 100 per cent of the floor design live load should be taken. At the other extreme the typical steel frame office building should have only 10 lb. per sq. ft. on all working floors with nothing allowed for the corridors.

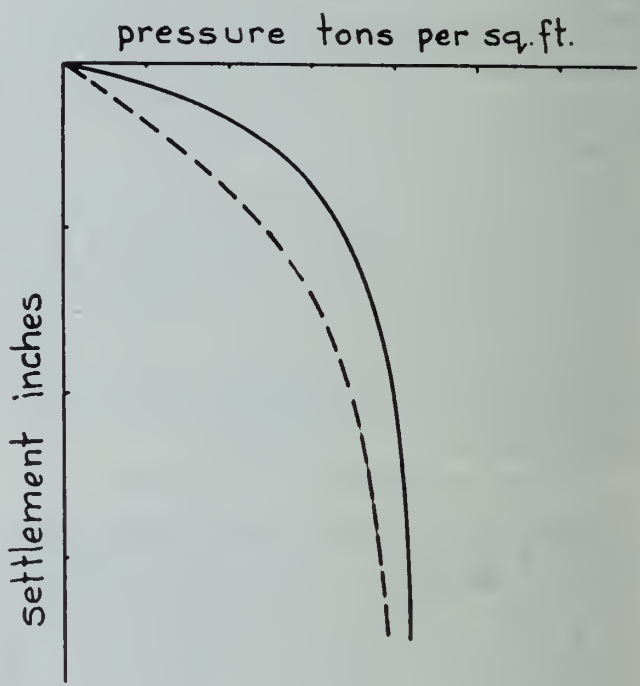

Fig. 8

This will be ample, though a larger allowance should be made for the basement floor which may be used for storage. No allowance need be made for snow on the roof except in certain localities. Such buildings as department stores, machine shops, etc., fall between these extreme cases. In any event, the determination of the footing loads should be given careful attention. It is indeed too often neglected. No proper proportioning of footings can be carried out without attention to an accurate estimate of the proper wall and column loads and this is one of the most difficult parts of foundation design.

ANNUAL MEETING, HAMILTON, ONT., FEBRUARY 6th and 7th, 1941

THE PREPARATION OF SMOOTH SURFACES

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Paper presented before the Border Cities Branch of The Engineering Institute of Canada at Windsor, Ont., on November 15th, 1940

(ABRIDGED)

During the past six years the author has directed the research on the development and application of fine metallic surface finish for the Chrysler Corporation. We evolved a revolutionary technique in the commercial preparation of smooth surfaces, which has solved major production and mechanical problems for the Corporation, and is called 'superfinish.' We then began the study of how to explain the production of fine metal surfaces from a technical viewpoint, so that a more universal use could be made of this development. This study has made headway, but many discussing the problem from both a technical and practical aspect base their conclusions on what they see, or rely exclusively on measurements by some instrument such as the profilometer and surface analyser, failing to realize that the metallurgical structure of the surface is of equal importance to the geometrical development in eliminating wear.

In order to discuss metallic surface finish intelligently from the industrial viewpoint, one should be able to answer the following questions:

1. What is a defective surface, and what are the factors causing it ?
2. What would be the practical industrial value of perfected metal surface finishes ?
3. What would be the loss to the public if surface finishing problems were not solved according to commercial and engineering requirements ?
4. What is the relationship of refined metal surfaces to wear and lubrication ?
5. What is the difference in topography between a ground surface and a geometrically developed smooth surface as shown by metallography ?
6. What is an unbroken oil film ?
7. What is the metallurgy of surface finish ?
8. What are the relative merits of the different methods of measuring refined metal surfaces such as: metallography, sound, stylus point, light wave, friction and microscopic ?
9. What processes are involved, and what are the major considerations in producing a refined finish on all types and shapes of metal surfaces ?

Excellent results in the development of fine metallic surfaces are being obtained daily on parts being produced for use in automobiles, aircraft motors, tractors, sewing machines, and in every conceivable type of mechanism.

The Beginning of 'Superfinish'

The story of 'superfinish' begins early in 1934,when the replacement of roller bearings in the front and rear axles of new cars was causing serious annoyance and trouble to the dealers and owners. The defect called, "brinelling" by service men, was an indentation on the bearing races, caused by the weight of the cars on the bearings acting during railroad transit to distant points. An examination showed that this indentation was very slight, measuring approximately .0001 in. in depth, yet in road driving it caused an obnoxious buzzing noise, making replacement necessary to satisfy owners. The indentations could be removed by lapping, indicating that they were not in the solid crystalline metal, but only in the "fuzz" left on the finished surface by the finish grinding operation. This started experimental work on how to remove economically this "fuzz" developed by the dimensional and finish grinding operation. Lapping with abrasive and oil did not produce a satisfactory surface from a commercial or economical point of view, but we developed a simple reciprocating device using a bonded abrasive stone, that was arranged to give a short reciprocal stroke under light pressure while the work was rotating. This device quickly removed the grinding "fuzz" which is really fragmented, amorphous, non-crystalline and/or smear metal, doing so in about fifteen seconds of time and leaving a smooth surface which under the microscope appeared black with a few scratches below the contacting surface.

By the use of this simple apparatus sufficient bearings were completed to equip, over a period of three months, approximately 200 cars to be shipped to distant points such as California. The shipments were accompanied by a toolmaker and service man, and none of the cars with properly finished bearing surfaces gave any indication of "brinell" or failure. This confirmed the necessity for having all bearings finished in such a manner as to remove the defective surfaces developed by the dimensional operations of finish grinding, and to-day more than one hundred million bearings have been 'superfinished' in the taper roller bearing factories. Experiments were made with ball bearings, for they have exactly the same defects where the surfaces are finished by grinders. The balls will indent under static loads and movement such as in railroad car shipping under load and pressure.

Fig. 1—Fragmented metal caused by severe machining methods. Scale: one inch = 0.040 inch.

A "Wear-Proof" Surface

While we were trying to perfect the production of this new finish it was found that after approximately fifteen to thirty seconds of operation, when the fragmented, non-crystalline metal had been removed, the action of the bonded abrasive entirely ceased and the operation could be continued for hours without removing any additional material.

By further experiments with lubricants of different viscosity we found that the lubricant supported the abrasive stones as soon as sufficient smooth area had been developed on the metal surface to permit the viscosity of the oil to balance the pressure of the load between the abrasive and metallic surface just as it would in the action of a journal bearing.

It then became evident that we could extend this surface finishing to practically all of our products, and experimental work continued from then to now on a wider basis. Up to May 1, 1940, the Chrysler Corporation had spent a total of $265,000 in research and study for the development of refined metallic surface finish, and between three and five million dollars has been spent by industry for 'superfinishing' machines, showing that this new method of producing refined metallic finish is accepted by industry as a mechanical advance. The photographs shown in Fig. 2 are evidence of this.

The Application of 'Superfinish'

After taper bearings we next used the application of 'superfinish' methods to the finishing of crankshafts with equally successful results, and this has been extended until today we are 'superfinishing' in some degree every surface in our motors, such as pistons, crankshafts, tappet barrels and faces, valve stems, camshaft bearings and cam contours, and many other parts where the elimination of wear and "break-in" periods is advantageous. In addition, such surfaces are capable of carrying bearing loads more than double those formerly possible. Also, fatigue failures caused by surface defects are eliminated.

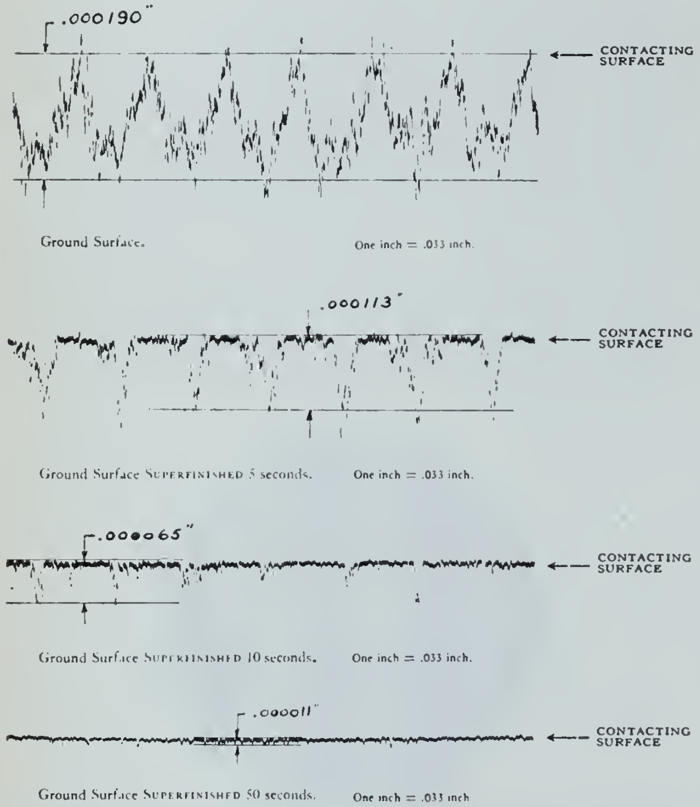


Fig. 2—Series of profilographs of a ground steel surface 'superfinished' at progressive lengths of time. Magnification: vertical 5,000, horizontal 30.

The highest quality cutting tools are now 'superfinished' in order that a cutting surface will be produced that is free of irregularities and any degree of annealed cutting edge formed by the grinding operation.

To-day's Description of 'Superfinishing'

The technique developed after several years of experience may be described as follows:

'Superfinish' is the name given to a mechanically-made metal surface finish that is the final process, superimposed on all other types of dimensional metal surface finishing methods, such as turning, honing, machine grinding and lap-grinding, and can be developed upon flat, internal, external, round, concave, convex and irregular surfaces whereby the metallic surface is metallurgically changed by economical methods and mechanical means from a fragmented, amorphous, non-crystalline or smear metal condition to a geometrically smooth, developed crystalline surface, free or practically free of all surface defects and scratches. This type of metal finish is produced by the combined action of proper bonded abrasive, low abrasive speed, light abrasive pressure and a combination of multi and random motion, short abrasive stroke, variable work and abrasive speeds and variable abrasive pressures, all in combination with a lubricant of proper viscosity whereby defective fragmented and non-crystalline metal is removed from the surface of the crystalline base metal, exposing for support of moving or static loads on lubricated or non-lubricated surfaces a geometrically smooth, developed surface of unworked crystalline base metal to permit of basic metallurgical conditions for the elimination of the development of wear and to permit greatly increased bearing pressures without oil film rupture or failure.

'Superfinishing' Technique

There are two main objectives in the production of a good metallic bearing surface, the one, metallurgical, is to remove the defective metal at the surface, previously produced by the shaping or dimensioning operation, and expose the true crystals of the material actually bisected so as to leave an extremely fine plane surface; and the other, geometrical, is to remove the hills and valleys (scratches and/or flaws), and by the laws of physics to generate a true and smooth surface which will eliminate the danger of oil film rupture and metal-to-metal contact that only lead to increased friction, wear and failure.

'Superfinish' technique differs from past practices for the development of smooth metallic surfaces for mass production in industry. The basic differences are as follows:

1. Abrasive speeds for average 'superfinishing' are 3 to 50 ft. per minute, with 5 to 20 ft. preferred, versus 6,000 to 10,000 ft. per minute for finish grinding.
2. The abrasive pressure for average 'superfinishing' for internal surfaces is 1 to 30 lb. per sq. in., preferably 3 to 10 lb., versus 500 to 1,000 lb. for average honing operations which must develop dimension and surface qualities simultaneously; (honing pressures are developed using 50 to 100 lb. hydraulic direct pressure, multiplied many times by the wedge action of expanding cones within the hones).
3. The pressure on the abrasive for average 'superfinish' of external surfaces is 3 to 50 lb., 3 to 20 preferred, versus pressures of approximately 200,000 lb. per sq. in. or more in grinding operations with only wheel line contact. (The high abrasive pressures of honing and grinding develop great heat which serves to make the surfaces more ductile, and the severity of the operation develops defective non-crystalline surfaces.)
4. True 'superfinish' technique makes extreme use, where mechanically possible, of multi and random motion together with a very short abrasive stroke performed with great rapidity (preferably of the vibratory order) by the abrasive stones. In order to take advantage of the geometrical laws for the generation of true surfaces, strokes of 1/16 to 1/4 of an inch at 300 to 3,000 reversals or more per minute (crank motion preferred) replace the continuous direction motion of wheel grinding, and the 50 to 100 reversals per minute, of much greater lengths of travel, of standard honing machines and honing methods.
5. 'Superfinish' technique uses a light oil of proper viscosity primarily for lubrication and to stop abrasive action, and not for cooling purposes, as low abrasive speed and pressure do not generate destructive heat. The light oil is used to carry away the minute particles abraded from the metallic surface by short abrasive stone stroke.
6. 'Superfinish' was developed primarily as a finishing operation and not a dimensional operation. On fine finishes in the past, such as required for the manufacture of gauges of all types, valves, air and liquid seals, a finishing operation was needed after the dimensional operation to eliminate metallic and surface defects

caused by the dimensional operations. 'Superfinish' is only an expansion of this to commercial and mass production ideas using basically new mechanical theories for the production of such surfaces.

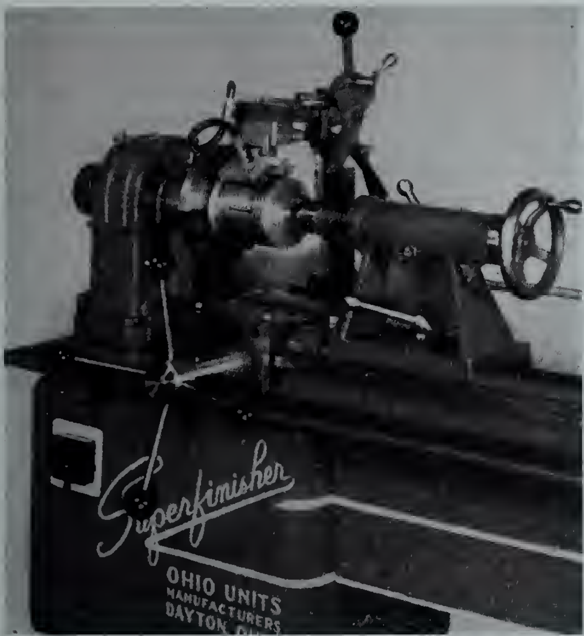


Fig. 3—The 'superfinisher' pictured here is set up for 'superfinishing' pistons. The stone-holder is reciprocated mechanically and the entire stone-holder mechanism traversed longitudinally by actuating the hand wheel shown in the foreground. The motions, with the revolving of the piston, produce the random motion necessary for the production of smooth 'superfinished' surfaces.

7. Dimensional sizing of work is made easy by the use of of 'superfinish' technique by the action of a coarser abrasive plus additional speed and pressure which will give dimensional accuracy that is not attained at the present time and at much greater production speeds. After this 'superfinishing' *dimensional operation* is completed the 'superfinishing' *finishing technique* is used for developing the crystalline, non-wearing metallic surface.
8. Finally, dimension and a fine, smooth, crystalline finish cannot be arrived at simultaneously, as the brutal action necessary to rupture metallic crystals to get dimension, destroys the contacting metallic surface, leaving it in a fragmented, amorphous, non-crystalline or smear condition. It is this surface, or "Beilby's Layer," that is removed by 'superfinishing,' used only as a finishing operation, that is, with low abrasive speed and pressure.

Surface Structure

It is now desirable to discuss the manner in which fragmented and smear metal is developed upon metallic surfaces and how it is produced by the processes of turning, grinding and honing. The principal methods are herewith outlined.

TURNING

1. If a turning tool is free-cutting without drag it will produce on the surface principally fragmented, or amorphous metal, but if the turning tool is arranged not only to turn metal off the surface, but is arranged with what is known as a drag or contacting surface just behind the turning or cutting edge, it will cut and compress the non-crystalline and fragmented metal into an amorphous or smear condition in such a manner as to leave a fairly smooth and bright surface. The quality and appearance of such a surface may be improved if coolants of anti-welding characteristics, such as soda or sulphur compounds are used, but the heat resulting from this compression, speed and pressure is such that a smear metal surface is developed which adheres tenaciously to the crystalline metallic base. This type of smear metal compares to the formation of "smear" snow by sliding a ski over a snow surface under load.

BURNISHING

2. Exactly the same condition of smear metal is developed on a turned or ground surface by roller burnishing. A smooth surface roller, forced under high pressure over a turned surface, crushes and compresses the fragmented material developed by the turning or grinding operation and the combination of heat and pressure results in a fairly smooth film of smear metal of greater uniformity, more smooth in appearance and which, perhaps on an average, adheres with somewhat greater tenacity to the crystalline base surface due to greater heat than that smear metal produced by a turning tool. This type of smear surface development leaves a surface that might be compared to a "metallic paint" and when such surfaces are developed by the best accepted burnishing practices they produce a bearing which may be satisfactory where there is low bearing pressure, reasonably continuous lubrication and slow speed as for railroad axles. This type of smear metal compares to formation of "smear" snow by rolling a lawn roller over the snow on ice under load.

GRINDING

3. The next and most common method of producing smear metal on a metallic crystalline surface is by finish grinding. Rough grinding with free-cutting wheels can be compared to turning with a tool that is not ground and arranged with a drag. However, finish grinding with sufficient high pressure to remove metallic material requires high abrasive speeds of from 6,000 to 8,000 ft. per minute and, with fine grit and hard bond, causes heat generated by the lack of cutting action of such finish grinding wheels. This heat produces a smear metal surface in which there are still hills and valleys (scratches) on the surface. These surface irregularities are produced by the points of the grain abrasive under pressure and prevent the maintenance of thin oil films without metal-to-metal contact, which under ordinary conditions is the cause of initial wear because of the difficulty of lubrication. This type of finish-ground surface was the cause of the taper bearing trouble that was previously referred to.

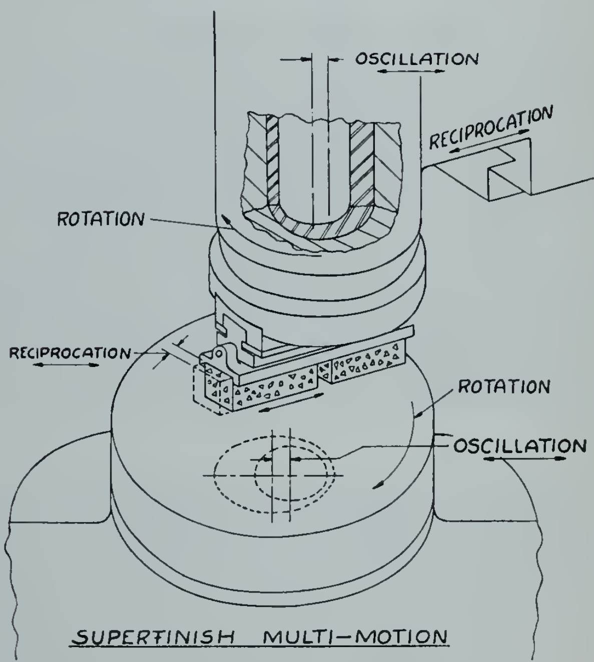
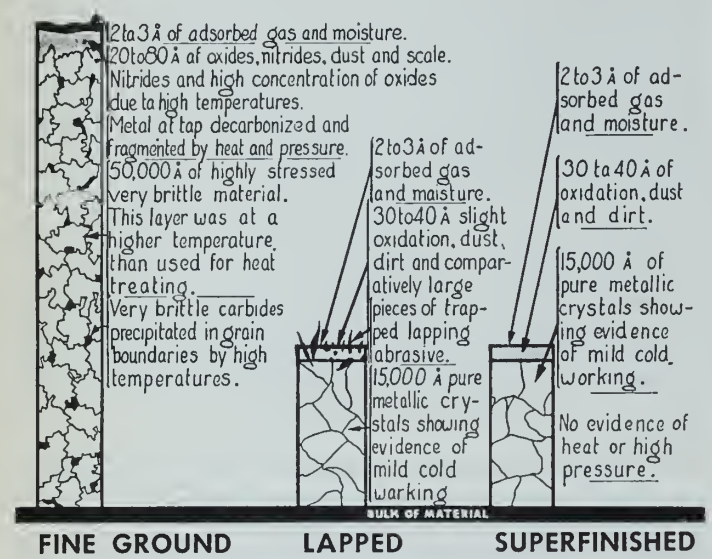


Fig. 4—Diagram showing the method of obtaining random path 'superfinishing' cutting action for flat work, of size limited only by machine capacity.

SLOW WHEEL GRINDING

4. The next type of smear metal surface is that produced on grinders, both centreless and centre type, with a slow speed abrasive wheel of approximately 300 to 1,500 surface feet per minute. The abrasive wheel is a combination of very fine abrasive grain and a very hard bond, or a bond of rubber, bakelite, plastic, etc. This method is usually a surfacing and not a dimensioning process, and produces a surface which has low microinch reading for surface defects,



The Ångstrom Unit (Å) for sub-microscopic distances

One Å = 4/1,000,000,000 inch

Fig. 5—Diagram showing the structure of metal surfaces finished by various methods.

but is defective from a metallurgical standpoint. The pressure of the broad, smooth, hard wheel so compresses, crushes and heats the surface that there is on an average a somewhat thinner and denser smear metal surface than is produced by other mechanical methods. On the finest of these surfaces one would be amazed by what is revealed by not more than three or four seconds of 'superfinishing,' showing under this surface the defects that are covered up by smear metal developed by the slow wheel grinding method.

As smear metal is formed by pressure and resulting heat of slow wheel grinding (burnishing) operations, its physical structure is harder than the bulk crystalline material; therefore, after flaking off is easily crushed and rolled through the bearing, producing a continuous, non-stopping abrading action.

HONING

5. Honing is the usually accepted method for finishing internal diameters. A grinding head, of great abrasive stone contact area is expanded and inserted into an ordinary single tooled or reamed bore and by the use of high speed, both rotating and traversing, and with great pressure, usually between 500 and 1,000 lb. per sq. in., a surface of smear metal is produced, often beautiful in appearance (except for cross hatch marks) of microinch reading of 5 to 15. Only a small amount of material is removed in the honing, dimensioning and finishing process, usually not more than .005 to .010 on the surface. This smear metal surface is developed because of the large abrasive contact area, long traversing stroke combined with speed and pressure, and a short hone.

From the above description of the development of smear metal surfaces, it will be noted that smear metal is always developed by trying to obtain a dimension and a surface finish simultaneously, which is brought about by pressure, speed and resulting heat.

Surfaces thus produced contain inclusions of the abrasive grain and only 'superfinish' or the finest of hand lapping eliminates this condition.

METALLURGICAL CONDITIONS OF SURFACES

In the past, surface metallurgy has not been given proper recognition for wear elimination and increased bearing load capacity. Beilby, in 1911, indicated that a surface structure existed on commercially finished metal surfaces that was different from the base metal and this has since been known as "Beilby's Layer." However, this condition was not then suspected as the cause of wear, oil film rupture and limitation of load-carrying bearing capacity.

Attention was first drawn to the metallurgical aspects of a bearing at the surface when examination of wheel bearings that had failed showed a distinct flaking off of a separate layer of metal over previous machining marks. These bearings had been finished by slow-wheel grinding.

These observations started a study of the surface of bearings processed by all commercial machining methods. Studies made by plan-view photomicrography revealed little, but efforts to produce informative profile-photomicrographs proved a success.

Information gathered from the study of such profile pictures led to further study by the newest and most up-to-date method, electron diffraction. These investigations were conducted for us by the Massachusetts Institute of Technology, and proved conclusively that the metal at the outer surface of a machined bearing is definitely different from that in the body of the bearing.

There appear to be three metallurgical conditions existing above the crystalline base metal when the metal surface has been finished by turning, grinding or honing. First is the fragmented crystalline metal that has been ruptured from the main crystalline body but still retains its crystalline structure. The second is the so-called amorphous structure that, through cohesion, holds the fragmented crystals together. The third is the undisturbed crystalline structure, that is, the bulk metal structure, points of which extend into the defective surface. The amorphous cement acts as a binder and fills in the voids or space that exists between the free crystalline and the base crystalline metal. The heat that is developed in the dimensioning operation caused the initial cohesion of the fragmented grain, amorphous and base crystalline structure.

Burnishing crushes the free fragmented grain and the points of crystalline base that extend into the disturbed surface structure, reducing all to an amorphous condition and leveling out of the base metal crystalline surface.

By the use of 'superfinishing' apparatus and technique the fragmented metal is more rapidly removed, and the clean, crystalline base more readily exposed than when the same set-up is used on the smear metal surface. The resultant quality of surface finish is the same, time being the only difference. This fact will in time, tend toward the elimination of finish grinding in industry.

MEASURING

What does industry require of refined surface finish measurement? First, the method of indicating the quality of finish must be as simple as the inch so that there will be a common understanding by the physicist, engineer or shop mechanic. Second, the apparatus must be accurate and inexpensive so that it can be supplied to all mechanics in industry. Third, the apparatus should indicate bearing load-carrying capacity. Recently, an article in a trade journal advocated the adoption of the microinch as a basis of evaluating surface quality. Evidently the author of this article did not try to analyze the limitation of this method at the present time for industry as a whole. First, there are over 200,000 industrial plants, and perhaps 5,000,000 mechanics, that have requirement for surface indicating equipment, yet there have been fewer than 150 microinch indicators built, and these, when delivered and ready for laboratory, or shop use, cost around $1,000 each. Also, it has been proved that this type of instrument does not give a comparative measurement except upon surfaces made under the same conditions. As an example, a fine ground finish of 10 microinch quality will carry only 50 per cent of the load of a 20 microinch ground finish that has been 'superfinished' to a 10 microinch quality. This is, of course, because of 'superfinish' development of smooth surface, replacing the hill and valley (scratches) of the fine ground surface. Yet both will measure 10 microinches.

A great and outstanding job in the field of refined surface measurement has been done by the manufacture of the profilometer, but this certainly is not the answer to ultimate universal requirement for industry, unless it can be produced for less than $100 complete, and then only if a method is not devised that is better.

For geometrically developed smooth surfaces as produced by 'superfinish' technique, the friction type, for recording surface quality, appears to have great possibilities; first, because it makes a known record of surface condition; second, because it has universal application; third, because it is reasonably cheap to build; and fourth, because, unlike the profilometer, it requires no trained operator. It has the drawback that surfaces must have smooth topography of 10 microinches or less to have recordable friction value. Measurement of bearing surfaces by their load-carrying capacity, which automatically takes into account the bearing area available, is provided for in the Wallace surface finish recording dynamometer. Utilizing pendulum action, and either surface or line-contact to the surface being tested, enables the dynamometer to be used for external, internal, and flat surfaces.

Enclosed in the pendulum is a clock timing device. This records accurately the time the pendulum is in motion.

Lubrication of moving load-carrying bearing surfaces has always been an engineering problem. Until the advent of 'superfinish,' ground surfaces produced in mass production had reached a peak of quality which engineers could not surpass by existing methods, and the only way that increased loads could be carried upon bearings was to increase the size of the bearings. But now, through technique which develops a true, smooth surface topography and exposes the crystalline base metal for load support, bearing surfaces are carrying more than double the loads they were formerly carrying under pressure lubrication. The smoother the bearing finish the more effective is the lubrication, but the finish of the bearing surface is far more important than the quality of the lubrication. For instance, a perfectly smooth bearing would probably function indefinitely under a heavy load and pressure lubrication with any clean oil, almost regardless of its lubricating qualities, whereas, the best oil will fail on a ground bearing surface of 15 to 25 microinch surface defect with all other conditions the same.

Bearing Lubrication

In our engineering department tests were made on an S.A.E. oil testing machine to determine the load-carrying capacity of surfaces of different smoothness and also a comparison of surfaces that had been ground and 'superfinished.' In this case the viscosity was known and the test cups were of different finish values. The result of one such test is shown in Table I where the total load applied in pounds designate the failure point of the load-carrying capacity of the oil.

We have found that an oil film has the maximum capacity to support great loads only if it is uniform in thickness and there are no projections above the supporting surface that destroy the structural strength of the oil film, which strength is due to molecular cohesion. This film strength increases at an inverse ratio as pressure reduces its thickness. But the projections above the supporting surface increase largely the material weakness of the film strength. Thus with a film thickness under load, and surface projections of 15 microinches R.M.S. which in reality means projections of 50 microinches, by actual measurement will reduce the oil film by half of its physical thickness, and since the entire surface is defective there is no possibility of maintaining the oil film under such conditions.

'Superfinishing' technique is the only method that will give the desired surface conditions from a metallurgical, as well as a physical standpoint, at an economical cost.

Table I

Machine used—Standard SAE oil-testing machine	*Microinches rms.*		*Total Load Applied, Pounds* 1	2	3	Average
R.P.M. 950	22 to 28	Ground	62	65	86	71
Rubbing Ratio 14.6:1	16 to 18	Ground	140	110	100	117
Load increase, lb. per sec 83.5	12 to 14.5	Ground	116	130	96	114
Oil used .... M.S. 782	8 to 10	Superfinished	165	148	146	153
Viscosity of oil used:	4 to 6	Superfinished	200	160	...	180
150 sec. at 210°F .... (99°C.)	0 to 2	Superfinished	222	224	204	217

Bearings of the Future

The economical production of bearing surfaces of the future with equipment that industry is now using and will be obliged to use for many years to come for economic reasons, will be geometrically true, developed by a compromise between so-called rough and finish grinding, 'superfinished' to a smooth topography of crystalline metal and super-surfaced in use by addition of chemical compounds in the lubricant, or super-surfaced by shop operation before assembly on such parts as ball and roller bearings, and on units that are completed before assembly of a final machine or device.

The preparation of really smooth surfaces, such as now required by engineers and industry, is in its youth, but sufficient results have been accomplished to greatly stimulate increased endeavor by physicists, engineers and production men, and still greater effort will be necessary to satisfy the engineer of the future.

ANNUAL MEETING, HAMILTON, ONT., FEBRUARY 6th and 7th, 1941

THE ST. LAWRENCE PROJECT

A REVIEW OF EARLY AND RECENT DEVELOPMENTS

Recently the St. Lawrence project has been brought to public attention again by the appearance in the press of statements credited to authorities in Washington and Ottawa to the effect that steps will be taken shortly to launch the undertaking. In view of the absence of any official statement regarding the scheme of development that is to be adopted in the International Rapids section, the news items in which reference is made to various schemes of development have been somewhat confusing. Because of the interest the engineering profession has in the undertaking, it was considered that the *Journal* might, with propriety, review briefly the evolution of the proposed Great Lakes-St. Lawrence development, in an endeavour to present a clearer view of the status of the project at the present time.—*Editor*.

Though, from time to time, various power interests both in Canada and the United States had attempted to bring about partial development in the International Rapids section of the St. Lawrence and both countries had evinced an interest in a general project, it was not until 1919 that they finally agreed to a joint study of the problem. In that year the International Joint Commission was asked to investigate what further improvements were necessary to make the St. Lawrence River between Montreal and Lake Ontario navigable for deep-draft vessels and to give the estimated cost. The Commission was also asked to consider a combined development for navigation and power to obtain the greatest beneficial use of the river. The Commission reported in 1921 that the development of the St. Lawrence for navigation and power was feasible, both economically and physically, and recommended a scheme combining navigation and power in the International section and a development for navigation alone in the National section with power development later.

Power interests in both Canada and the United States had submitted schemes for the development of the International Rapids section, and this led the Commission in its report to recommend that, before embarking upon the undertaking, the two countries set up an international engineering board to study the engineering features in greater detail and determine a scheme of development.

After some delay, what was known as the Joint Board of Engineers was formed, on which each country was represented by three engineers. This Board submitted its report in November of 1926. While agreeing as to the method of development in the National section, the Board could not agree upon the method to be followed in the more important International Rapids section. Two schemes of development were submitted: that presented by the American section of the Board was known as a Single-Stage Project, in which the total fall in the section was concentrated by a dam and power houses placed at the foot of Barnhart Island, navigation being carried around this obstruction by means of a side canal and locks on the American side; and that proposed by the Canadian section was a Two-Stage Project, with the upper dam and power houses at Ogden Island and the lower dam and power houses at the lower end of Barnhart Island. As an alternative, the Canadian section presented a second two-stage scheme, in which the upper plant was located at Crysler Island, the lower plant being located at Barnhart Island, as in the other scheme.

For various reasons, considerable time elapsed before the report was considered jointly by the two countries, but, in the meantime, it was under consideration by different official bodies in both Canada and the United States. The National Advisory Committee, set up by the Dominion, reported in January of 1928. Its report was generally favourable to the scheme, with the exception that it was definitely recommended that development of the National section should first be gone on with. As the United States' interests were confined solely to the International section, this recommendation did not make for progress.

It was not until June of 1931, due largely to changes in the political situation from time to time in either country, that negotiations were opened which ultimately resulted in the signing of a St. Lawrence treaty on July 12th, 1932.

The treaty provided for a two-stage scheme of development in the International Rapids section, with the upper dam and power houses located at Crysler Island and the side canal and locks on the Canadian side. The lower dam and power houses were placed at Barnhart Island, with the side canal and locks on the American side. When, however, the treaty came before the United States Senate in March, 1934, ratification was defeated. This marked another hiatus in the movement toward international action on the St. Lawrence development, which lasted until the spring of 1938.

In May, 1938, the United States Secretary of State, Mr. Cordell Hull, in a note to the Canadian Government, submitted a new draft treaty, and intimated that the United

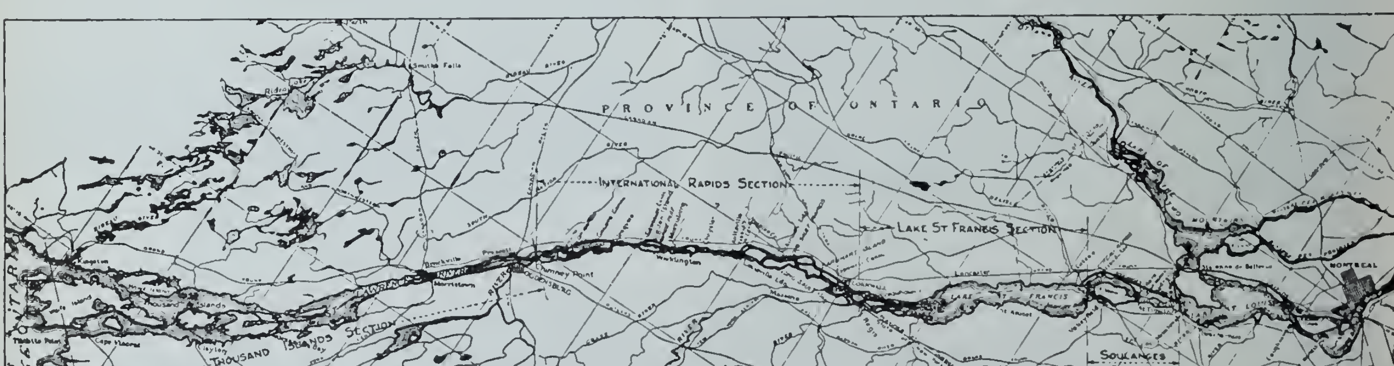


Fig. 1—Map of the St. Lawrence River, showing harbours, canals, rapids and the five divisions of the project suggested and used by the Joint Board.

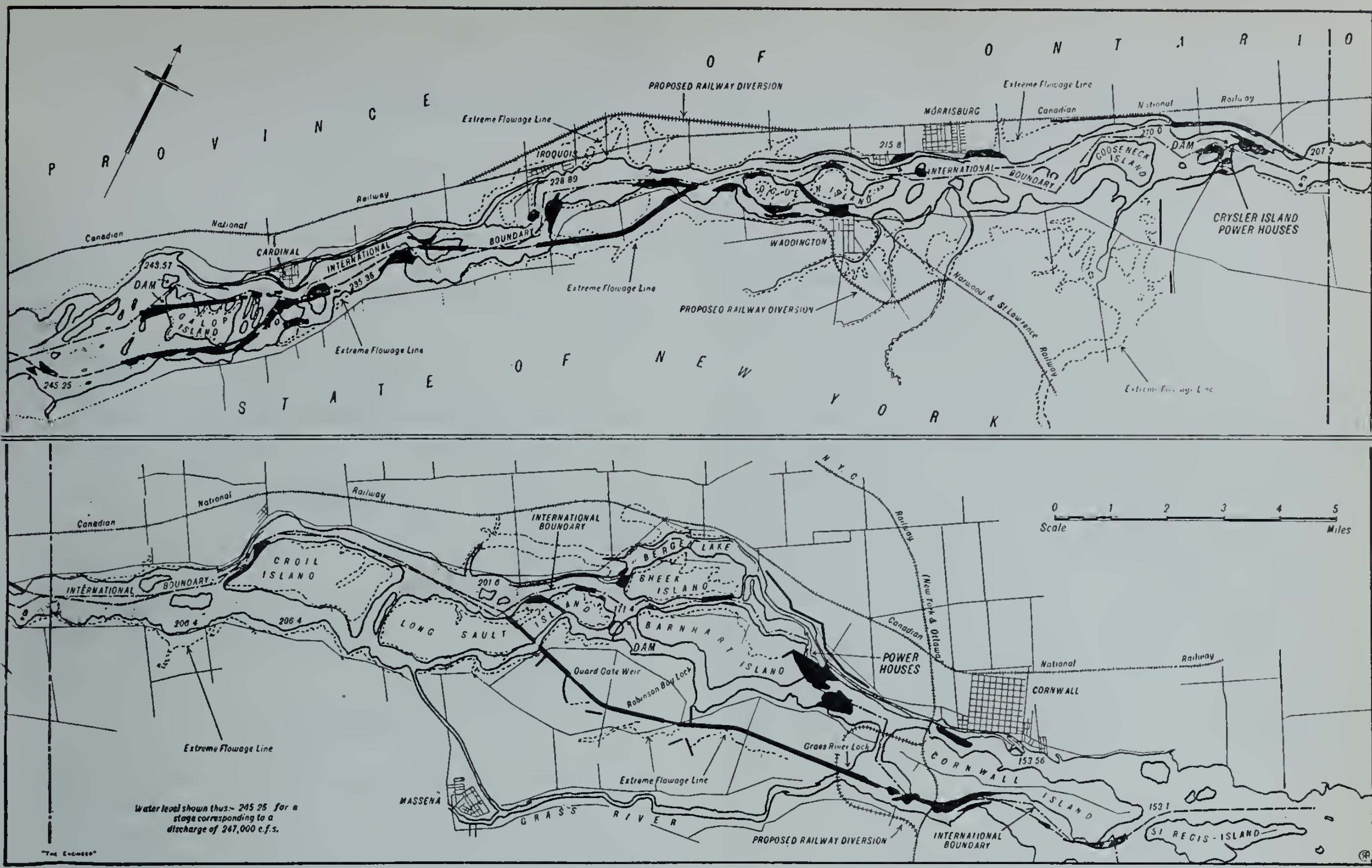


Fig. 2—Map showing proposed works in the International Rapids section.

States Government was prepared to enter into further negotiations. It was not, however, until the end of 1939 that any further action took place.

It is quite evident that full development of the St. Lawrence for navigation or for power is dependent upon agreement between Canada and the United States as to the scheme of development to be followed in the International section, and it is equally evident that such agreement is necessary before Ontario can make use of the potential power resources in the International section of the river, which forms a valuable part of that province's natural resources.

The cost of the whole St. Lawrence basin development has been the subject of much discussion, and a great many articles have appeared in the press from time to time criticizing the estimates first presented by the Joint Board of Engineers. The fact remains, however, that in the final analysis these estimates represent the opinion of those who have given the most study to the question, and they are used herein.

When considering the development of the St. Lawrence as a combined power and navigation project, it should be kept in mind that the costs of the undertaking fall into two main divisions: first, those which are properly part of the cost of developing power and producing electric power; and second, those which are properly chargeable to navigation. In the first division will be those costs assumed by the different authorities charged with the development and sale of power. It is stated that the investments in these undertakings would be self-liquidating and hence would not add to, or take from, the financial burden of the Government of Canada. Those costs coming under the second heading would be the obligation of the Federal Government.

In so far as the development of the International Rapids section is concerned, Ontario, as the owner of one-half of the power in this section, would make certain payments to Canada in respect to power's share of the cost of the undertaking, and these payments, when set off against those that Canada would make in respect to its share of the whole undertaking, would materially reduce that total.

The International agreement, which preceded the signing of the 1932 St. Lawrence treaty, was based upon a scheme known as the Two-Stage Crysler Island Project. The scheme was essentially that proposed by the Conference of Canadian Engineers, in which the upper dam, power houses and navigation locks were located at Crysler Island, where a head of twenty-four feet would be concentrated. The lower dam was located at the head of Barnhart Island, and the power houses at the foot of that island, where a head of sixty feet would be available. Provision was made to pass navigation around these works by means of side canals and the necessary locks.

The estimated cost of the two-stage Crysler Island project was $274,742,000.00, which amount was made up as follows:

Works solely for navigation	$ 34,188,000.00
Works primarily for power	132,452,000.00
Works common to power and navigation	108,102,000.00
Total	$274,742,000.00

Under the terms of the 1932 treaty, the United States would provide funds to construct all the works common to navigation and power and the substructures of the power houses.

The works in the International section for which Canada would pay were as follows:

Navigation works on the Canadian side	$ 8,219,000.00
Lands and rehabilitation works on the Canadian side	14,101,000.00
Total	$22,320,000.00

According to the 1932 agreement between Canada and

Ontario, the Province would pay the Dominion $67,202,-500.00, made up as follows:

Substructures of power houses, and headrace and tailrace excavation..........	$29,295,500.00
On account of lands and rehabilitation on the Canadian side, works common to power and navigation, and channel improvements....................	37,907,000.00
Total........................	$67,202,500.00

It is pertinent to note that, of this amount, the payment of $4,240,000.00 in respect to engineering and certain deferred power works was contingent upon Canada being able to arrange with the United States for the financing of these deferred works and for engineering services as and when required by Ontario. Actually, therefore, the sum guaranteed for payment by Ontario was $62,962,500.00.

According to the public press, what was described as "substantial agreement" was reached on the engineering features of the project by the Canadian and American engineers in Washington last January, and it was indicated that a single-stage scheme formed the basis for such agreement. The actual project was not disclosed, but it is understood that the basis of this agreement was a modified single-stage project in the International Rapids section which resembles, in its major features, the Single-Stage Project that was presented in the report of the Conference of Canadian Engineers of 1929.

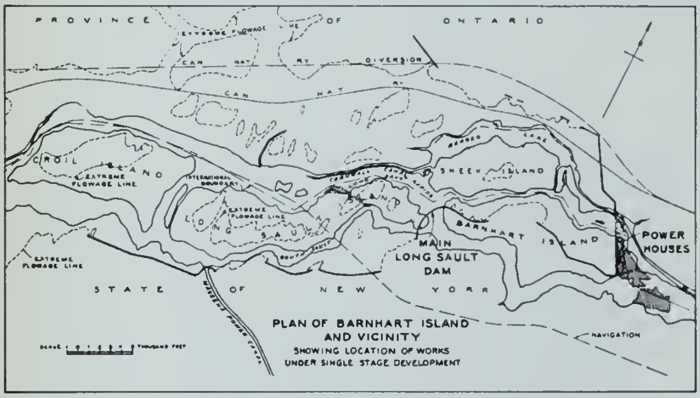


Fig. 3—Map showing location of the proposed power houses in the vicinity of Barnhart Island.

That report considered a single-stage scheme in which the main dam was located at the head of Barnhart Island and extended from that island to the foot of Long Sault Island and thence to the United States shore. The power houses were located at the lower end of Barnhart Island at the mouth of Little River, and were flanked by dykes extending on the south to high ground on Barnhart Island, and on the north to the high ground north of Mille Roches. Twenty-seven foot navigation was to be carried around these obstructions by means of a canal and locks located on the American main shore. Provision was also made to control the outflow and level of Lake Ontario by structures placed at the head of the Canadian Galops Rapids, at the head of the unwatering channel through Galops Island, and between Adams and Galops Islands.

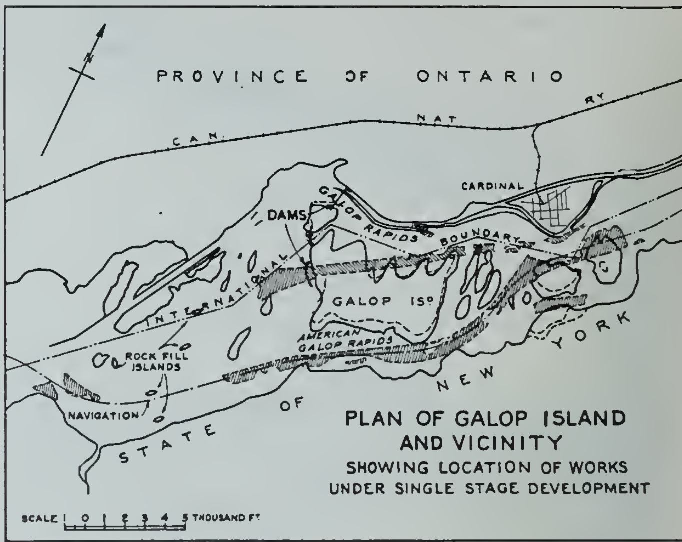


Fig. 4—Map showing the proposed control works at the head of Galops Rapids.

The lands and improvements that would be affected were the same as in the Two-Stage Crysler Island scheme, from the head of the Galops Rapids downstream as far as Crysler Island. Below Crysler Island the areas subject to flooding would be increased under the proposed plan, due to the higher water level and because no dyking was contemplated to protect any of the lands lying below the flood contour. The total land area below the extreme emergency level would be 28,600 acres, of which 14,800 acres would be on the Canadian side and 13,800 acres on the American side. Provision was made in the estimates for the rehabilitation of Iroquois and Morrisburg.

The cost of the Single-Stage scheme is estimated to be $236,418,000.00 made up as follows:

Works solely for navigation...........	$ 27,741,000.00
Works primarily for power............	87,481,000.00
Works common to power and navigation.	$121,196,000.00
Total.........................	$236,418,000.00

If Ontario contributed towards the cost of common works on the same basis as under the 1932 agreement, then the total payment would be:

Substructure of power house and excavation...........................	$18,909,500.00
On account of rehabilitation in Canada, and common works.................	42,418,500.00
Total........................	$61,328,000.00

ANNUAL MEETING, HAMILTON, ONT., FEBRUARY 6th and 7th, 1941

Abstracts of Current Literature

Abstracts of articles appearing in the current technical periodicals

THE BOEING B.17 AND DOUGLAS B.19 BOMBERS

From *Engineering* (London) November 15, 1940

Recent reports of the new American bombers, either ordered by Britain or for the United States Air Services, stress their size as an outstanding point.

One type of big American bomber is the Boeing B.17, sometimes called the "Flying Fortress." Actually, as big four-motored aircraft go, it is not unusually large. Its general dimensions and range correspond to those of Britain's 20-ton, four-engined flying boat, the Short "Sunderland." Its wing span of 105 ft. is 8 ft. less than that of the "Sunderland" and some 18 ft. less than the span of the Armstrong Whitworth "Ensign," Britain's biggest civil air liner, also a four-motored aircraft. As first produced some few years ago, the original "Flying Fortress" had four 1,000 H.P. Wright "Cyclone" motors, which give it a maximum speed of about 250 m.p.h. The effective range claimed was around 3,000 miles—say, from London to Tripoli and back—and the service ceiling just under 6 miles. Bomb load is a variable factor, dependent, among other things on the amount of fuel carried, but it is safe to assume that the B.17 could carry 4 to 5 tons of bombs and ammunition on a round trip of 2,000 miles. A feature of the design, which gave the B.17 the name of "Flying Fortress," is the number of protective gun positions. Four of these were originally provided in "blisters" on the outside of the fuselage, but later examples show gun turrets, similar to the British practice. Even so, the total gun power is not likely to approach that possessed by the latest versions of Britain's famous bombers, such as the turreted "Wellington." An improved "Flying Fortress," produced just before the war, had a cleaned-up external design and a special super-charging system for giving greater engine power at heights above 20,000 ft. The resulting performance figures were not made known, but it may be assumed that the maximum speed of 250 m.p.h. has been improved upon.

AIRCRAFT AND THE WEATHER

From *The Engineer* (London) November 15, 1940

There would still seem to be some doubt in the public mind concerning the influence of the weather on aerial activity. On some occasions the Air Ministry has announced that operations by aircraft of the Bomber Command have had to be cancelled or restricted because of unfavourable weather conditions, whereas on the self-same nights enemy aircraft have been over this country. It is therefore asked why we must be idle while the Germans are active. One reason is that while the weather over the target area is important, the weather over the bases from which the aircraft operate is even more important. British aircraft can take off and fly in the worst kind of weather, just as, presumably, the enemy's machines can, but they have to get back to their bases and land safely. Undoubtedly the enemy is more favourably situated in this respect than we are. His bombers on the outward journey have usually a short distance to travel to reach their objectives, and can carry enough petrol to enable them to return and land at almost any aerodrome from Bordeaux to Norway, some one or more of which will probably be outside the belt of bad landing weather. British aircraft, on the other hand, are compelled to work from a much smaller area, and frequently have to cover long distances to reach their targets. If on their return they find their bases partly obscured or blacked-out by low cloud or fog, the gravest risk is imposed on the crews and the aircraft. The enemy's strategy for a time consisted of endeavouring to inflict as much damage as possible without paying great attention to the casualties which he suffered. It is probable that the severity of the lesson administered to him has induced him to be less rash and that he is now paying more respect to the weather, as well as to the Royal Air Force, in planning his operations against us.

WARTIME INVENTIONS

From *The Engineer* (London) November 15, 1940

In an address which was broadcast by Dr. D. R. Pye, F.R.S., the Director of Scientific Research of the Ministry of Aircraft Production, the question of the many inventions received from the general public relating to war matters was dealt with in a most interesting way. Dr. Pye revealed that since the war started well over 20,000 inventions had been sent to the Air Ministry and the Ministry of Aircraft Production. They came, he said, from all over Britain, the Dominions and from abroad as well. At the present time they were pouring in at the rate of about 3,000 a week. Each letter or memoradum was recorded, filed and answered. For this work there were some thirty scientists, engineers and technicians, together with the necessary clerical staff, which devoted its whole energies to sifting and analysing the flood of ideas. In addition, there was a distinguished scientist and engineer of long experience, who acted as a referee in difficult cases. The ideas received, Dr. Pye said, included those of every imaginable kind. Among them were wild and fantastic, the sensible but already well known, and the interesting and unusual. The fantastic included the optimist who wanted to freeze the clouds and mount anti-aircraft guns upon them. There was also a wonderful helicopter, worked by a perpetual-motion engine, for carrying searchlights, guns and men to colossal heights. There were, too, many varieties of death rays. Most of those inventions were pious hopes, which the inventor hoped the technical expert would turn to practical use, of course under his own supervision. The most interesting group always was suggested by the need of the moment. A few months ago it was schemes for coping with the parachutist, and just now it was how to tackle enemy bombers after dark. In most cases the proposals submitted were some variant of schemes which had been studied and experimented with for many months or even years past. In such cases the most important thing to do was to see whether some new suggestion might not render a scheme practical which hitherto had not seemed worth while pursuing. Dr. Pye recalled that nearly five years before the war an Advisory Committee of Scientists was helping us to foresee what would be needed if war should come and to provide against it. So it was only to be expected perhaps that a large number of ideas now being put forward should have been thought of before. Any of those which showed promise were developed and experimented with, tests and calculations were made and full-scale trials were often carried out. He could not say very much as to the suggestions which had proved fruitful as we wanted them to be unplesant surprises for the enemy. In inviting his hearers to send in any suggestions which might help to win the war Dr. Pye said that there was close collaboration between the Directors of Scientific Research at the Admiralty, the Ministry of Supply and the Ministry of Aircraft Production, and any suggestion received was at once passed to the right department for examination.

GRANT OF ARMS TO THE INSTITUTION OF MECHANICAL ENGINEERS

From *Engineering* (London) November 15, 1940

In the Annual Report of the Council of the Institution of Mechanical Engineers for the year 1939, it was stated that a grant of armorial bearings had been made to the institution under Letters Patent from the College of Arms. The Royal Charter of Incorporation which was granted by the Crown in 1930 constituted the Institution of Mechanical Engineers "one Body Corporate and Politic, with perpetual succession and a Common Seal with power to break, alter and make anew the said Seal from time to time at their will and pleasure." By virtue of this authority, steps were taken to apply for these Letters Patent, so that the seal, arms, crest and supporters should be devised on correct heraldic principles. The accompanying illustration reproduces the emblazoned drawing by Mr. Cecil Thomas, who was commissioned by the Council to prepare the steel die for the seal.

The symbolism adopted is briefly as follows: On the shield, a device signifying the art of measurement and accuracy of workmanship; as the crest, controlled power dominating the world, typified by a heraldic horse chained to the globe from a coronet, which is itself a symbol of a chartered body; lastly, as supporters (to which the institution is entitled as a chartered body), a representation of Archimedes appears on the left, to signify science, and of Vulcan, on the right, to signify craftsmanship. The word "Progress," appearing below the shield, has been used by the institution on various of its devices and at different times since it was founded. The Council state that they were greatly assisted in the whole undertaking by one of their members, the late Colonel Sir George Willis, C.I.E., M.V.O., Mech.I.M.E., then Chairman of the Southern branch, who was an authority in heraldic matters.

In the words of the grant, the symbolism just given is thus described:

"Sable between the points of a pair of Callipers inverted Or a Plate and for the Crest on a Wreath of the Colours:—Upon a terrestrial Globe a Grey Horse forcene proper gorged with a Coronet composed of four Fleur-de-Lys with Chain reflexed over the back Or . . . : And by the Authority aforesaid I the said Garter King of Arms do further grant and assign the Supporters following that is to say:—On the dexter side a Figure representing Archimedes holding in his exterior hand a Pointer and on the sinister side a Figure representing Vulcan resting his exterior hand upon a Sledge Hammer proper . . . the whole to be borne and used for ever hereafter by The Institution of Mechanical Engineers on Seals, Shields, or otherwise according to the Laws of Arms."

LARGE OR SMALL A.R.P. SHELTERS

From *The Engineer* (London) November 15, 1940

When this war began, as everyone knows, German aircraft, intent upon raiding this country, had of necessity to begin their flights from within German borders and thus had to make a journey of several hundreds of miles. It was expected at that time that on the outbreak of war an aerial blitzkreig would be directed against London and other large cities; that it would be maintained by thousands of aircraft, and that the weight of the attack would be broken within a few weeks. When the blitzkreig did not materialize the only alternative that seemed probable was a succession of relatively frequent, but short-time, raids kept up by a smaller number of aircraft operating mainly in daylight; for it was known that the Germans did not regard night bombing as effective. There can be little doubt that the official policy of A.R.P. works designed to meet those conditions and adopted by Sir John Anderson was the right one in the light of expectations. It relied upon the dispersal of the population in Anderson shelters, street shelters, basements, and cellars to reduce the loss of life resulting from the effects of any single bomb. The public shelters envisaged, of which many have now been constructed, were to provide protection against blast and splinters, but were not intended to give security against a direct hit. As against a policy of building deep bomb-proof shelters which was advocated long before the outbreak of war, it was argued, and at that time we think rightly argued, that there was insufficient time to construct them and, of greater importance, that those requiring shelter when the sirens wailed would not have sufficient time to travel any distance, but must look for shelter on the spot. Since large shelters must be spaced out at relatively large distances, no expectation could be held out that their capacity for holding hundreds or even thousands of people would ever be properly used.

When, however, first Norway, then Holland, Belgium, and France were overrun by the Nazis in quick succession, the original conditions no longer held true. Thanks to the magnificent efforts of the R.A.F., daylight raids remained of the short-lived type. But the Germans began to raid by night and, thanks to the proximity of their captured aerodromes to our coasts, they are now able to maintain a raid from dusk to dawn. At night, therefore, instead of being forced to retire for an occasional short period to a place of security, as originally envisaged, the majority of the population, if it remains at home, has to choose between spending the night in safety and discomfort, as represented by a garden shelter, or in comfort and at risk as represented by the house itself. It is little wonder that as the weather has become progressively colder and wetter more and more people have deserted their homes each night and carried what comforts they can to public shelters, where warmth at least is usually combined with a greater sense of safety. They have done so in spite of the fact that those shelters were originally built with the intention of providing protection only for people caught in the streets—not for the surrounding householders and tenants. In fact, expectations regarding raids have not been realized. The chief objection to large shelters holding thousands of people has become no longer valid. For where such shelters exist, as in the case of Aldwych tube, they are filled to capacity before the night raids begin. In the light of these facts the A.R.P. Coordinating Committee, an independent body which has doctors, architects, scientists and engineers on its membership, has recently sent a communication to Mr. Morrison the recently appointed Minister of Home Security, condemning the policy recently announced by the Minister, which, so far as the provision of shelters is concerned, provides for little modification of his predecessor's methods. The object of the Committee, which has been in existence since a date before the war began, is to encourage the provision of really secure shelters for the greater part of the population. The Committee advocates the construction of large and really bomb-proof shelters. They can be of the tunnel or "deep" shelter type or built on the surface, then depending, not on depth, but on concrete and steel for their bomb-proof qualities; additionally, as indeed already provided for by the Government, it proposes construction of new shafts from the tube railways. The shelters, it is argued, should be of large size, for several reasons, the most important being that for a given expenditure per head the large shelter can be made safer than the small one. As to the cost, it is stated that the contract for the scheme for a deep shelter at Finsbury, that caused so much controversy in February, 1938, was actually being negotiated at that time for an amount which worked out at the not unreasonable figure of £13 per head.

Great sympathy will be felt by everyone with the objects of the Committee. There can be little doubt about the technical possibility of building bomb-proof underground shelters. We may, too, reasonably suppose that the Committee has satisfied itself, at least, regarding the possibilities of overcoming the technical difficulties of building really bomb-proof shelters above the ground. The large shelter, it is claimed by the Committee, has other advantages apart from its safety. The erection of bunks and the provision of ventilation, warmth and sanitary services, all necessities if the health of the people is to be maintained, can be very much reduced per capita as compared with small shelters. To some extent the Government has already admitted the need for large shelters by its decision to drive additional headings from the tube railways in London and by opening the Aldwych tube and the platforms and passages of other tube stations to those seeking all-night shelter. But it is clear that it still views with disfavour the general construction of large bomb-proof shelters. There are, of course, many factors which the Government in coming to that decision has had to take into account, notably in relation to finance and the availability of materials and labour. In that connection it is stated by the Committee that out of a pre-war steel productive capacity of 13 million tons annually, only 11,000 tons annually has been allocated to A.R.P. purposes. The whole matter, too, is obviously influenced by the possibility, the chances of which the Government is in a better position than anyone else to reckon, that the answer to the night bomber may be imminent. But at least the arguments of the Committee deserve careful consideration in conjunction with all other information available to the Government. It certainly must not be mere departmental inertia in failing to understand the altered conditions that holds back a change of policy, if such a change would be beneficial.

AMERICAN AIR EFFORT

Abstracted from *Trade and Engineering* (London), October, 1940

Buffalo and Boston

The United States is now delivering in quantity to the R.A.F. two useful types of aircraft—the Brewster single-seat fighter and the Douglas light bomber. In this country they will be known as the Buffalo and the Boston respectively. The Buffalo was originally developed for use by the United States Navy as a deck-landing fighter, but will be employed by the R.A.F. as a land-fighter. It is a midwing monoplane with a very short and deep fuselage, at first glance not unlike the Curtiss Hawk, which did such good work for the French Air Force. An undercarriage of unusual design, which retracts partly into the wing and partly into the fuselage, is a feature of the design. Generally, the aircraft is of orthodox stressed skin construction, with the exception of the movable control surfaces, for which fabric covering is employed. Power is provided by a Wright Cyclone nine-cylinder radial air-cooled engine, which drives a variable-pitch airscrew. It is believed that its performance is such as to make it an invaluable acquisition to the R.A.F. In size the Buffalo is similar to our Spitfire, but it can hardly be claimed to have such attractive lines.

The Boston is a twin-engined light bomber of unorthodox design. It is of monoplane type, with sharply tapered wings and a fairly deep, narrow fuselage. The undercarriage is of the tricycle type, with the two rear wheels retracting into the rear of the engine nacelles, and the nose wheel retracting rearwards and upwards into the fuselage. When raised, it is covered by hinged panels. Two Wright Cyclone nine-cylinder radial air-cooled motors should give a reasonable speed, but no performance data may yet be published.

Production Growing

Recently the United States National Defence Advisory Commission published a report stating that the country's aeroplane production was about 1,000 a month. Early next year it will be 2,000, and by the end of 1941 it will be 3,000. The report contained no indication of what proportion of the figures represents bombers, fighters, and trainers. It is also stated that by next spring mass production of defence materials generally will be developing rapidly. It contradicted Mr. Knudsen's statement that motor-car factories would be turned over to aircraft production, pointing out that the country would need plenty of motor-cars and lorries in the defence programme and that the present factories were best equipped to produce them.

Aircraft for Great Britain

Of special interest to this country is the statement that it has been arranged that Britain shall receive an average of 700 American fighter aircraft a month over the next 20 months. According to a usually reliable source this means that, counting aeroplanes which are already being manufactured in the United States, Britain will be able to buy a total of 14,000 aircraft by April, 1942, if she wishes to do so. The same source states that the record of British aircraft purchases in the United States between the middle of 1938 and August 27 of this year is as follows: ordered by the British Government, 4,778; undelivered French orders 3,286. These two figures give a total of British orders amounting to 8,064. Exports to the British Government were put at 2,633, while aeroplanes delivered but not yet exported numbered 195, leaving an undelivered balance of 5,236. The same report stated that the United States War and Navy Departments have also approved British orders for 1,820 additional aeroplanes, but that these have not yet been allocated among manufacturers. When they are allocated the total number of aircraft now being produced for the British Government in the United States will reach 7,056 and another 7,000 will be produced, according to present arrangements, in the next 20 months, as orders for them are placed.

Chain of Factories

According to the American paper, Wall Street Journal, Great Britain is planning to build a chain of aircraft factories in the United States, so as to produce about 1,300 aeroplanes a month by the end of 1941. Whether this is so or not, a number of aircraft factories are to be built by the United States, with loans from the Reconstruction Corporation, at an estimated cost of between £37,000,000 and £50,000,000. This scheme includes a loan to the Packard Motor Company for works at which Rolls-Royce aero engines will be constructed under licence. The Wright Aeronautical Corporation, which is doing a great deal of important work these days, has also accepted loans amounting to approximately £23,000,000 for new buildings and plant. As a safety measure the U.S. War Department has insisted on new aircraft factories being established in a special area which is several hundred miles inland from the Atlantic coast and already contains a number of blast furnaces, foundries, metal working shops, and machine-tool plant. Five well known companies—Douglas, Lockheed, Boeing, Vultee, and Consolidated—have also issued a joint statement announcing that without waiting to ascertain what legislation Congress will pass to limit their profits, they are going ahead with preparations to increase production. The Allison concern recently effected a considerable expansion of plant, with the result that a rapid increase has been taking place in its output of aero engines, and by the end of the year they should be coming out at a rate in excess of 500 a month. Equally big expansion has been achieved by the Pratt and Whitney division of the United Aircraft Corporation, which expects to produce between 700 and 800 aero-engines a month from now on, while the Curtis Wright Corporation is believed to have exceeded 600 engines a month.

Meanwhile, production is going ahead satisfactorily in Canada, and it was recently announced from Ottawa that the British Government had placed an order for 600 Hurricane fighters with the Canadian Car and Foundry Company. They will be built at the Company's plant at Fort William, Ontario.

CROMPTON'S FIRST APPRENTICE

From *Bepco Journal*, March, 1940

We give below a copy of the official apprenticeship indenture of Crompton's first apprentice, Mr. W. A. Murrell, who we regret to announce passed away at Chelmsford on May 5th, 1938.

"This Indenture Witnesseth that William Augustus Murrell, Son of William Bartwell Murrell, Innkeeper of the Three Cups Inn, Springfield Road, Chelmsford in the County of Essex, with his own free will and by the consent of his Father doth put himself Apprentice to Rookes Evelyn Bell Crompton of Anchor Iron Works, Chelmsford in the county aforesaid, to learn his Art and with him after the Manner of an Apprentice to serve from the eighteenth day of October, one thousand eight hundred and eighty unto and including the eighteenth day of October, one thousand eight hundred and eighty-five unto the full End and Term of Five Years from thence next following to be fully complete and ended. During which term the said Apprentice his Master faithfully shall serve his secrets keep his lawful commands every where gladly do. He shall do no damage to his said Master nor see to be done of others but to his Power shall tell or forthwith give warning to his said Master of the same. He shall not waste the Goods of his said Master nor lend them unlawfully to any. He shall not commit fornication nor contract Matrimony within the said Term shall not play at Cards or Dice Tables or any other unlawful Games whereby his said Master may have any loss with his own goods or others during the said Term without Licence of his said Master. He shall neither buy nor sell. He shall not haunt Taverns or Playhouses nor absent himself from his said Master's service day or night unlawfully. But in all things as a faithful Apprentice he shall behave himself towards his said Master and all his during the said Term.

"And the said Rookes Evelyn Bell Crompton his said Apprentice in the Art of a Light Brass Finisher and Electrician which he useth by the best means that he can shall teach and Instruct or cause to be taught and instructed. And the said Rookes Evelyn Bell Crompton agrees to pay to the said William Bartwell Murrell for the services of the said apprentice during the said term except through inability to work or loss of time arising either from illness or otherwise, namely, during the first year the sum of three shillings per week during the second year the sum of four shillings per week during the third year the sum of five shillings per week during the fourth year the sum of six shillings per week during the fifth year the sum of eight shillings per week. Hours of Labour to be regulated according to the Factory Act.

"And for the true performance of all and every the said Covenants and Agreements either of the said Parties bindeth himself unto the other by these Presents. In witness whereof the Parties above named to these Indentures interchangeably have put their Hands and Seals in the Fourty-fourth Year of the Reign of our Sovereign Lady Queen Victoria by the Grace of God of the United Kingdom of Great Britain and Ireland, Queen Defender of the Faith and in the Year of our Lord One Thousand Eight Hundred and eighty-one."

Witness:

W. A. Robinson
Chelmsford

W. A. Murrell
W. B. Murrell
R. E. B. Crompton

William Augustus Murrell the within named apprentice has completed the term of his apprenticeship to my entire satisfaction.

R. E. Crompton

Chelmsford, October 20, 1885.

AIR-RAID DAMAGE AND MUNITIONS PRODUCTION

From *Engineering* (London) November 15, 1940

Broadly speaking, the strategy of the aerial warfare between Germany and her ally, and Britain, exhibits two principal phases. In one of these the machines have been used as auxiliaries to the ground or sea forces, for reconnaissance purposes and as a means of transporting offensive weapons, which can thus be used with great freedom against the opposing navies, armies and even the civil population. The Germans have exploited this method to the full, and it will be admitted that, from a purely military point of view, its value has been proved by events in Poland, Holland and France.

In the other phase, aircraft are also employed as destructive weapons; not, however, so much against the enemy's own fighting forces as against his land, sea and air communications, and especially against those industrial resources upon which his supply of munitions depends. It is this phase that we ourselves are now employing to the full, selecting targets the destruction of which will impede the enemy's war effort. That this policy, too, has not been lacking in success is shown by the reports of the condition of Hamburg, which has now virtually ceased to be a centre of production. For his part, the enemy, in his attacks on this country, has adopted the opposite view and in so doing has clearly shown his ignorance of the psychology of the British race. The result is that while by his constant raids he has exposed a number of innocent people to a great deal of unnecessary suffering and inflicted some thousand of casualties on men, women and children, he has, as Mr. Herbert Morrison recently pointed out, failed to reduce the productive capacity even temporarily by more than a small fraction of 1 per cent.

From a military point of view, we may, therefore, congratulate ourselves, both on adopting the more correct policy, and that, thanks to the efforts of the Royal Air Force, the enemy's contrary ideas have been proved to be fallacious, both in theory and practice. There is, however, another side to the picture. Though the damage that has been done to our factories and communications by indiscriminate bombing, considered from the material point of view, is small, it is not negligible. Moreover, it is by the nature of things more evident in London and South-Eastern England than in any other part of the country. How important this is is shown by the fact that this area is inhabited by something like a quarter of our population, and includes about the same proportion of the productive capacity of the industries which supply our munitions, using that term in its widest sense. Not only is this the case, but because the locality of London, as regards liability to bombing is so vulnerable, there are problems, among which transport is obviously one, which are not met with so acutely elsewhere.

How best to repair the damage to our productive capacity that has been caused by enemy action in this area is, therefore, rightly receiving the closest attention of the London and South Eastern Area Board. This Board, which is duplicated by others of the same nature in the rest of the country, comprises representatives, both of employers and of the trade unions, as well as of the Ministries concerned with aircraft production, naval construction and repair, and the needs of the army. Labour problems are looked after by the divisional controller of the Ministry of Labour, and the export trade by a representative of the Board of Trade. Moreover, there is liason with the Industrial Capacity Committee, of which the Area Boards in the country are a part, and through this committee with the War Cabinet. Finally a representative of the Minister of Transport has recently been added, since, in the London area at least, the maintenance of easy and rapid communication between the workers' homes and places of employment is an important part of the problem.

It may also be pointed out that one of the duties of these Area Boards has been to examine the machine tool census which, as is well known, takes place at regular intervals, and in this way to find means of using spare capacity of tools and premises, to see that labour is used in the most productive way, and particularly to make alternative arrangements which will ensure that industrial capacity is commensurate with industrial requirements when premises become partially damaged or disabled as the result of enemy action. It is in this connection particularly that transport is important. While it may be possible, even relatively easy, to arrange for the work of an essential factory to be carried on, at least temporarily, in one that is not so essential a few miles distant, such a transfer imposes disabilities on the workpeople, which are not willingly borne and which they can hardly be expected to bear. There is evidence that this is a point which employers sometimes tend to forget under the pressure of other work, and, if the Board can do anything to relieve the situation in this respect, they will have done much towards justifying their existence. The Board has also undertaken the task of arranging for the replacement of such precision tools as are the workers' personal property.

It will not be denied that if production is to be maintained under "Blitzkrieg" conditions, some organization, which will operate speedily and efficiently, and we had almost said with due disregard for rules and regulations, is required. It remains to be seen whether the arrangements which the Board has made fulfil these conditions. Actually, what has been done is to set up nine "clearing centres," seven in London and two in the South Eastern Area, to which those in need of help can refer and which can, in turn, invoke the assistance of their fellows. So far these clearing centres have been mainly concerned with engineering firms, and in particular have designed rather elaborate machinery for classifying the machine tools available. In this way, it is hoped that the possibilities of idle tools or idle labour will be eliminated, and the best and most economic use of the reserves will be secured. It is proposed to extend their labours by organizing such reconstruction of damaged premises as may be necessary after the emergency service designed by the Ministry of Aircraft Production has operated. It will, it is hoped, do this without duplicating the work of other departments, though, of course, it will work in the closest conjunction with them.

THE EAST-WEST AXIAL ROAD IN BERLIN AS A TRAFFIC ROUTE

By H. Langer
From *Verkehrstechnik*, 1939

Abridgement of an abstract compiled by the Department of Scientific and Industrial Research and Ministry of Transport, London

The provision of an axial road from east to west of Berlin formed part of the reconstruction plan sanctioned in 1937. This plan involved the partial reconstruction of the Charlottenburger Chaussée, Bismarckstrasse and Kaiserdamm. On the first of these, the new cross-section includes two 48-ft. carriageways each having a uniform straight crossfall and separated by a central strip 13½ ft. wide. The verges are raised about 9 in. above the carriageways; each contains a 4-ft. safety strip, a cycle track 6½ ft. wide and a footway 21 ft. wide. The provision of the safety strip between the cycle track and carriageway obviates danger to cyclists from the opening of car doors, etc. Access to the carriageway is gained only at important junctions. Trees are planted outside the footways. On one short section an additional carriageway 20 ft. wide is provided for local traffic. On the Kaiserdamm, where less space is available, the widths of the safety strips, cycle tracks, and footways are reduced respectfully to 2½ ft., 5 ft., and 20 ft. and the cycle track is separated from the footway by a line of trees. At intersections the cycle tracks have a gradient of 1 in 15 to the carriageway level, the slope beginning 24 ft. from the junction; the footways continue at their normal level to the actual junction, where the standard radius of curvature is 23 ft. Other important works include the reconstruction of the Grosser Stern, where seven roads meet. Here two subways have been provided for pedestrians. The whole of the intersection has been enlarged, the present extreme radius being 330 ft. and that of the central space 196 ft. At the intersection with the north-south axial road, two vehicular tunnels have been provided for cross traffic, and a single vehicular tunnel has been constructed at the important Knie intersection. The carriageways are surfaced throughout with a two-course carpet of stone-filled mastic 2 in. thick, placed on a 12-in. concrete foundation. All joints in the latter are close joints containing a double thickness of bituminised felt. The joints are protected by building paper painted on the under side with bituminous material. A spacing of 33 ft. is adopted for transverse joints. The central reservation is surfaced with small granite setts on an 8-in. concrete foundation. The safety strip is paved with rough granite setts, the cycle tracks with concrete slabs 12 by 12 by 1.6 in., and the footways with artificial stone slabs 20 in. square or with yellow gravel. The road is lighted by lamps carried in pairs at a height of about 19 ft. on posts 22 ft. high erected on the footways. The direction in which light is emitted is varied on different sections according to local conditions, e.g., the presence of trees. The posts are placed respectively 82 ft. and 62 ft. apart on the eastern and western portions of the route. The lanterns are cylindrical. Each contains two 750-watt filament lamps, one placed vertically above the other. A diagrammatic summary shows the maximum, minimum and average intensity of illumination on different portions of the road. Three-colour automatic signals are provided at intersections, one series controlling vehicular and cycle traffic and the other the movements of pedestrians.

FIFTY-FIFTH ANNUAL GENERAL

HAMILTON - ROYAL

THURSDAY AND FRIDAY,

H. A. COOCH
General Chairman

J. R. DUNBAR
General Vice-Chairman and Chairman of the Hotel Arrangements Committee

PROGRAMME

THURSDAY, FEBRUARY 6th

9.00 a.m.—Registration.

10.00 a.m.—Annual Meeting and Address of Retiring President.

12.30 p.m.—Luncheon.

2.30 p.m.—General discussion on the training and welfare of the young engineer under the auspices of the Institute's Committee of that name.

7.00 p.m.—Joint dinner with the Niagara District Electric Club.

8.00 p.m.—Joint Meeting. Lecture and demonstration by Dr. J. O. Perrine of the Research Division of the American Telephone and Telegraph Company.

FRIDAY, FEBRUARY 7th

9.30 a.m.—Technical Sessions.

12.30 p.m.—Luncheon.

2.30 p.m.—Technical Sessions.

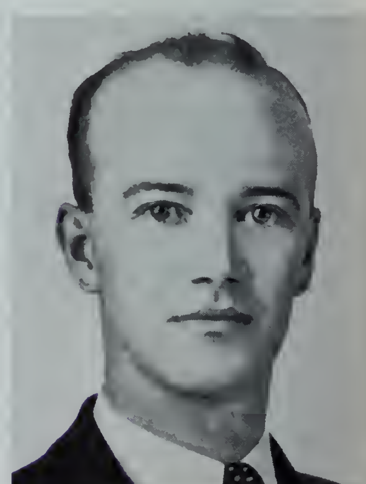
7.30 p.m.—Banquet.

10.30-2.00 a.m.—Dance.

Dr. William Elgin Wickenden, President of the Case School of Applied Science of Cleveland, Ohio, will be the guest speaker at the banquet on Friday night.

E. P. MUNTZ
Chairman of Papers and Meetings Committee

T. S. GLOVER
Chairman of the Publicity Committee



W. E. BROWN
Chairman of the Registration and Information Committee

Special return tickets will be supplied by the railways at the rate of one and a third of the regular one-

AND PROFESSIONAL MEETING

CONNAUGHT HOTEL

FEBRUARY 6 AND 7, 1941

MRS. HUGH LUMSDEN
Convener, Ladies Committee

PAPERS

Training for National Defence, by Dean A. A. Potter, Chairman of the Advisory Committee on Engineering Training for National Defence, Washington, D.C.

La Tuque Power Development, by J. A. McCrory, Vice-President and Chief Engineer, Shawinigan Engineering Company, Montreal.

Earth's Crust Resistance and Lightning, by A. S. Runciman, Superintendent of Transmission Lines, Shawinigan Water & Power Company, Montreal.

Canada's Highway—Banff to Jasper, by T. S. Mills, Department of Mines and Resources, Ottawa, Ont.

Moment Distribution and the Analysis of a Continuous Truss of Varying Depth, by E. R. Jacobsen, Structural Engineer, Dominion Bridge Company, Lachine, Que.

N. A. EAGER
Chairman of the Finance Committee

Ignition Rectifiers for War Industries, by J. T. Thwaites, Canadian Westinghouse Co. Limited, Hamilton, Ont.

Estimating Production Costs in Aircraft Manufacture, by A. T. Wanek, British Air Commission, New York.

W. L. McFAUL
Chairman of the Visits Committee

MAJOR H. B. STUART
Chairman of the Reception and Entertainment Committee

way fare. Necessary certificates will be mailed shortly along with a programme of the entire meeting.

From Month to Month

News of the Institute and other Societies, Comments and Correspondence, Elections and Transfers

A New Year's Message

To every member of the Institute I extend my Best Wishes for a Very Happy New Year.

The year 1940 will be long remembered in the annals of civilization for its poignant tragedy, as well as for the inspired determination of the British people to fight for the freedom of all peoples and for the end of selfish national aggression.

Although 1941 will bring hardship and suffering and will test our strength and endurance to the utmost, we can, I am sure, find happiness in the knowledge that our contribution will be to the lasting benefit of all mankind.

President

CO-OPERATION ON THE MARCH

Another milestone on the road to co-operation was passed on December the fourteenth at Calgary. President Hogg of the Institute, and President McLean of the Association of Professional Engineers of Alberta, at that time signed a co-operative agreement between the two bodies. The occasion was marked by a dinner at the Renfrew Club, which set up a new record for attendance and for interest. One hundred and fifty engineers, from Montreal to Vancouver gathered to celebrate the important event and to participate in it.

The same enthusiastic support that was given by ballot to the proposal was given also to the ceremony of signing. It must be a source of much satisfaction to the leaders of the movement in the province to know that the profession backs them so wholeheartedly in their actions. The dinner left no doubt in the matter.

Alberta has joined the small group of provinces which, separately and collectively, are now taking practical steps towards bringing the profession together. For them, co-operation ceases to be a theory, a mirage or a football. It becomes a fact, a principle and a practice.

Although this event brings the total of agreements to only three, it marks a distinct forward movement. It is still a long way from complete co-operation, but within each province co-operation will be complete. The success of the movement in these three proving grounds should be an encouragement to engineers in other places who have similar ideals. Discussions are underway now with other provinces, which it is believed will lead within a short time to the submission of similar proposals in those areas. Eventually, a genuine desire for co-operation will bring to pass great and beneficial changes within the profession, and to these three pioneering provinces will go the lion's share of the credit.

THE PRESIDENT VISITS THE WEST

The visit of a president to any branch is an event of importance, but it carries extra values to those branches in the west and the east. Therefore it has been particularly pleasing that President Hogg was able to take time from the pressing demands of his office to go to Calgary for the signing of the co-operative agreement. In this way he emulated the example of his two immediate predecessors, each of whom carried out a similar ceremony during his term of office.

The president stopped at Winnipeg on the way west, and after the meetings at Calgary extended his trip to the coast. Splendid meetings were held at each stop, and great interest was shown on every hand. Thus the president rounds out a very active year. He visited all branches in Quebec, many in Ontario, and several in the west. If it were not for increased demands upon his time due to war time industrial expansion, he would have been able to get to the Maritimes, and branches elsewhere that he has been forced to pass by.

With the president on his western tour were Past-President Lefebvre, Councillors Vance of London, McLeod of Montreal, and the general secretary, and at Calgary Past-President Gaby was also present. This "entourage" was greeted with real western hospitality, and by its presence indicated the interest that is taken in far away branches by officers from central Canada.

At Winnipeg the president addressed a meeting of the branch held at the University on the evening of December eleventh, and on the following day met with the executive and past officers of the branch at luncheon. Both functions were presided over by Branch-Chairman H. L. Briggs. That evening the President's party went by plane to Calgary.

There were two outstanding events at Calgary. On the Saturday morning a regional meeting of Council was held, at which an attendance of forty was recorded. The presence of several past councillors and officers of the branch added materially to the interest and value of the discussions.

That night the main event took place at the Renfrew Club. It was a dinner given jointly by the Association of Professional Engineers of Alberta and the Alberta branches of the Institute, presided over by P. M. Sauder, vice-president of the zone, to celebrate the signing of the co-operative agreement. The local officials certainly did justice to the occasion. The attendance and the enthusiasm were gratifying in the extreme. Distinguished officers of sister societies such as the Canadian Institute of Mining and Metallurgy, the Dominion Council of Professional Engineers, and officers of the Institute from branches throughout the zone were present, and gracefully presented the greetings of the bodies which they represented.

The ceremony of signing the agreement was carried out with a dignity and a formality that would have done justice to the opening of an ancient parliament. There were impressive looking documents, gold presentation pens, pages in uniform, and much of the paraphernalia of pomp and circumstance. The arrangements were perfect, and the Alberta committee has "shown the world" how a ceremony should be conducted.

Early Sunday morning (the fifteenth), the party started on what was supposed to be a four hour flight, but nature took a hand in the proceedings, and so completely "fogged out" Vancouver that the plane had to go on to Patricia Bay, just north of Victoria. From Victoria the trip to Vancouver was completed by boat—substantially behind schedule.

On Monday, the president was guest speaker at a luncheon meeting of the Vancouver Board of Trade, under the chairmanship of H. N. Macpherson, councillor-elect of the Vancouver Branch, and in the evening attended a dinner meeting of the branch at which Branch-Chairman Dean J. N. Finlayson presided. Unfortunately, at this stage, President Hogg was forced to change his plans and return to Toronto, without going on to Victoria. However, the balance of the party visited the island and participated in a very enjoyable dinner meeting on Tuesday night, with Branch-Chairman E. W. Izard in the chair.

From Victoria the group returned to Vancouver, and were the guests of the Council of the Association of Professional Engineers of British Columbia at lunch on Wednesday, under the chairmanship of Frank MacNeill, the recently elected president. This gesture of hospitality was greatly appreciated by the Institute representatives, and was the last event of a very crowded programme.

Previous to going to Winnipeg, Councillor Vance and the general secretary visited the Lakehead Branch on Tuesday, the tenth, having luncheon in Fort William with the executive, and dinner in Port Arthur with the branch, Branch-Chairman H. G. O'Leary presiding over both functions. An interesting feature of the visit was a trip through the local aeroplane factory under the competent guidance of Elizabeth MacGill.

It was the opinion of the president's party that the affairs of the Institute in the west are in excellent condition. The activities of most branches throughout the year were greater than they have been for some time. Branch officers expressed themselves as feeling that the Institute was gathering momentum, and that the future held for it even greater things than have been disclosed in the past. Certainly, the enthusiasm expressed on all occasions was encouraging.

It would be a great thing if more members could become familiar with branches other than their own. A trip such as this is a revelation. It gives one a new grasp of the significance of the Institute, and a greater appreciation of its possibilities for the future. In every city the leading engineers are found guiding or supporting the affairs of the branch. Such interest and such loyalty are indeed sources of satisfaction and of inspiration to everyone. It is to be hoped that future presidents will be able to continue the well established and happy practice of visiting branches during their term of office. The value of such visits cannot be overestimated.

Details of the functions held at the various branches during the presidential tour will eventually be published in the News of Branches section.

NEW LIBRARY AND AUDITORIUM HALL FOR THE ECOLE POLYTECHNIQUE

The Ecole Polytechnique of Montreal is now completing another addition to its existing buildings. This new construction, five stories in height and covering a ground area of 5,200 sq. ft., will house a new laboratory for the chemical engineering course, a library of applied sciences, and an auditorium hall of a seating capacity of 360. The building is entirely fireproof, being a reinforced concrete structure with stone and brick walls. It was built primarily to answer the necessity of providing more adequate library facilities for the students, and the layout was conditioned by that fact and also by the restricted size of the plot of ground available. In the plan finally adopted, the laboratory occupies the basement floor, the library stack is arranged on the next three floors, with a general reading room occupying the full height of the three floors, and the hall is on the top floor. This arrangement was chosen for convenience of access to the library by the students. It was considered that the hall, being intended for infrequent uses only, ground floor entrance was not as important a factor as for the library, which is in constant use by the students and the alumni.

The library has now in its stack 32,000 volumes and 500 periodicals, besides hundreds of bulletins, catalogues and reports of various nature, and is one of the most complete in engineering and applied sciences. The stack has a capacity of 60,000 volumes and should answer the needs of the School for some years to come.

The official opening will take place as soon as the installation of the equipment and furniture has been completed, which should be towards the end of January.

CALVIN W. RICE MEMORIAL

One of the features of the recent Annual Meeting of the American Society of Mechanical Engineers was the unveiling of a bronze tablet to commemorate the character and work of Calvin Rice, who for twenty-eight years was secretary of the Society.

From *Mechanical Engineering* for January the following paragraphs have been extracted.

"On Monday noon, in the lobby of the Engineering Societies Building, a tablet to Calvin W. Rice, former secretary, 1906-1934, that had been hanging in the Society rooms for several years, was unveiled by Secretary Davies and formally dedicated. Henry A. Lardner, Fellow A.S.M.E. and president, United Engineering Trustees, Inc., the agency which handles the affairs of the Engineering Societies Library, and the Engineering Foundation, presided. He explained that the rules of the Trustees made it necessary for five years to elapse between the death of a person and the placing of a memorial to him in the public rooms of the building. It was most appropriate, he said, that a tablet to Mr. Rice should hang in the lobby of the building which the former secretary had been so influential in securing as a home for the engineering societies and their combined libraries. He then introduced Charles F. Scott, member A.S.M.E., who had been a member with Rice of the building committee and who had gone with Rice to solicit the interest and aid of Andrew Carnegie, donor of the building. Mr. Scott said: It is fitting that the tablet to Calvin Rice should be placed here, where 'If you seek his monument, look about you.' Across the lobby are the Carnegie letter of gift and the acknowledgment of the funds the societies raised for the land. In both Rice played a leading part."

"The building we see, but we sense something here we cannot see. Engineering Societies Building is more than a structure; the societies animate it with a professional spirit and vigorous life; it is an institution with hundreds of active groups—technical and general—national and local. And in all this Rice was at the forefront; even before the building project he was chairman of the first committee for establishing local sections and student branches.

"Rice became secretary of the mechanical engineers in 1906; just before the building was dedicated. He came with a wide experience in industry, in engineering, and with men; it ranged from Lynn to Anaconda including Schenectady and Pittsburgh and New York. He saw our modern industrial life from many angles. He had human understanding. He saw what engineering societies were doing and he visioned what they might do for their own members and for the nation, and also in world-wide co-operation. Anticipating the motto now on the Society's Fifty-Year Medal, 'What is Not Yet, May Be,' he acted.

"An old-time member likens the Society to a narrow-gauge, single-track road—a technical society—until Rice came. He expanded it into a standard-gauge modernized system, covering a wide area. He pioneered lines into fields of industrial relations, of economics, of social welfare. He installed interconnections with other branches of the profession. He visited England and Europe and South America, fostering intercourse and understanding among engineers.

He humanized engineering and he broadened and dignified its function in our modern life.

"The great engineering capability of Calvin Rice lay in his understanding of the role engineers and engineering should play in our modern advancing civilization. A stranger marveled that his list of honours, many of them foreign, record in 'Who's Who in Engineering,' should have come to an engineer with no great technical achievements; his achievement was the adjustment and co-ordination of engineering to life."

Following Mr. Scott's address, Mr. Lardner introduced C. E. Davies, Mr. Rice's successor as secretary of The American Society of Mechanical Engineers, who unveiled the tablet. Mr. Lardner then read the inscription on the tablet.

1868 1934

CALVIN WINSOR RICE

Erected in Appreciation
of a Life devoted to
the Advancement
of the Profession
of Engineering and of
His
Active Part in obtaining
from Andrew Carnegie
the gift of the
Engineering Societies
Building

MEETING OF COUNCIL

Minutes of a regional meeting of the Council of the Institute held at the Palliser Hotel, Calgary, Alberta, on Saturday, December 14th, 1940, at nine-thirty a.m.

The president expressed the pleasure that it gave him to preside at a Council meeting in Calgary, and invited all guests to participate in the discussions.

The general secretary read the following resolution from the Lakehead Branch: "Resolved that the Lakehead Branch regrets the action taken by the Council at the Montreal meeting on June 15th, 1940, in respect to the Unemployed Insurance Bill, and suggests that action of this importance should only be taken after consulting the general members."

He explained that he and Mr. Vance had visited the Lakehead Branch on Tuesday, December 10th, and that at a meeting of the executive this matter had been discussed in detail. It was the opinion of the Lakehead executive that representations made to the government by business bodies that some time should be given to study the proposed insurance legislation was designed principally with the object of delaying the enactment of the legislation. The executive thought that Council had lent itself to a scheme to defeat unemployment insurance.

After a short discussion it was unanimously agreed that Council was quite within its proper field in taking an interest in such matters as unemployment insurance, and that it was not thought the organizations which had asked for time to study the legislation had in mind anything but the best interests of the whole proposal. The secretary was instructed to inform the Lakehead Branch that while Council appreciated the interest they took in all matters involving the Institute, Council did not see that in this particular instance anything had been done but what could be thoroughly approved in the light of the full information.

The president called for nominations for the Institute's two representatives on the joint finance committee to be established under the provisions of the Alberta co-operative agreement. Five names were submitted and balloted upon, the results showing that Messrs. B. L. Thorne, of Calgary, and J. T. Watson, of Lethbridge, were elected.

The secretary read a statement of results in Nova Scotia, which showed that of the ninety-four members of the Association who were not members of the Institute at the time of the signing of the agreement, seventy had since made application. Nine persons who had become members of the Association since the signing of the agreement had also joined the Institute.

The secretary reported on a meeting of the joint committee in Winnipeg which took place three days earlier, to which he had been invited. He explained that complete agreement had been reached on all clauses of a proposed agreement, and that it was expected the committee would prepare a final draft for submission to the Council of the Association and the Council of the Institute within a short time.

Past-President Lefebvre, as a member of the Institute's Committee on Professional Interests, outlined the developments in New Brunswick. He explained that a draft agreement had been drawn up and that there had been considerable discussions by correspondence, but he believed that within a short time an arrangement would be arrived at that would be perfectly acceptable to both organizations.

Past-President Lefebvre also dealt with the situation in Quebec, explaining that while very little action had been taken towards arriving at a written agreement, the very best of relationships existed between the Institute and the Corporation.

The general secretary read a letter from the Associate Minister of National Defence, C. G. Power, which was written in reply to the Council's letter complaining that unfair treatment was being accorded engineers in the Ordnance Department. The letter acknowledged the correctness of the claim, and stated that some reorganization was contemplated, but would be withheld until a report was received from Brigadier Carr, who was now in England and who was to investigate the British regulations before he returned. The letter also expressed appreciation of the Institute's interest and offered assurance that the Institute would be kept informed of any changes that were made. It was agreed that the Institute should communicate with certain of its members now in England with the object of having them get in touch with Brigadier Carr in order to emphasize the importance of obtaining complete information on the British regulations. This matter was left in the hands of the president and the general secretary.

A letter was read from one of the councillors in which attention was called to the small wages paid to engineers employed by the government on war work, with particular reference to airport construction. The general secretary stated that upon receipt of this communication, he had discussed the question with certain officials of the Department at Ottawa, and had been informed that the classifications were set by the Civil Service, and the rates of pay accordingly were governed by that scale. Unfortunately, Civil Service rates of pay were based on the assumption that the employee had a permanent position leading to a pension. These conditions did not apply to construction men on war work, but nevertheless it had not been possible to get the Civil Service to change their regulations.

After considerable discussion it was decided that Council should discuss the situation with some of the officers at Ottawa, to see if it would not be possible to have this work so arranged that it would not be controlled by Civil Service classifications. Finally, it was agreed that the matter be left with the president and the general secretary to investigate at Ottawa.

The secretary read a letter from the Institution of Mechanical Engineers stating that the James Watt Medal, which had been awarded to Professor Stodola, of Switzerland, was to be presented in London at a special ceremony, and asking the Engineering Institute of Canada to name a representative to attend. It was agreed that either General McNaughton or Sir Alexander Gibb be asked to do this honour for the Institute.

The Finance Committee recommended that each of the branches be given an opportunity to assist in meeting the costs of underpinning the Headquarters building. Their idea was that if every branch would accept a quota based on a rate of $1.00 for each corporate member and Junior in the branch it would raise a very substantial sum of money which would assist materially in meeting this unforeseen but necessary expense. The entire effort was to be on a voluntary basis, and the method by which the branches approached their members was to be left entirely to each individual branch. This recommendation was approved by Council, and the President agreed to write a letter direct to the chairman of each branch, outlining the proposal and asking for the co-operation of the branch.

Past-President Lefebvre, a member of the Provisional Committee for the Julian C. Smith Medal, presented on behalf of the committee, the names of eight members of the Institute to whom the committee desired the Julian C. Smith Medal to be awarded. While it was intended to restrict awards to one or two a year, the committee thought it desirable to make a multiple award in the inaugural year.

Dr. Lefebvre gave a short citation for each of the nominees outlining the manner in which he had rendered distinguished service in furthering the development of Canada. The names will be announced publically at the Annual Meeting.

It was unanimously agreed that members of the Dominion Council of Professional Engineers be invited to attend the annual meeting and Council meeting of the Institute to be held in February in Hamilton. It was also hoped that the Dominion Council would be able to arrange its annual meeting either immediately before or immediately after the Institute's annual meeting so that those in attendance would be able to participate in the Institute's activities. Mr. D. A. R. McCannel, president of the Dominion Council, thanked the president for the invitation, and said that he hoped it would be possible for many of the Dominion Councillors to accept.

The general secretary outlined an exchange of correspondence which had taken place between the Commissioner of Income Tax and himself relative to the wording of the brochure issued by the government describing exemptions to the income tax. This brochure listed five groups, the first one being headed "Learned Professions," which did not include the engineers.

It was explained that a change in classification would not in any way affect the amount of income tax, but would tend to wipe out some of the old-time impression that engineering was not a skilled profession. On the motion of Mr. McLeod, seconded by Mr. Sauder, it was unanimously agreed that the secretary again communicate with the Commissioner of Income Tax, requesting that engineering be included in the learned professions.

In accordance with established practice, it was unanimously Resolved that a Student membership for one year together with a free subscription to the "Engineering Journal," be awarded to the four students who had presented papers at the Annual Student Night of the Montreal Branch, held on November 21st.

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

Elections	
Members	6
Juniors	4
Affiliates	1
Students admitted	26
Transfers	
Junior to Member	7
Student to Member	3
Students to Junior	17

Councillor Robertson said that on behalf of the Vancouver Branch he wanted to express appreciation of Council's policy of holding meetings away from Montreal. He thought that from the point of view of local branches, the value of such meetings could not be over-estimated. He hoped that Council would continue the practice in the future.

It was decided that the next meeting of Council would be held in Montreal on Saturday, January 18th, 1941.

The Council rose at one o'clock p.m.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF ONTARIO

1941 Council

The Nominating Committee appointed to make nominations for the 1941 Council of the Association of Professional Engineers of the Province of Ontario, made the following nominations. Inasmuch as there were just sufficient nominations made to fill the vacancies, and since no other nominations were received the following will constitute the Council for 1941.

S. R. Frost, M.E.I.C.

President: S. R. Frost, M.E.I.C., Sales Director, North American Cyanamid Ltd., Toronto.

Vice-President: W. C. Miller, B.Sc., M.E.I.C., City Engineer, St. Thomas.

Past-President: J. W. Rawlins, B.A., B.Sc., 27 Ava Road, Toronto.

Councillors:

Civil Branch: W. E. P. Duncan, B.Sc., M.E.I.C., General Superintendent, Toronto Transportation Commission, Toronto; J. Clark Keith, B.A.Sc., M.E.I.C., General Manager, Windsor Utilities Commission, Windsor; J. L. Lang, B.A.Sc., M.E.I.C., Lang & Ross, Engineers and Contractors, Sault Ste. Marie.

Chemical Branch: R. M. Coleman, Smelter Superintendent, International Nickel Co., Copper Cliff; R. A. Elliott, B.Sc., General Manager, Deloro Smelting and Refining Co. Ltd., Deloro; E. T. Sterne, B.Sc., Manager, G. F. Sterne & Sons, Brantford.

Electrical Branch: H. A. Cooch, B.A.Sc., M.E.I.C., Vice-President, Canadian Westinghouse Co., Hamilton; J. H. MacTavish, M.B.E., M.C., B.A.Sc., Secretary, Toronto Electric Commissioners, Toronto; Com. C. P. Edwards, M.E.I.C., O.B.E., Chief of Air Services, Dept. of Transport, Ottawa.

Mechanical Branch: C. C. Cariss, M.E.I.C., Chief-Engineer, Waterous Ltd., Brantford; L. T. Rutledge, B.A.Sc., M.E., M.E.I.C., Associate Professor of Mechanical Engineering, Queen's University, Kingston; K. R. Rybka, M.E., D.Sc., M.E.I.C., Associate W. J. Armstrong, Consulting Engineer, Toronto.

Mining Branch: J. M. Carter, B.A.Sc., Mill Superintendent, Omega Gold Mines Ltd., Larder Lake; C. H. Hitchcock, E.M., B.S., Vice-President, Smith & Travers Co. Ltd., Toronto; D. G. Sinclair, B.A.Sc., Assistant Deputy Minister of the Department of Mines, Toronto.

Stanley R. Frost, M.E.I.C., Sales Director of the North American Cyanamid Ltd., the new president of the Association of Professional Engineers of the Province of Ontario, will assume office at the general meeting of the association, which is being held at the Royal York Hotel, Toronto, on January 18th, 1941.

Mr. Frost has taken an active interest in the affairs of the Association, of which he has been a member since 1923. He served as representative of the Mechanical Branch on Council for the years 1935, 1936 and 1937, during which time he was chairman of the Publicity Committee. For the past year, he has been vice-president and chairman of the Finance Committee.

In his early career he was engaged in the manufacture of iron and steel, Portland cement and similar industries in Canada and United States. For the past twenty years, he has been on the staff of the North American Cyanamid Ltd., with plants in Niagara Falls and Ingersoll.

Not only does Mr. Frost typify the engineer in industry, but he is an example of the engineer active in public service. While resident in Niagara Falls, he served on the aldermanic board of that city for several years and was an active member of the Town Planning Commission and the Chamber of Commerce. He was appointed to the Board of Water Commissioners and was chairman of the Board during the construction of the Niagara Falls filtration plant. On moving to Toronto a few years ago, he became an active member of the Engineering Branch of the Toronto Board of Trade and is now branch vice-chairman. He was recently appointed a member of the Zoning Commission of the City of Toronto and when the Committee for the Stimulation of Employment was formed at the instance of Dr. F. J. Conboy, he was appointed to the Farm Placement Committee.

Mr. Frost is a member of the Canadian Society of Technical Agriculturists, the Engineering Institute of Canada, and other engineering societies.

ELECTIONS AND TRANSFERS

At the meeting of Council held on December 14th, 1940, the following elections and transfers were effected:

Members

Blowey, John Frederick Gill, Bach. Mech. Engrg. (Detroit Inst. of Tech.), supervisor of trade school, Ford Motor Co. of Canada, Windsor, Ont.

Kelly, Joseph John, B.A.Sc. (E.E.), (Univ. of Toronto), mgr., Hamilton District Office, Lincoln Electric Co. of Canada, Ltd. Hamilton, Ont.

Laughton, James Alexander, B.Sc. (Civil), (Univ. of Man.), welding engr., shop supt., Hamilton Bridge Co. Ltd., Hamilton, Ont.

McGorman, Donald, B.A.Sc. (Mech.), (Univ. of Toronto), supt., Schultz Die Casting Co., Wallaceburg, Ont.

Robinson, Richard Henry, B.Sc. (Civil), (Univ. of Man.), sales engr., Vulcan Iron Works Ltd., Winnipeg, Man.

Simard, Joseph W., B.A.Sc., C.E., (Ecole Polytechnique, Montreal), International Water Supply Limited, Montreal, Que.

Juniors

Campbell, Noel, B.Eng. (Mech.), (McGill Univ.), engrg. dept., Ford Motor Co. of Canada, Windsor, Ont.

Dugal, Fernand, B.Eng. (Mech.), (McGill Univ.), purchasing dept., Canadian Associated Aircraft Ltd., Montreal, Que.

Glance, Earl Irvine, B.Sc. (Elec.), (Univ. of Man.), elec. engr., T. Pringle & Son, Montreal, Que.

Affiliate

Spall, Edward Arthur George, mgr., Penn Electric Switch Divn. Powerlite Device Ltd., Toronto, Ont.

Transferred from the class of Junior to that of Member

Akerley, William Burpee, Lieut., R.C.E., B.Sc. (Civil), (Univ. of N.B.), Works Officer, Dept. of National Defence, Saint John, N.B.

Climo, Percy Lloyd, B.Sc. (Queen's Univ.), mech. engr., Gaspesia Sulphite Co. Ltd., Chandler, Que.

Lochhead, Kenneth Young, B.Eng. (McGill Univ.), bldg. supt., Hudson's Bay Company, Vancouver, B.C.

Minard, Guy McRae, B.Sc. (Queen's Univ.), Pilot Officer, R.C.A.F., Aero-Engineering School, Montreal, Que.

Patriquen, Frank Andrew, B.Sc. (Elec. & Civil), (Univ. of N.B.), junior engr., Dept. of Public Works Canada, Fairville, N.B.

Stratton, William Donald George, B.Sc. (Civil), (Univ. of N.B.). res.engr., Civil Aviation Br., Dept. of Transport, Saint John, N.B.

Wheatley, Eric Edmund, B.Sc. (McGill Univ.), asst. to divn. engr., Laurentide Divn., Cons. Paper Corpn. Ltd., Grand'Mere, Que.

Transferred from the class of Student to that of Member

French, Philip Bemis, B.Eng. (McGill Univ.), sales engr., Canadian SKF Limited, Montreal, Que.

Mayhew, Earle Chandler, B.Sc. (Queen's Univ.), Deputy Chief Inspector of Armaments (G), Department of National Defence, Ottawa, Ont.

Plamondon, Sarto, B.A.Sc., C.E. (Ecole Polytechnique, Montreal), asst. sanitary engr., Ministry of Health, Amos, Que.

Transferred from the class of Student to that of Junior

Brannen, Edwin Ralph, B.Sc. (Elec.), (Univ. of N.B.), chief inspr., Canadian Johns-Manville Co. Ltd., Asbestos, Que.

Cartier, Léonard, B.A.Sc., C.E. (Ecole Polytechnique, Montreal), lab. asst., hydraulic laboratory, Ecole Polytechnique, Montreal, Que.

Demcoe, John William, B.Sc. (Civil), (Univ. of Man.), asst. divnl. engr., C.N.R., Toronto, Ont.

Desjardins, Roger, B.A.Sc., C.E. (Ecole Polytechnique, Montreal), engr., Provincial Public Service Board, Quebec, Que.

Ford, John Franklin, B.A.Sc. (Univ. of Toronto), job engr., Russel Constrn. Co., Toronto, Ont.

Gershfield, Max, B.Sc. (Elec.), (Univ. of Man.), asst. supt., Radio Oil Refineries, Winnipeg, Man.

Gervais, Aimé, B.A.Sc., C.E. (Ecole Polytechnique, Montreal), technical secretary, Public Service Board, Montreal, Que.

Hertel, Alfred Frederick, B.Sc. (Civil), (Queen's Univ.), junior engr., Dept. of Public Works Canada, London, Ont.

Hewitt, Herbert Eugene, B.Sc. (Civil), (Univ. of Alta.), engr., Sudbury Hydro-Electric Commission, Sudbury, Ont.

Hurtubise, Jacques Edouard, B.A.Sc., C.E. (Ecole Polytechnique, Montreal), i/c testing materials lab., Ecole Polytechnique, Montreal, Que.

LeBel, Raymond, B.A.Sc., C.E. (Ecole Polytechnique, Montreal), engr., J. M. Eug. Guay Inc., consltg. engrs., Montreal, Que.

MacKay, Norman Allison, B.Eng. (Mech.), (McGill Univ.), lubrication engr., Dominion Steel & Coal Corporation, Sydney, N.S.

Peters, James Horsfield, B.Sc. (Chem.), (Univ. of N.B.), shift supervisor, Defence Industries Limited, Brownsburg, Que.

Pope, Francis Robert, B.Eng. (Mech.), (McGill Univ.), asst. supt., Western Clock Co. Ltd., Peterborough, Ont.

Sanders, George Ostrom, B.Sc. (Queen's Univ.), mtce. engr., Howard Smith Paper Mills Ltd., Cornwall, Ont.

Sawle, Ross Tregerthen, B.Sc. (Queen's) M.A.Sc. (Univ. of Toronto), design engr., English Electric Co. of Canada Ltd., St. Catharines, Ont.

Whitehouse, Ralph John, B.Eng., (McGill Univ.), machine shop progress clerk, Cons. Mining & Smelting Co. Ltd., Trail, B.C.

Students Admitted

Archambault, Jean (Ecole Polytechnique), 289 de l'Epée St., Outremont, Que.

Freeman, Rex Morton (McGill Univ.), 1535 St. Mark St., Montreal, Que.

Freeman, Paul Ora (McGill Univ.), 131 Percival Ave., Montreal West, Que.

Gauthier, Raymond Claude (Univ. of Man.), 554½ DesMeurons St., St. Boniface, Man.

Galvas, Edward Henry (Univ. of Sask.), 274 Colony St., Winnipeg, Man.

Guy, Ross Thomas (Queen's Univ.), 303 University Ave., Kingston, Ont.

Haun, Glen Robert, B.Sc. (Civil), (Univ. of Alta.), 2322 Carleton St., Calgary, Alta.

Hodgson, Ronald H. (McGill Univ.), 1227 Sherbrooke St. West, Montreal, Que.

Kelly, James Oswald (McGill Univ.), 4109 Northcliffe Ave., Montreal, Que.

Kennedy, Lowell Keith (McGill Univ.), 3507 University St., Montreal, Que.

Keyfitz, Irving Mortimer (McGill Univ.), 3454 Addington Ave., Montreal, Que.

Koropatnick, Peter, (Univ. of Man.), 75 Edmonton St., Winnipeg, Man.

Lafond, R. Olier, (Ecole Polytechnique), 3646 St. Denis St., Montreal, Que.

Miller, Zavie (McGill Univ.), 673 de l'Epée Ave., Outremont, Que.

Morris, Robert McCoul, B.Eng. (Elec.), (N.S. Tech. Coll.), 548 Prince Arthur St. West, Montreal, Que.

Morse, Clifford Eric (McGill Univ.), 3437 Harvard Ave., Montreal, Que.

Olafson, Harold Sigmar (Univ. of Man.), Riverton, Man.

Parker, William Alfred, B.A.Sc. (Univ. of B.C.), 516 Charlotte St., Peterborough, Ont.

Russell, Gordon Douglas (McGill Univ.), 2358 Grand Blvd., Montreal, Que.

Sheinberg, Sydney (McGill Univ.), 4362 Laval Ave., Montreal, Que.

Smith, Harold Pennell (Univ. of Toronto), Newtonbrook, Ont.

Wilson, John Howard (McGill Univ.), Hudson Heights, Que.

Personals

News of the Personal Activities of members of the Institute, and visitors to Headquarters

Past President E. A. Cleveland, M.E.I.C., has seen his term of office extended as chief commissioner of the Greater Vancouver Water District and chairman of the Vancouver and District Joint Sewage and Drainage Board, although the law required him to retire. Commenting on the special measure passed to this effect by the British Columbia Legislature, the *Vancouver Daily Times* writes: "The eminent engineer is entitiled to retirement; and the provincial House decided that he is too valuable a man to exchange the exactions of his highly-important and responsible position for the serenity and satisfaction one associates with life on a comfortable pension; Dr. Cleveland will carry on. From one day long ago, when he and some Danish settlers almost starved to death on Vancouver Island, and on down the years, his life has been strenuous. To add anything to the act of the Legislature and what it symbolizes would be to gild the lily."

A. W. Whitaker, M.E.I.C., was recently appointed general manager of the Aluminum Company of Canada, Limited. A graduate in chemical engineering from the University of Pennsylvania, he joined the company in July, 1913, as a research engineer. In 1926, he became superintendent of the newly built carbon plant at Arvida, Que., and in 1928 was made superintendent of the Arvida ore plant. In 1930, Mr. Whitaker became manager of the Arvida works, which post he held until 1939 when he was appointed chief engineer of the company. He will combine his new duties with those of chief engineer.

R. J. Durley, M.E.I.C., secretary emeritus of the Institute, has been elected as a member of council of the Institution of Civil Engineers of Great Britain and is chairman of the Canadian Advisory Committee of the Institution.

A. J. T. Taylor, M.E.I.C., chairman of British Pacific Securities Limited, and formerly president and chief engineer of the First Narrows Bridge Company, Vancouver, is now with the British Air Commission in Washington, D.C., as deputy to Mr. Morris Wilson, president of the Royal Bank of Canada, Montreal, who represents in North America Lord Beaverbrook, the head of the British Ministry of Aircraft Production. Mr. Taylor joined Mr. Wilson last June in New York, and has lately been transferred to Washington.

Lieut.-Col. J. L. Melville, M.E.I.C., is in command of the Corps Troops Engineer Units, designated C.R.E. Corps Troops, with the Army Corps commanded by Lt.-Gen. A. G. L. McNaughton in England. Colonel Melville resigned his position as commissioner on the War Veterans Allowance Board in the Federal Department of Pensions and National Health last spring to command the 1st Canadian Pioneer Battalion, Royal Canadian Engineers, C.A.S.F.

W. G. Mitchell, M.E.I.C., who has been associated during the past year with the Department of Munitions and Supply in Ottawa, has recently returned to Montreal to assume an executive position with Allied War Supplies Corporation in the same connection. Following graduation from McGill University (M.Sc., 1914), Mr. Mitchell spent some years abroad, engaged on various technical and economic investigations and, on his return to Canada in 1921 joined the staff of Price Brothers & Co., Limited, as assistant to the president. Admitted to the Institute as a Member in 1920, he became the first chairman of the newly established Saguenay Branch in 1923, serving in that capacity for two years. Later (1927-1931) he served for four years as Institute vice-president for Zone C. Terminating his connection with Price Brothers & Co., Limited, in 1932, he spent some three years engaged in private practice, principally in the southern United States. Returning to Canada in 1935, Mr. Mitchell acted for some two years as technical adviser to the Canadian Pulp and Paper Association, principally in relation to the re-organization of policy of the Pulp and Paper Research Institute in Montreal. In 1937, he established headquarters for a consulting practice in Montreal and since early in the present year has been engaged in connection with the national defence and war procurement programme.

W. R. Smith, M.E.I.C., who for the past sixteen years had been assistant county engineer of Middlesex County, Ont., has been appointed county engineer to succeed **Charles Talbot,** M.E.I.C., who is retiring after a long service in this capacity.

A. T. Hurter, M.E.I.C., has accepted a position as project engineer with Defence Industries Limited in Montreal. Lately he was representative at Red Rock, Ont., of the receiver and general manager of Lake Sulphite Pulp Company Limited. He had previously been engineer in charge of construction and assistant manager of the company.

W. M. Harvey, M.E.I.C., has joined the staff of Rhokana Copper Corporation at Nkana, Northern Rhodesia. Mr. Harvey, who is a Queen's graduate in mechanical engineering, had been for the past eight years with Noranda Mines Limited at Noranda, Que. He was previously connected with the Wabi Iron Works Limited of New Liskeard, Ont.

W. G. Mitchell, M.E.I.C.

A. J. T. Taylor, M.E.I.C.

A. W. Whitaker, M.E.I.C.

T. W. Lazenby, M.E.I.C., is now employed as a mechanical draftsman with the Consolidated Mining and Smelting Company at Trail, B.C.

M. L. Walker, M.E.I.C., has been commissioned with the rank of flying officer in the engineering branch of the R.C.A.F. and is now posted at Yarmouth, N.S., as technical officer. He was previously with the Imperial Oil Limited at Sarnia, Ont.

R. W. Angus, Hon.M.E.I.C. (left), receives congratulations from W. H. McBryde, retiring president of the American Society of Mechanical Engineers, after having been presented with an honorary membership certificate at the annual meeting of the Society, last December, in New York.

A. H. Cole, Jr.E.I.C., has joined the staff of the Canadian Car & Foundry Company Limited at Montreal. Since his graduation from McGill University in 1936 he had been with the D. W. Ogilvie and Company Inc., in Montreal.

A. W. Howard, S.E.I.C., has been transferred from Calgary to Montreal and is now employed with the Montreal Engineering Company Limited. Since his graduation from the University of Toronto in 1935 he had been with the Calgary Power Company, Calgary, Alta.

A. J. Ring, S.E.I.C., is on the staff of Defence Industries Limited in Montreal. He was graduated in civil engineering from the University of New Brunswick last spring.

G. L. Archambault, S.E.I.C., is a sales and maintenance engineer with the Minneapolis-Honeywell Regulator Company at Montreal. He was graduated in mechanical engineering from McGill University in 1939.

A. A. Buchanan, S.E.I.C., is now a pilot officer in the R.C.A.F. and is following a course at the aeronautical engineering school in Montreal. He is a graduate in mechanical engineering from the class of 1939 at McGill University.

R. Eastwood, S.E.I.C., is with the Consolidated Paper Corporation at Grand'Mere, Que. He was graduated in mechanical engineering from McGill in 1939.

F. Dugal, Jr.E.I.C., is now assistant to the purchasing agent with Canadian Associated Aircraft Limited at Montreal. Upon his graduation in mechanical engineering from McGill University in 1939 he went with the Department of National Defence as aircraft inspector. He also worked for a few months with Defence Industries Limited in Montreal.

D. H. Ferguson, S.E.I.C., is located at Shawinigan Falls, Que., with the Aluminum Company of Canada Limited. He was graduated in mechanical engineering from McGill University in 1939.

R. N. Ferguson, S.E.I.C., is on the staff of International Foils Limited, Cap-de-la-Madeleine, Que., as assistant engineer. He is a graduate of the 1939 class in mechanical engineering from McGill University.

R. H. Garrett, S.E.I.C., is training with the R.C.A.F. at Regina, Sask. Upon his graduation in mechanical engineering from McGill University in 1939 he went with the Mackenzie River Transport Company, at Edmonton, Alta.

R. E. Gohier, S.E.I.C., is a metallurgical engineer with Sorel Industries Limited at Sorel, Que. Upon graduation in mechanical engineering from McGill in 1939 he went with the International Foils Limited, at Cap-de-la-Madeleine, Que., a position which he left last month to accept his new appointment.

J. Hall, S.E.I.C., a graduate in chemical engineering from the class of 1939 at McGill, is with Shell Oil Company of Canada Limited at Montreal East, Que.

J. G. Langley, S.E.I.C., is with Canadian General Electric Company at Peterborough, Ont. He was graduated in electrical engineering from McGill University in 1939.

W. H. McGowan, S.E.I.C., an electrical engineering graduate from the class of 1939, McGill University, is with the Bell Telephone Company of Canada Limited in Montreal.

A. Mendelsohn, S.E.I.C., who was graduated in mechanical engineering from McGill in 1939 is now on active service and is located at Kingston, Ont.

S. Nathanson, S.E.I.C., is aircraft examiner with the British Air Commission at Montreal. He was graduated in civil engineering from McGill University in 1939.

H. C. Oatway, S.E.I.C., who was graduated in mechanical engineering from McGill University in 1939 is acting as temporary instructor at the University.

H. F. Staniforth, S.E.I.C., has joined the Royal Canadian Air Force as a pilot officer and is, at present, following a course in aeronautical engineering at Montreal. He was graduated in mechanical engineering from McGill in 1939.

Eric Tait, S.E.I.C., is with the Shawinigan Engineering Company Limited at Montreal. He was graduated in civil engineering from McGill in 1939.

W. J. Tanner, S.E.I.C., a chemical engineering graduate from the class of 1939 at McGill, is now with the Aluminum Company of Canada Limited at Shawinigan Falls, Que. Upon graduation he went for a few months with General Foods Limited at Montreal.

VISITORS TO HEADQUARTERS

Alfredo Medina, contractor, from Merida, Yucatan, Mexico, on November 26th.

R. L. Dunsmore, M.E.I.C., superintendent, Halifax refinery, Imperial Oil Limited, from Dartmouth, N.S., on December 3rd.

Past President Dr. Charles Camsell, C.M.G., M.E.I.C., Deputy Minister, Department of Mines and Resources, from Ottawa, Ont., on December 6th.

Major W. B. Redman, M.E.I.C., assistant engineer, Canadian National Railways, from Toronto, Ont., on December 18th.

Geoffrey Stead, M.E.I.C., from Saint John, N.B., on December 23rd.

Arsène Babin, M.E.I.C., resident engineer on construction, Quebec North Shore Paper Company, from Baie Comeau, Que., on December 24th.

L. P. Cousineau, M.E.I.C., assistant resident engineer, Quebec Streams Commission, Rapid No. 7, Ottawa River, from Cadillac, Que., on December 24th.

P. W. Greene, M.E.I.C., from New York on December 27th.

Capt. V. R. Davies, M.E.I.C., Royal Military College, from Kingston, Ont., on December 28th.

Obituaries

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

John Kershaw Ashworth, M.E.I.C., died suddenly in the hospital at Montreal on December 16th, 1940. He was born in Hebdon Bridge, Yorkshire, England, on October 18th, 1885. He was educated at Halifax (England) Technical College and Manchester University. He came to Canada in 1911 for the firm of Hans Renold Limited of Manchester, England. Later he was engaged with the Coventry Chain Company Limited. From 1914 to 1916 he was in active service overseas, and upon returning from France in 1916 he became engaged in shell production with the Steel Company of Canada at Montreal. From 1920 to 1925 he was designing and sales engineer with Jones & Glassco Registered for the Coventry Chain Company Limited of Coventry, England. In 1927 he became manager of the Coventry Company Registered at Montreal. In 1933 he was appointed manager of R. & M. Bearings Canada Limited in Montreal. Until last April he was vice-president of the Company.

Mr. Ashworth joined the Institute as an Associate Member in 1925.

William Bell Cartmel, M.E.I.C., died at Montreal, on December 5th, 1940, after a long illness. He was born at Liverpool, England, on January 4th, 1872. He received his Bachelor of Science degree from the Case School of Applied Science of Cleveland, Ohio, in 1900, and two years later he obtained the degree of Master of Arts from the University of Nebraska. During the years 1902 and 1903 he was laboratory assistant in the Bureau of Standards at Washington. From 1903 to 1905 he was instructor in physics at Cincinnati University, and in 1906 to 1907 he was a Whiting Fellowship student in physics at Harvard University. From 1907 to 1911 Mr. Cartmel was professor of physics and electrical engineering at the University of New Brunswick. In 1911 he joined the Northern Electric Company at Montreal, and in 1915 he became in charge of the transmission division. In 1933 he was president of the W. B. Cartmel and Son Limited, electrical engineers and contractors of Montreal. For the past three years he had been a research associate at the University of Montreal.

Mr. Cartmel joined the Institute as a Member in 1922.

Valentine Irving Smart, M.E.I.C., died suddenly at his home in Ottawa on December 2nd, 1940. He was born at Brockville, Ont., on February 14th, 1875, and he was educated at Upper Canada College and Queen's University, Kingston, where he was graduated in 1887 as a Bachelor of Arts. He joined the Federal Government service in 1897 as a surveyor. From 1902 to 1907 he served as assistant manager, signal engineer and engineer of maintenance of way with the Chicago and Eastern Illinois Railway of Chicago. From 1907 until 1914 Colonel Smart was professor of railway engineering at McGill University. Later he became engaged with the General Railway Signal Company of Canada Limited of Montreal of which he was vice-president and general manager. For some time he also was a partner in the firm of Smart and Burnett, consulting engineers of Montreal. He was consulting engineer with the Department of Railways and Canals in connection with the Grand Trunk Railway arbitration from 1920 to 1923. He joined the Canadian National Railways in 1923 as a special engineer and in 1928 he became general superintendent of transportation for the western region. In 1930 he was appointed Deputy Minister of the Department of Railways and Canals at Ottawa. In July, 1940, when the Hon. C. D. Howe became Minister of Munitions and Supply with control also over civil aviation, Col. Smart held the unique position of being deputy to two ministers. He continued his work with the Transport Department under the Hon. P. J. A. Cardin and also was retained by Mr. Howe, former Transport Minister, in the air branch of his department.

Part of Col. Smart's work with the air services was undertaking construction of 100 aerodromes in Canada for the British Commonwealth Air Training Plan. Earlier he had been responsible to a large extent for detailed preliminary work with Trans-Canada Air Lines, planning flying fields, radio facilities, and similar work.

V. I. Smart, M.E.I.C.

Col. Smart was a member of the defence co-ordination committee and served as chairman of a sub-committee on reserved occupations which dealt with decisions on keeping men valuable in civilian occupations out of the armed forces.

During the Royal visit in 1939 he was chairman of a committee in charge of transportation arrangements for Their Majesties and the Royal party.

Col. Smart joined the Institute as a Member in 1917.

COMING MEETINGS

Association of Professional Engineers of the Province of Ontario—Annual general meeting, Royal York Hotel, Toronto, January 18th. Secretary, Walter McKay, 350 Bay St., Toronto, Ont.

The Dominion Council of Professional Engineers—Annual Meeting, Royal York Hotel, Toronto, January 20th and 21st.

Canadian Electrical Association—Mid-Winter Conference, Windsor Hotel, Montreal, January 20th and 21st.

American Road Builders' Association—Annual Convention at the Pennsylvania Hotel, New York City, January 27th to 30th. Director Charles Upham, International Building, Washington, D.C.

American Institute of Electrical Engineers—Winter Convention. Philadelphia, January 27th to 31st.

The Engineering Institute of Canada—Fifty-fifth Annual General and Professional Meeting to be held at Hamilton, Ont., on February 6th and 7th.

American Institute of Mechanical Engineers—Annual Meeting, New York, Engineering Societies Building and Commodore Hotel, February 17th to 20th.

Ontario Good Roads Association—Annual Convention, Royal York Hotel, Toronto, February 26th to 27th. Secretary, T. J. Mahony, Court House, Hamilton, Ont.

Canadian Institute of Mining and Metallurgy—Annual Meeting, Montreal, March 10th to 12th.

FLASHES OF THE PRESIDENT'S WESTERN TRIP

AT LAKEHEAD—1. Three veterans, Messrs. Duncan, Armstrong and Antonisen.

2. Councillor Doncaster, Elizabeth MacGill, and Chairman O'Leary.

AT WINNIPEG—3. The executive entertains, left to right, Mr. Attwood, the President, Chairman Briggs and Past-Chairman Hurst.

4. Past-President Lefebvre speaks, with John Porter on his right and the President to his left.

AT CALGARY—5. President Hogg signs the co-operative agreement with Chairman Sauder on his left and B. L. Thorne on his right.

6. President McLean signs for the Association, with Chairman Sauder looking on.

7. D. A. R. McCannel, President of the Dominion Council.

8. Past-President S. G. Porter tells the history of the profession in the province. In the background is H. R. Webb, Registrar of the Association.

9. President Howard McLean of Calgary.

10. P. Turner Bone.

AT VANCOUVER—11. The head table with Messrs. Cleveland, Hogg, Finlayson, Lefebvre, Vance and Walkem.

12. You can recognize Wm. Smaill, H. C. Fitz-James, Perce Buchan.

13. Kirk McLeod brings greetings from Montreal.

14. Dean Finlayson is chairman of the branch.

15. Past-President E. A. Cleveland.

■

AT VICTORIA—16. Chairman of the branch E. W. Izard, with W. A. Carrothers on his right.

17. Secretary Kenneth Reid reports.

18. Past-President Lefebvre calls on C. A. Magrath, Hon. M.E.I.C.

19. James Vance brings greetings from the London branch.

News of the Branches

Activities of the Twenty-five Branches of the Institute and abstracts of papers presented

BORDER CITIES BRANCH

H. L. Johnston, m.e.i.c. - *Secretary-Treasurer*
A. H. Pask, Jr. e.i.c. - - *Branch News Editor*

On November 15th, 1940, the monthly meeting of the Border Cities Branch was held in the Prince Edward Hotel beginning at 6.30 p.m. with a dinner. Following a short business meeting, Mr. T. H. Jenkins introduced the speaker of the evening, Mr. M. W. Petrie of the Production Research Department of Chrysler Corporation. The subject of the address was **Superfinish and Fluid Drive.**

Superfinish originated in the attempts to improve the life of bearing races by removing the grinding fuzz with lapping. This was very effective and a machine was devised to do this work. The value for other machine parts was seen and machines were devised for them.

The speaker enumerated the different methods of finishing from turning to honing and burnishing and gave the disadvantages of each. Turning has the highest speed and the greatest actual pressure at the working point, which may be equal to hundreds of tons per square inch. The pressure creates high temperatures which are sufficient to change the character of the surface metal. The temperature and pressures are true to lessening degrees for other finishing methods as grinding, honing and burnishing. These operations create an amorphous non-crystalline layer of metal about one one-thousandth deep which is best removed by lapping.

Superfinishing is a lapping operation done with very low unit pressures and speeds, using combined and superimposed short reciprocating motions. By using three or more motions combined it is possible to produce a geometrically perfect surface. In practice five motions are used.

The metal peaks left by the sizing operation, which may have been turning, are removed by superfinishing in a few seconds. As the actual unit pressure is initially low it becomes very low when the peaks are worn down flat. The lubricant used has a definite viscosity so that when a certain abrasive area is reached the pressure is supported by the lubricant and effective work stops. Usually only .0001 or .0002 inches of metal are removed for this.

The superfinish process, by removing peaks of metal leaves a surface much more easily lubricated as the film is not broken by these points, and metal to metal contact is avoided. Bearings finished in this way may therefore be initially used with a closer fit and will operate longer as lubrication is maintained better.

The speaker also described fluid drives as applied to the modern automobile and gave its advantages in this service.

Following an interesting question period, a vote of thanks was moved by Mr. J. E. Daubney. The meeting then adjourned on the motion of Mr. C. F. Davison.

CALGARY BRANCH

P. F. Peele, m.e.i.c. - - *Secretary-Treasurer*
F. A. Brownie, m.e.i.c. - *Branch News Editor*

The November 6 meeting of the Calgary Branch was featured by an address by Mr. R. E. Allen newly appointed chairman of the Alberta Petroleum and Natural Gas Conservation Board who spoke on the general subject of **Conservation.**

Conservation was defined as the "application of measures designed to produce the greatest oil recovery in the most economical way."

Mr. Allen then proceeded to discuss the various aspects of conservation. One of the most important of these is of course reservoir pressure. Below a certain critical pressure in any field the gas tends to come out of solution in the oil leaving the oil more viscous and less capable of flowing readily through the sand to the well. The maintenance of pressures above this critical point is of course of paramount importance. That this is the case is indicated by the great interest and activity in the United States in repressuring projects which return the gas to the producing horizon after it has produced its oil.

Reference was made to the varying degrees of government control exercised by different states. In Turner Valley to-day, for instance, only one well is permitted to each 40 acres of land. In the past, in certain states, as many as three wells have been drilled under one derrick resulting in a productive life of only a few weeks.

In recent years, the acidizing of wells to increase production has become an important factor displacing the more spectacular but less efficient method of "shooting" wells with nitro-glycerine.

Mr. Allen stressed the necessity of extending the productive area of Turner Valley by new wells and of developing new fields by "wildcatting" if the present production rate is to be maintained. Future possibilities were discussed briefly if oil production in Alberta can be increased by the discovery of new reserves.

The lengthy discussion which followed indicated the great interest which Mr. Allen's subject held for Branch members.

The meeting of November 21st was unusual in that it presented four speakers, three of whom were Branch affiliates.

Mr. A. Baxter discussed the **Design of the Coal Handling Plant at Murray Collieries in East Coulee.** By means of pictures and a flow sheet the course of the coal was followed from mine head to car.

Mr. L. R. Brereton dealt with **Some Considerations in the Design of Steel Castings.** This paper indicated the benefits to be gained by having steel casting designs checked by an experienced foundryman from the point of view of such factors as ease of casting, effects of shrinkage, and composition of various elements of the casting.

A rather unusual topic was presented by Mr. C. Lattman in his paper on **Standardization of Paper Sizes in Switzerland.** Under the scheme adopted all sheets of paper are standard sizes which, no matter how large, can be reduced by folding to the size and shape of the smallest standard sheet. The advantages of this system in filing and cutting of larger sheets is obvious.

The fourth paper by the Rev. R. J. Donavan, a Branch Affiliate, discussed the importance of economics to the engineer.

The evening of December 5th was designated as annual Ladies' night by the Calgary Branch. Since members' wives were present the programme consisted of a showing of natural colour slides under the title **Colour in the West** by Mr. S. R. Vallance, who also carried on a running commentary on the slides.

The first group showed a number of very beautiful views in and near Victoria, B.C. These were followed by a series made around Banff and Lake Minnewanka. Besides showing some striking new views of the magnificent mountain scenery they illustrated a number of interesting expeditions by Mr. Vallance which he described.

This programme was followed by the serving of refreshments. The meeting was held in the Palliser Hotel and Branch Chairman James McMillan presided.

EDMONTON BRANCH

B. W. Pitfield, M.E.I.C. - *Secretary-Treasurer*
J. F. McDougall, M.E.I.C. - *Branch News Editor*

The November dinner meeting of the Edmonton Branch was held in the Macdonald Hotel on November 26th. Thirty-six members were present for dinner. After dinner, thirteen additional members joined the meeting to hear the speakers of the evening.

After a short business session, Chairman E. Nelson introduced the speakers, Professor W. E. Cornish of the Department of Electrical Engineering and Professor R. M. Hardy of the Department of Civil Engineering of the University of Alberta.

Mr. Cornish had spent the past summer in eastern Canada and he described the construction of a large industrial plant on which he was working during his stay in the East. His paper was illustrated by a number of slides and he gave a very clear description of the plant.

Mr. Hardy had recently returned to Edmonton after a year's sabbatical leave from his duties at the University. He spent this sabbatical year at Harvard University doing post graduate work in soil mechanics. He described this work in a paper entitled, **Soil Mechanics and Foundation Engineering.**

In this paper he referred to the fundamental principles of soil mechanics, briefly outlined the nature of these principles and showed how they could be used in design of foundations. His topic was new to a number of the members and a very interesting discussion followed his paper.

A vote of thanks to both speakers was moved by Dean R. S. L. Wilson.

HAMILTON BRANCH

A. R. Hannaford, M.E.I.C. - *Secretary-Treasurer*
W. E. Brown, Jr.E.I.C. - *Branch News Editor*

On December 16th, in the lecture theatre at McMaster University the branch held Student and Junior members' night. The papers presented were in competition for the branch prize and also became eligible for the John Galbraith prize.

After opening the meeting the chairman, Alex Love, turned the meeting over to W. E. Brown.

L. C. Sentance, of the Canadian Westinghouse Company, Hamilton, spoke on **Working Stresses in Machine Members.**

M. D. Stewart of the Babcock-Wilcox and Goldie-McCullough Company, Galt, spoke on **The Effect of Wet Coal on Pulverisers and Boiler Performance.**

Mr. Sentance gave a review of some of the factors that influence the behaviour of materials used in machine members and which consequently affect the selection of suitable stress limits. The paper was illustrated with slides dealing with various theories of failures.

Mr. Stewart dealt with the many factors which combine to result in what we call boiler performance. He considered the matter from the storage bins up to the state of combustion. However, he stated plainly that he was mainly dealing with the matter from the point where pulverisation takes place.

Moisture, he said, caused a heat loss in the boiler and an increase in moisture would add to the fuel cost. The paper was of a distinctly technical nature and therefore many points were exemplified by a number of slides showing various diagrams.

Professor C. R. Young of the University of Toronto, one of the three judges appointed by the branch, concluded the meeting with an address entitled, **The Engineer and the Technologist.**

In his opening remarks, the speaker congratulated the branch on having as members such able young engineers as the competing speakers had proved themselves to be. He added that the replies to the lively discussion showed that both Mr. Sentance and Mr. Stewart were masters of their respective subjects.

Professor Young said that the work of the engineer had a direct effect on the lives and fortunes of the people, and he differed from the technician because, to be of real use to the world at large, the engineer must consider the human side of his works and not only the efficiency of his labours but the beneficial results to those under him and to mankind in general. He stated that the bishop of Ripon had once suggested the engineers and scientists "lay off" for a period of ten years so that the peoples of the earth might regain their equilibrium.

The engineer having created comfort, pleasure and methods of destruction had kindled a flame that he should beware did not consume us all.

Alex Love moved a vote of thanks to the speakers and particularly to Professor Young for his most interesting address. The 49 members and visitors enjoyed coffee and light refreshments after the meeting.

LAKEHEAD BRANCH NEWS

H. M. Olsson, M.E.I.C. - *Secretary-Treasurer*
W. C. Byers, Jr. E.I.C. - - *Branch News Editor*

The Lakehead Branch held a dinner meeting at the Shuniah Club, Nov. 21st, commencing at 6.30 p.m., and 30 members were present.

Mr. H. G. O'Leary presided at the meeting and welcomed Mr. David Boyd of Montreal and Mr. E. J. Soulsby and Mr. S. T. McCavour.

The Chairman then introduced the speaker of the evening Mr. J. M. Fleming, president of C. D. Howe Company Limited, consulting engineers, of Port Arthur. His subject was **The Grain Storage Situation in Canada.**

The speaker said that at the present time there is 850 million bushels of grain in sight this crop year in Canada, and due to consumption and export 300 million bushels will be removed, leaving in July, 1941, 550 million bushels to be stored. The total storage capacity in Canada is 500 million bushels including the temporary storage on farms. Of the regular storage capacity of 425 million bushels there are 5,700 country elevators with 190 million bushels capacity and 160 terminal and mill elevators, totalling 235 million bushels. The Lakehead, with 95 million, has 40 per cent of terminal storage capacity of Canada. There are now about 3,000 of the timber storage units—commonly called "Balloon Annexes"—built adjacent to country elevators, with a total capacity of 75 million bushels. The limit of this storage, however, is about 110 million bushels, being limited by spouting distance from the country elevator.

The storage of grain in box cars is not practicable because of the requirements by the railways for transporting other materials essential to the war effort. Very little grain can be stored in grain boats because of the anticipated busy season and the inability of the grain companies to guarantee removal of the grain at the opening of navigation.

The most logical location for the storage of large quantities of grain appears to be at the Lakehead, where terminal facilities can be used for unloading, drying and cleaning, and then the top grades could be placed in temporary timber structures. The wheat, if in a dry condition, can then be stored for several years, if necessary, without impairing the milling or food qualities. The other requirements for a development of this nature, such as railway and water facilities, vacant and suitably located property, and cheap power, are all available.

The speaker stressed the economic aspect of the problem which would govern the feasibility of a development of this nature. There are four types of storage that could be built, namely: the standard concrete elevator, annexes with large concrete bins, rows of concrete bins enclosing a large space with roof and concrete slab, and the temporary timber bins of reinforced warehouse type equipped with belts and elevator legs.

The timber structures were considered to be the best suited for storage of large quantities of grain over a short period of time, when the structures must be removed when emptied in about two or three years. Some guarantee perhaps should be given by the Wheat Board, of use of temporary storage space for a time sufficient to retire the cost of construction.

Mr. Fleming thought that some measure of acreage control could be effected. One measure might be to take the marginal land out of wheat production and use it for other crops, thus removing at least two million acres out of the wheat category.

A large quantity of wheat in storage is of great value to the Empire's war effort, he said. The crops of the last two years were abnormal; two years of poor crops would reduce the carryover in Canada to normal, and there was sure to be a demand for wheat in Europe after the war.

Mr. O'Leary thanked the speaker and opened the discussion in which several members took part. The points brought up added to the interest in the address.

A dinner meeting of the Lakehead Branch was held at the Kakobeka Inn on Oct. 16th, commencing at 6.30 p.m. There were 22 members and guests present.

Mr. N. G. O'Leary, the chairman, presided at the meeting and introduced the speaker of the evening, Mr. E. J. Davies, principal of the Port Arthur Technical School.

Mr. Davies spoke on **The Training of Young Men for Industries.** He described the method of instruction and how some students became readily adapted to their work while others were much slower in adapting themselves. More time is now being spent on some of the academic subjects than was formerly required in the vocational training. Night classes have been given in welding with remarkable success in placing the welders in local industries.

Mr. P. E. Doncaster extended a vote of thanks to the speaker.

The address was followed by a period of discussion in which nearly all of the members took part.

Mr. Bird, chief engineer of Kaministiqui Power Company, invited the members and guests to visit the hydro plant of Kakabeka before returning to the city. Most of the members visited the plant which is a 35,000 hp. plant operating under 190 ft. head.

LONDON BRANCH

D. S. Scrymgeour, M.E.I.C. - *Secretary-Treasurer*
John R. Rostron, M.E.I.C. - *Branch News Editor*

The regular meeting was held in the Public Utilities Board Room at 8 p.m. on Wednesday, November 20th, 1940. The speaker of the evening was V. A. McKillop, chief engineer of the London Public Utilities Commission.

The speaker chose as his subject, **The Distribution of Electrical Power in the City of London.** By means of graphical charts he followed the distribution of power from its source to the consumers in the several sections of the city, indicating the improvements which had been installed, the service which was being given, and the advance in electrical distribution in recent years.

Following the address, many of those present took part in the discussion, indicating that the subject was of interest to engineers generally.

The chairman announced that the secretary-treasurer, D. S. Scrymgeour, who has occupied that position for the last five years, had severed his connections with the London Structural Steel Company Limited, and was joining the staff of the Standard Steel Company Limited of Welland, Ontario, on the 1st of December.

In recognition of the valuable services of Mr. Scrymgeour to the branch, Mr. W. C. Miller presented Mr. and Mrs. Scrymgeour with a floor lamp, to which Mr. Scrymgeour suitably replied, indicating the pleasure that it had been to work for the London Branch, and that he appreciated the many associations he had been able to make. He said that he would always remember his friends in London, and hoped that they would not forget him.

Following the resignation of Mr. Scrymgeour, Harry G. Stead was elected secretary-treasurer for the balance of the present year.

Eighteen members and guests were present.

OTTAWA BRANCH

R. K. Odell, M.E.I.C. - - *Secretary-Treasurer*

Development of Dual Lane Highways

The Development of Dual Lane Highways in Ontario was the topic for discussion at the noon luncheon of the Ottawa branch on November 21. C. A. Robbins, district engineer for southern Ontario, of the provincial Department of Highways, Toronto, was the speaker. W. H. Munro, chairman of the branch, presided and introduced the speaker. A motion picture was also shown of the Queen Elizabeth Highway, a super-highway recently opened up from Toronto to the Niagara peninsula. Details of construction methods were shown, as well as views of the completed highway in use, including over- and under-passes, bridges, "clover leaf" designs, and other notable traffic control features.

Super-highways of the future are getting farther and farther away from the narrow lane idea with ditches flanking each side, stated Mr. Robbins. Occupying a right-of-way anywhere up to 300 feet in width, with ditches shallow or non-existent, with easy curves and grades reduced to a minimum, and with a boulevard separating the two streams of traffic, they may truly be characterized as "streamlined." Bridges will not only be utilitarian but beauty spots as well, small parks will be spaced along at frequent intervals to add their charm to the route, and hot-dog stands and ramshackle service stations will not be permitted. Centres of population will be by-passed, crossing roads and railways will be over or under passed, and entrances and exits will be effected so as to cause no interruption to traffic.

Registration of cars all over the world for 1939, stated Mr. Robbins, was about 44 million of which United States and Canada had about three-quarters of the total, with Canada alone accounting for about a million and a half vehicles. Over 80 per cent of the traffic in Ontario, according to a traffic census, accommodates itself to 20 per cent of the road mileage, and accordingly the concern of most road authorities today is how to divide up this 20 per cent. In Ontario the division is approximately: 2 per cent super-highways, 2 per cent express highways, and 16 per cent local and service roads.

Super-highways will cross the province from east to west and north to south and will be of the divided type suited for carrying four lanes of traffic. Express roads will be tributary to them reaching to the outlying sections of the province. They will be of the two or three lane type, and of a higher standard than the local road, missing densely settled areas but with convenient entrances and exits thereto. The local and service roads will join towns and cities, will provide access to markets, speed up industry, and develop suburban areas. These roads we will always have, remarked the speaker.

Naval Armaments

Guest speaker at the noon luncheon on December 5th, 1940, at the Château Laurier was Captain C. S. Miller, R.N., Inspector of Naval Ordnance, British Admiralty Technical Mission, who spoke on **Naval Armaments.** Naval guns on which a pressure of 20 tons per square inch is exerted at the time of firing, shells that penetrate heavy armour plate before they burst, star shells designed to silhouette the enemy vessels at night, magnetic mines that may wreck a whole ship's structure without blowing a hole in it, depth charges that can be set to explode at any depth from 50 feet under water to 500 feet, torpedoes, and other features of naval armaments were described by the speaker.

Naval cadet at Osborne Royal Naval College, 1908, and midshipman before the last war, Captain Miller saw action at Heligoland Bight in 1914, Dogger Bank on the battle cruiser H.M.S. *New Zealand* in 1915, and was at the Battle of Jutland in 1916 on the battle cruiser *Princess Royal* in which he served as sub-lieutenant and lieutenant. Later briefly with the Royal Australian Navy he subsequently specialized as a gunnery officer, serving in various ships and gunnery schools of the Royal Navy, was assigned to armaments inspection, research and experimental duties in 1926 and in July last to duty in Canada and the United States with the British Admiralty Technical Mission.

The speaker paid a tribute to the engineering profession in the progress made on the part of Canadians toward supplying munitions not only for the Royal Navy but for other naval forces of the British Commonwealth as well.

QUEBEC BRANCH

Paul Vincent, m.e.i.c. - *Secrétaire-Trésorier*

Assemblée Annuelle

Lundi soir, le 25 novembre, avait lieu à l'Edifice Quebec Power l'assemblée générale annuelle de la section de Québec. Une quarantaine de membres y assistaient.

L'assemblée débutait par la nomination des scrutateurs pour dépouiller les bulletins d'élection pour l'année 1940-41. Le secrétaire lut ensuite le procès-verbal de l'assemblée annuelle du 4 novembre 1939. Le rapport du comité exécutif pour les activités de l'année écoulée et le rapport financier du secrétaire-trésorier furent aussi présentés aux membres. Après quoi, l'assemblée s'occupa de la formation des divers comités avec les résultats suivants:

Comité de Législation: président, Olivier Desjardins, J. O. Martineau, J. G. O'Donnell.

Comité de Recrutement: président, Paul Vincent, Hector Cimon, E. D. Gray-Donald.

Comité d'excursions: président, Theo. M. Dechêne, W. R. Caron, Yvon R. Tassé.

Comité de Nominations: président, A. O. Dufresne, Lucien Martin, G. W. Cartwright.

Comité de Bibliothèque: président, A. V. Dumas, René Dupuis, Théo. Miville Dechêne, J. O. Martineau, Burroughs Pelletier.

Les scrutateurs présentèrent alors le rapport des élections pour 1940-41 et le président de l'assemblée, M. Philippe Méthé en donna lecture aux membres comme suit:

Président: L. C. Dupuis, élu par acclamation.

Vice-président: E. D. Gray-Donald, élu par acclamation.

Sec.-trésorier: Paul Vincent, élu par acclamation.

Conseillers élus pour 2 ans: Robert Sauvage, Gérald Molleur, Olivier Desjardins.

Les autres conseillers, élus l'an dernier pour deux ans, ont encore un an d'office. Ce sont: MM. Théo. Miville Dechêne, Adhémar Laframboise et A. O. Dufresne.

Le comité est complété à l'unaminité par la nomination de MM. Alex. Larivière, R. B. McDunnough et Philippe Méthé, comme membres ex-officio et de M. A. R. Décary, président honoraire à vie de la section.

Dans une brève allocution, le président sortant de charge, M. Philippe Méthé, remercia la Compagnie Quebec Power pour son hospitalité ainsi que les membres de l'Institut pour être venus aussi nombreux à l'assemblée. Il félicita les nouveaux élus et il témoigna sa reconnaissance au comité exécutif et à tous les membres pour leur collaboration aux activités de la section sous sa présidence. Il terminait en présentant le nouveau président, M. L. C. Dupuis, qu'il invita à prendre le fauteuil présidentiel.

M. Dupuis remercia alors ses confrères de la marque d'estime dont il était l'objet. Il assura aussi les membres de ses meilleures dispositions en prenant charge de sa nouvelle fonction. Le nouveau président déclara en terminant qu'il s'efforcerait de suivre l'exemple de son prédécesseur, Monsieur Méthé.

Pour marquer l'ouverture de la saison des activités de la section, les membres voyaient se dérouler devant eux un documentaire intéressant. Ce film sonore intitulé **Warnings** fut gracieusement prêté par le Comité de la Protection Civile. L'assistance put constater les dangers des raids aériens modernes pour les populations civiles. Tous les moyens adoptés pour la protection des citoyens à Londres au cours de ces raids furent très bien illustrés.

La réunion se termina par un petit goûter, des rafraîchissements et de la tire à l'occasion de la Ste-Catherine. Les membres, avant de se quitter, eurent alors l'occasion d'échanger leurs vues sur les problèmes mondiaux et leurs activités professionnelles.

Monday night, December 16th, some thirty members gathered in the Committee Room of the Château Frontenac to hear a very interesting lecture on the **Britannia Mines.** The speaker, Mr. G. W. Waddington, a graduate from British Columbia University, resigned his position as chief engineer of Britannia Mining and Smelting Co. Ltd. last summer to join the staff of Laval University as professor of mining engineering.

Britannia mines are located 30 miles by boat from Vancouver, B.C., on the east side of Howe Sound. The dominant geological feature is the coast range batholith, which is exposed over a length of 1,000 miles along the west coast of Canada and Alaska. Ore deposits of the gold-silver and silver-lead type are found along the eastern flank of the batholith while along the western flank copper deposits are found. Britannia belongs to this latter type. The Britannia ore bodies are replacements in a shear zone seven miles long by two miles wide. The economic minerals are chalcopyrite, sphalerite, pyrite, gold and silver.

Mr. Waddington gave a short history of the mines. Copper, he said, was discovered on the east side of Howe Sound by Dr. A. A. Forbes in 1888. Ten years later, in 1898, Oliver Furry located five mineral claims. It is from these five original claims that a large portion of the mine production has since come. Active production started in 1905.

The speaker then went on to explain the present operations of mining, transportation, milling and production. With very good projections illustrating his talk, Mr. Waddington stated that narrow veins were ordinarily mined by rill stopes or by square set stopes. The large ore bodies were mined by a retreating shrinkage system, frequently combined with powder drifts for primary breaking. The broken ore travels by gravity to the main haulage levels. Electric trolley locomotives haul this ore and dump it to the primary crusher located underground on the 3,900 ft. level. The crushed ore is then trammed on the 4,100 ft. level to the mill in 18-ton cars through a distance of over 2½ miles.

The process of milling used is selective flotation and the concentrator handles 6,000 tons of ore per day. The ratio of concentration is 30 to 1. The principal product is a copper concentrate containing copper, gold and silver. Other products are pyrite concentrate and sometimes zinc concentrate. The concentrates are loaded into ships by conveyor belts. In 1939, Mr. Waddington mentioned that Britannia produced 2,113,784 tons of ore, from which were recovered 9 per cent of copper or 37,059,210 pounds, 22,238 ounces of gold and 203,019 ounces of silver. In addition 105,418 tons of pyrite were marketed, and it is mainly used to produce sulfuric acid. Development work amounted to 32,203 ft. or 6.1 miles in that year. During the 35 years that Britannia plant has operated, development work has totalled 86 miles.

All ditch water flowing from the mine is passed through a precipitation plant, which recovers an average of 3,000 pounds of copper daily with an efficiency of 93 per cent.

Easily available hydro-electric power, he added, low cost mining methods and cheap sea transportation contribute to the successful mining of these relatively low grade ore bodies.

The speaker then answered for about twenty minutes to the questions of his audience.

Mr. L. C. Dupuis, chairman of the branch, presented Mr. Waddington who was thanked by René Dupuis, assistant general superintendent of the Quebec Power Company.

SAGUENAY BRANCH

T. A. I. C. Taylor, Jr. E.I.C. *Secretary-Treasurer*
B. E. Surveyer, Affil. E.I.C. *Branch News Editor*

The Saguenay Branch held its first meeting of the season on the 15th August at the Arvida Protestant School. The speaker was Mr. J. T. Thwaites of the Canadian Westinghouse Company who was supervising the installation of the Ignitron Station in Arvida. His subject was **Ignitrons.** Mr. Thwaites discussed the development of mercury arc rectification by means of the Westinghouse ignitrons, giving essential differences between multiple and single tank rectifiers.

The following meeting of the branch was held on 10th October and Mr. E. F. Hartwick, of the Aluminum Company of Canada, Limited, gave an illustrated lecture on **The Manufacture of Alpaste in Arvida.** Mr. Hartwick described the different processes used in making paint pigment. He explained the various steps of the process employed in Arvida exemplifying some of the dangers which could be encountered and the precautions which were taken to minimize them.

Water Filtration and Purification was the subject of an address given by Mr. Ross Watson at a meeting held on the 14th November. Mr. Watson is at present installing a filtration plant in Arvida and he gave a description of its equipment and its operation including the pumping, filtering and chemical treatment of water, and illustrated the different phases of the process. Following Mr. Watson's paper, Dr. H. G. Acres, well known hydraulic engineer, talked and showed some slides of the **Shand Dam, at Fergus, on the Grand River.** He discussed the engineering features of earth-filled dams and pointed out that a definite technique is now employed rather than the hit-and-miss method originally used. Following the presentation of these two highly interesting papers a meeting of the Executive of the Saguenay Branch was held.

SAULT STE. MARIE BRANCH

O. A. Evans, Jr.E.I.C. - *Secretary-Treasurer*
N. C. Cowie, Jr.E.I.C. - *Branch News Editor*

The seventh general meeting for the year 1940 was held in the Grill Room of the Windsor Hotel when 21 members and guests sat down to dinner at 6.45 p.m. The business portion of the meeting began at 8.00 p.m. with Chairman E. MacQuarrie in the chair. The minutes of the previous meeting were read and adopted on motion of W. Seymour and G. S. MacLeod. The chairman then called upon Mr. Perkins, manager of the Bell Telephone Company, to introduce the speaker of the evening, G. T. Long, historian of the Bell Telephone Company of Canada, who had for his subject, **War Time Communications.**

The value of the telephone in the mobilization, organization and direction of armed forces was recognized almost as soon as the invention was perfected. Alexander Graham Bell himself demonstrated its use at Aldershot in England with the assistance of the Royal Engineers in 1877. The first actual use of a telephone system on the field of battle took place in the Russo-Japanese war of 1905. The same tactics, only on a much larger scale, were used by both sides during the war of 1914-18. Telephone research workers produced many special inventions, including "electrical ears" for detecting enemy airplanes, gun emplacements, and submarines from afar, during that conflict.

In the present war, telephone research has produced instruments which help to promote air safety and, by means of teletype and telephoto, written messages and military maps can be transmitted over great distances by wire.

Overseas telephone service, now limited to official calls, is also assisting in maintaining imperial communications during the war. The speaker pointed out that the chief reason why the overseas telephone did not fulfill expectations as a peacemaker, by promoting international understanding, is that it was never given a chance in Europe. Europeans are less telephone-minded than Canadians and Americans. The good relations between the latter peoples he attributed in part to their use of the telephone to make contacts between them more personal.

In conclusion, the speaker said: "This is part of the story of one industry's contribution in men and materials to Canada's defence of principles which are dearer than life itself. Other industries can, no doubt, match that record. With resolute determination, Canada as a whole is working to defend the last citadel of democratic freedom. In the words of Prime Minister Churchill: 'Let us, therefore, brace ourselves to our duty, and so bear ourselves that if the British Commonwealth and Empire last for a thousand years, men will still say, 'This was their finest hour.' "

At the end of the speech, G. S. MacLeod moved a vote of thanks to the speaker. E. MacQuarrie thanked the speaker on behalf of the branch. N. C. Cowie moved that the meeting be adjourned.

TORONTO BRANCH

J. J. Spence, M.E.I.C. - *Secretary-Treasurer*
D. Forgan, M.E.I.C. - *Branch News Editor*

The subject for the third meeting of the branch held in Hart House on November 21st was as expected most interesting and provocative of much thought. Unfortunately, as a result of the incidence of other functions on the same night, the attendance was not as high as the excellence of the programme warranted.

The vice-chairman, Mr. H. E. Brandon, introduced the speaker, Mr. Chas. M. Baskin, B.Sc., whose subject was **Modern Problems in Highway Construction** and which dealt largely with problems of subgrade and base course design for roads. His talk brought home to the audience the fundamental facts relating to this important subject and stressed that more study should be given to the condition of the ground carrying the road. Proper consideration and treatment of this would result in cheaper and better road surfaces, and would probably extend surfaced roads into areas where these are not at present considered to be economically practical. Dr. N. W. McLeod of the Imperial Oil Laboratory was on hand to answer many of the questions propounded to the lecturer and himself. Coloured moving pictures of highway construction in South America were shown, and subsequent to the technical part of the lecture a second reel which depicted the wonderful scenery and the really large fish which can be obtained "Somewhere in South America."

The fourth regular meeting of the Toronto Branch of the E.I.C., held in Hart House, December 5th, was honoured by the presence of Dr. T. H. Hogg, B.Sc., D.Eng., president of the Institute, who introduced the speaker, Mr. McNeely DuBose, vice-president for Quebec. The latter's subject was **Man Power,** a non-technical paper of the type which, if the resultant discussion is a criterion, provoked a considerable amount of thought along lines which many engineers are not likely to study in the normal course of their activities. It was presented by Mr. DuBose in a masterly fashion, and it is expected that its matter will be reproduced elsewhere in the *Journal.* Careful study of the paper can be recommended.

The thanks of the meeting were ably tendered to the speaker by Mr. M. J. McHenry, after which refreshments were partaken of by most of those present and the discussion still carried on. This was a most successful meeting with an attendance of approximately 75.

VANCOUVER BRANCH

T. V. Berry, m.e.i.c. - *Secretary-Treasurer*
Archie Peebles, m.e.i.c. - *Branch News Editor*

Annual Meeting

The annual business meeting of the Vancouver Branch took place on Saturday, Nov. 23rd, in the customary manner of an informal dinner. Following dinner, the business of the meeting was transacted, including the election of officers and executive committee for 1941. The slate submitted by a nominating committee was elected by acclamation.

The secretary-treasurer presented his financial report, and the chairman, Mr. C. E. Webb, read his report for the year.

The address of the evening was given by Mr. J. G. Robson, president of the Timerland Lumber Co. and president of the B.C. Lumber and Shingle Manufacturers' Association. His subject was **The B.C. Lumber Industry Marches with the Troops.** In treating his subject, Mr. Robson described vividly the enormous expansion of the lumber industry to meet war requirements, in the face of many difficulties also occasioned by the war. Typical freight rates have advanced from $6 to $32, $12 to $60, and $15 to $75. Normal export markets were upset, and replaced by other export markets and an abnormal internal demand. Canada had to supply those demands which were formerly met in Norway, Sweden and Russia, increased many times for war needs. An example of this is in furnishing pit props for use in the United Kingdom, which required 200 cargoes of these in the past year. Another difficulty arose out of the control of shipping, whereby cargo space was allotted by the British Government, and was irregular and restricted. The positions of ships are not available in advance, so that cargoes must often be made ready on three or four days' notice. War construction also changed the usual distribution of lengths and sizes, and, in some cases, the species required in normal trade. A much greater proportion of high grade structural timber in large sizes and non-standard lengths was required. This called for careful distribution of orders among the mills equipped to cut long logs, and also for the production of longer logs in the logging camps. The very great demand for Douglas fir has resulted in a surplus of other woods which must be cut with the fir as they occur in the mixed growth forest areas. Some changes have been made by engineers in their specifications to use up some of this surplus. It is altogether likely that in about ten years time, Douglas fir will be a relatively scarce wood, and much of the ordinary building lumber used in homes, stores, warehouses and similar structures will be cut from hemlock, spruce and cedar. Fir will be reserved for structural work requiring large sizes and maximum strength.

This war time demand for lumber came from the building of hangars and supplementary buildings under the air training plan, from the new militia camps, warehouses for war supplies, new factories and their adjacent housing for personnel, from the needs of aircraft manufacture, as well as from a generally accelerated demand in residential and business construction. Mr. Robson gave some illuminating figures on some of these items which need not be repeated here. The logging industry had to step up its production in tune with the demand for lumber, and this had been done smoothly and efficiently, so that at no time was there any serious shortage of logs at the mills.

Throughout the period during which these changes took place, there was no form of government control beyond an order prohibiting the export of logs to non-empire countries. A timber control board was set up however, under Mr. H. R. MacMillan, which acted to co-ordinate demand and supply as far as possible. Through local committees of this Board, orders were distributed among producers according to their capacity and type of product. Stocks of standard sizes were cut in advance whenever possible, and advance shipments were also made in certain cases, so that construction might proceed more rapidly, by drawing on stock sizes. The price of lumber had been voluntarily stabilized at the June, 1940, level and will remain at this unless noticeable increases in production costs take place.

A vote of thanks for the above address was tendered the speaker by Mr. W. N. Kelly. Other guests at the head table were Mr. E. Redpath, president, and Mr. F. W. MacNeill, vice-president of the Association of Professional Engineers of British Columbia. The meeting concluded with the showing of an excellent film, "Alaska's Silver Millions," depicting the scenic beauty and the salmon fishing industry of that country. This was kindly loaned by Mr. Shayler of the American Can Co. Thirty-seven members and guests were present.

VICTORIA BRANCH

Kenneth Reid, m.e.i.c. - *Secretary-Treasurer*

On the evening of November 29th, thirty-five members and visitors of the Victoria Branch gathered at dinner at Spencer's dining room. The dinner was followed by a general meeting of the branch with the branch chairman, Mr. E. W. Izard, presiding. Among the visitors on this occasion were Mr. C. E. Webb, past chairman of the Vancouver branch, Mr. S. R. Weston, chief engineer of the B.C. Public Utilities Commission, and several members of His Majesty's Forces, who were made most welcome. On this occasion nominations for the officers for the year 1941 were received.

The principal speaker of the evening was Major J. C. MacDonald, engineer for the Province of B.C. Public Utilities Commission, who spoke on the subject, **Public Utility Regulations.** Major MacDonald reviewed the history leading to the necessity for regulation of the consumption of natural resources due to the wasteful methods created by our high standard of living and our competitive "open market" system. He cited the two schools of thought one of which regarded regulation as a necessity and the other as "tinkering with the laws of nature." In order to offset waste and destruction we must have regulation. The United States had been striving to work out a system of regulation but had found its Constitution a severe handicap with the result that regulatory bodies were constantly in the courts over decisions. Finally a model act was devised suitable to cover all states and it was upon this act that the present Public Utilities Act in B.C. was drafted.

The B.C. Water Board, of which Major MacDonald was previously a member, was the first body, outside of the Lieutenant-Governor-in-Council, with regulatory powers. Appeals to the various regulatory bodies formed since 1914 could only be made to the Lieutenant-Governor-in-Council and not to the courts. The fundamental principle underlying these bodies is that no public utility shall be allowed to exploit the public, yet shall be entitled to a reasonable return for service rendered. Appraisals of public utility holdings are essential in order to adequately set rates and this is often a difficult and laborious task. Major MacDonald then introduced Mr. S. R. Weston, chief engineer of the B.C. Public Utilities Commission who outlined the progress being made in this regard at present in British Columbia.

At the conclusion of these addresses, Mr. A. L. Carruthers moved a very hearty vote of thanks both to Major MacDonald and to Mr. Weston for their informative discussions of a most timely topic. Following the addresses, several reels of sound motion pictures obtained through the catalogues recently distributed by the Institute Papers Committee were shown and greatly appreciated by the membership, rounding out a very satisfactory evening programme.

Library Notes

Book notes, Additions to the Library of the Engineering Institute, Reviews of New Books and Publications

STANDARDIZATION OF ANGLES, BEAMS AND CHANNELS

To be rolled in Canadian Mills for the Structural Steel Fabricating Industry. These Standards are now in effect and will remain in effect for the duration of the war.

Angles

EQUAL LEGS	UNEQUAL LEGS	CHANNELS
6x6x1*	6x4x1 *	3″ @ 4.1
7/8*	7/8*	4″ @ 5.4
3/4	3/4	5″ @ 6.7
5/8	5/8	6″ @ 8.2
1/2	1/2	7″ @ 9.8
3/8	3/8	8″ @ 11.5
		9″ @ 13.4
x4x5/8*	6x3½x3/8	10″ @ 15.3
1/2	5/16	12″ @ 20.7
3/8		12″ @ 25 *
5/16	5x3½x½	12″ @ 30 *
1/4	3/8	15″ @ 33.9
	5/16	15″ @ 45 *
		15″ @ 55 *
3½x3½x3/8		
5/16	4x3x3/8	
1/4	5/16	
	1/4	
		I-Beams
3x3x3/8		
		3″ @ 5.7
5/16	3x2½x5/16	
1/4	1/4	4″ @ 7.7
		5″ @ 10.0
2½x2½x5/16	2½x2x5/16	6″ @ 12.5
1/4	1/4	8″ @ 18.4
3/16	3/16	10″ @ 25.4
		12″ @ 31.8
2x2x5/16		15″ @ 42.9
1/4		15″ @ 50 *
3/16		15″ @ 55 *
Modified H-Beams		**H-Beams**
8″ @ 25.9		6″ @ 20
		6″ @ 22.5
		6″ @ 27.75

NOTE—*Sizes marked * are "Special" and should be used by designer only when at least 50 tons of that size are required.*

ADDITIONS TO THE LIBRARY

TECHNICAL BOOKS

The following books have been graciously presented to the Institute's library by the Montreal Section of the Institute of Radio Engineers and they are gratefully acknowledged here:

THEORY OF THERMIONIC VACUUM TUBES *by E. Leon Chaffie.*

MEASUREMENTS IN RADIO *by F. E. Terman.*

COMMUNICATION ENGINEERING *by W. L. Everitt.*

RADIO ENGINEERING *by F. E. Terman.*

REPORTS

Canada Department of Labour

Annual report for the fiscal year ending March 31, 1940, Ottawa, 1940.

Canada Department of Mines & Resources—Mines & Geology Branch—Geological Survey—Memoir

Malartic area, Quebec, Memoir 222.

Canada Department of Mines & Resources—Mines & Geology Branch—Geological Survey—Papers

Wapiabi Creek, Alberta, preliminary map. Paper 40-13.

Canada Department of Transport

Annual report for the fiscal year from April 1, 1939, to March 31, 1940. Ottawa, 1940.

Canada Minister of Public Works

Report of the Minister of Public Works on the works under his control for the fiscal year ended March 31, 1940. Ottawa, 1940.

Canadian Engineering Standards Association

Insulated power cable C68(A)-1940; Canadian Electrical Code, part, 2, Construction and test of insulated conductors for power-operated radio devices, C22.2-No. 16-1940; Construction and test of pull-off plugs for electro-thermal appliances, C22.2 No. 57-1940. Standard specification for the procedure for fire tests on building construction and materials, A54-1940.

Canadian Government Purchasing Standards Committee

Specification for antifreeze liquids, types 1 and 11; specification for thinner for nitrocellulose finishers; specification for asphalt varnish; specification for bituminous paint (type 1, for steelwork not exposed to weather) specification for fluids for hydraulic and shock absorber mechanisms on aircraft.

Electrochemical Society—Preprints

Semi-conductor photocells and rectifiers; the electrolytic reduction of methyl ethyl ketone to sec-butyl alcohol and n-butane; structure and grain size of electrodeposited copper; the irreversible phenomena of thallium 2. cathode potential in Tl_2SO_4 solution. Preprints 79-1 to 79-4.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet the books are not in the Institute Library, but inquiries will be welcomed at headquarters, or may be sent direct to the publishers.

A.S.T.M. STANDARDS on TEXTILE MATERIALS, prepared by Committee D-13 on Textile Materials. October, 1940

American Society for Testing Materials, Philadelphia, 1940. 368 pp., illus., diagrs., charts, tables, 9 x 6 in., paper, $2.00 (10 to 49 copies, $1.50 each.)

Sixty-six standards and tentative standards covering definitions and terms, methods of testing and specifications for textile and related materials are presented in this compilation. Additional material appearing in appendices includes photomicrographs of textile fibers, tables for yarn number conversion and relative humidity, a glossary of textile terms, proposed test methods and abstracts of papers presented at committee meetings.

AIRCRAFT DESIGN, 2 Vols.

By C. H. L. Needham. Chemical Publishing Co., New York, 1939. illus., diagrs., charts, tables, 9 x 5½ in., cloth, Vol. 1, 215 pp., $6.00; Vol. 2, 308 pp., $6.50.

The general principles of aircraft design are presented both as a textbook and as a guide for the practical constructor. The first volume outlines in simple language the principles of flight and stability, control devices and the propeller, with a special chapter on parasite drag. The second deals mainly with the mathematical treatment of design, including materials, seaplane construction and experimental testing. The illustrative material is taken from British practice.

AIRCRAFT DIESELS

By P. H. Wilkinson. Pitman Publishing Corp., New York and Chicago, 1940, 275 pp., illus., diagrs., charts, tables, 2½ x 6 6 in., cloth, $6.00.

This book is devoted exclusively to the Diesel engine in aviation. It outlines the basic principles upon which the engine functions and the phases and processes involved. Fuel-injection equipment, superchargers and accessories are described, the construction of different types of engines is presented in detail, and standardized pages of data are provided. The development and mass production of Diesels in Germany are discussed, their commercial utility is described, and suggestions are presented for the future.

AIRCRAFT ENGINES, Vol. 1

By A. W. Judge. D. Van Nostrand Co., New York, 1940. 380 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, $5.50.

In the words of its author, "the object of the present book, which is the first of two volumes on aircraft engines, is an endeavor to present the principles and results of relevant research work upon internal combustion engines, for the benefit of those entering or already engaged in aircraft engineering work. It is also written to fill a gap existing in aeronautical literature, between the more advanced specialist books on theory and design and the elementary descriptive ones on aircraft engines, maintenance, etc." There is a bibliography.

BAUGHMAN'S AVIATION DICTIONARY and REFERENCE GUIDE, Aero-Thesaurus

By H. E. Baughman. 1st ed., 2nd printing. Aero Publishers, Inc., 202 Security Bank Bldg., Glendale, Calif., 1940. 598 pp., illus., diagrs., charts, tables, 9½ x 6 in., lea. cloth, $5.00.

This reference book contains a wide variety of information frequently wanted by those engaged in aviation. An excellent dictionary of aeronautical terms is given, as are the regulations of the Civil Aeronautics Authority which concern students. The information upon occupations, drafting, lofting procedure, shop mechanics and materials is extensive and practical. Flight manoeuvers are illustrated by diagrams. There are tables of specifications and of needed mathematical data; directories of periodicals, house organs, publishers, clubs, societies, manufacturers and schools; as well as many other data.

COMMISSIONING of ELECTRICAL PLANT and ASSOCIATED PROBLEMS (Monographs on Electrical Engineering, Vol. 5).

By R. C. H. Richardson. Chapman & Hall, London, 1938. 363 pp., diagrs., charts, tables, 9 x 5½ in., cloth, 24s.

The object of this book is to present general and specific information which has been found useful when putting into service both alternating and direct-current generating, transforming, motive and converting equipment. The preparation, likely troubles and efficient testing of such equipment are fully described, and the last chapter outlines briefly several important conceptions useful in electrical engineering calculations. There is a classified selected bibliography.

(*Continued on page 48*)

PRELIMINARY NOTICE

of Applications for Admission and for Transfer

December 28th, 1940

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, 1941.

L. Austin Wright, General Secretary.

*The professional requirements are as follows:—

A 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 he 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 attainment or practical experience qualify him to co-operate with engineers in the advancement of professional knowledge.

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

FOR ADMISSION

ANDERSON—HARRY CLYDE, of New Westminster, B.C. Born at Sturgis, Co. Dakota, U.S.A., July 13th, 1895; R.P.E. of B.C. 1926—Member of Council 1940; 1911, asst. on installn. of municipal water works and power plant at Merritt, B.C.; 1912-13, transitman and levelman with A. W. McVittie, Victoria, B.C., and E. H. Ferris, London, England, on land surveys and irrigation work; 1915-21, asst. on govt. surveys and private work consisting of installn. of irrigation systems, litigation surveys, etc.; 1919, charge of location of logging rly. for Nicola Pine Mills, Merritt; 1921-29, asst. district engr., Yale District, 1929-31, asst. dist. engr., and 1931 to date, district engr., Dept. of Public Works of B.C., New Westminster, B.C.

References: C. E. Webb, E. Smith, A. L. Carruthers, H. N. Macpherson, T. V. Berry.

BRIDGEWATER—ALBERT WILLIAM, of Westmount, Que. Born at Saskatoon, Sask., Oct. 7th, 1914; Educ.: B.Sc. (Civil), 1935, M.Sc. (Civil), 1936, Univ. of Sask.; R.P.E. of Ont.; 1936 (May-Nov.), instr'man. on constrn. of Borden Bridge 1937 (Feb.-Oct.), dftsman., Dominion Bridge Co. Ltd., Winnipeg; 1937-39, reinforced concrete detailer and gen. struct'l. designer, with M. M. Dillon, M.E.I.C., London, Ont.; 1939-40, res. engr., on constrn. of caustic finishing plant, for Canadian Industries Ltd., at Shawinigan Falls; March 1940 to date, with Defence Industries Ltd., at present, struct'l. designer.

References: S. W. Archibald, M. M. Dillon, I. R. Tait, B. A. Evans, D. A. Killam, W. C. Tatham, R. A. Spencer.

GLENN—JOHN BURGESS, of 204 Wineva Ave., Toronto, Ont. Born at Southampton, Ont., Sept. 18th, 1915; Educ.: B.Sc. (Mech.), Univ. of Sask., 1938; 1938, inspr., Rogers-Majestic Radio Corpn.; 1938 to date, production engr., Link Belt Ltd., Toronto, Ont.

References: C. J. Mackenzie, I. M. Fraser, W. E. Lovell, N. B. Hutcheson, G. M. Williams.

MURCHISON—JAMES GRAY, of Fort William, Ont. Born at Crathes, Kincardine, Scotland, Feb. 25th, 1902; Educ.: 1919, Robert Gordon's College, Aberdeen. 1921, one year Arts, Aberdeen University; 1929-30, levelman on highway constrn., Dept. of Nor. Development, Sudbury, Ont.; 1930-34, clerk and foreman, highway constrn. and installn. of water system, H. T. Routly Constrn. Co., Toronto; with Dept. of Highways of Ontario as follows: 1936, laying out of Nipigon bridge, 1936-37, instr'man., 1937-38, res. engr., 1938-39, instr'man, 1939, associate of the late H. L. Seymour, M.E.I.C., town planning consultant, on preparation of town planning data for the cities of Fort William and Port Arthur; 1939-40, dftsman. and designer, on elevator and mill constrn., C. D. Howe Co. Ltd.; 1940, supt. of constrn. of internment camp, comprising all bldgs., water, sewer and lighting; at present, consultant to the Fort William Town Planning Commission, on the preparation of a zoning by-law and town planning for the City of Fort William.

References: P. E. Doncaster, J. M. Fleming, B. A. Culpeper, C. B. Symes, S. E. Flook.

RAYNER—WARREN, of 113 So. Archibald St., Fort William, Ont. Born at Toronto, Ont., Nov. 22nd, 1914; Educ.: B.Sc. (Mech.), Queen's Univ., 1939; 1939-40, demonstrator, mech. engrg., Queen's Univ.; 1940 to date, jig and tool designer, Canadian Car & Foundry Co. Ltd., Fort William, Ont.

References: L. T. Rutledge, W. H. G. Flay, W. L. Saunders, E. M. G. MacGill, D. Boyd, D. S. Ellis.

REYNOLDS—JOHN ALFRED, of 176 West Moira St., Belleville, Ont. Born at Montreal, Oct. 23rd, 1903; Educ.: 1917-21, Toronto Technical School. 1931-35 (evening classes), Chrysler Institute of Technology, Detroit; 1921-26, Canada Cycle & Motor Co., Weston, Ont.; 1926-29, General Motor Research, Detroit, Mich.; 1929-36, Chrysler Motor Car Co., Detroit, Mich. 1931-36 as service engr. for the engrg. divn. of the Dodge Truck Co.; 1936-39, Singer Motor Car Co., Birmingham, England, i/c plant layout, and later i/c tool and jig design; 1939-40, mech. engr., Canadian Marconi Co., design of transmitters, receivers and test apparatus; at present, aircraft inspr., Trenton Air Station, R.C.A.F., Trenton, Ont.

References: D. C. Macpherson, R. T. Bell, H. J. Vennes.

WINTER—JOHN EDWARD, of Lethhridge, Alta. Born at Kharkov, Russia, Jan. 3rd, 1894; Educ.: 1923-24, 1st year engrg., Univ. of Alta.; 1921-24, rodman, chainman, leveller, topog'r., Dom. Dept. of the Interior, Reclam. Service; 1925-35, leveller, instr'man., asst. hydrographer, C.P.R., Dept. Natural Resources, Brooks, Alta.; 1935-38, instr'man., 1938-40, junior engr., Dom. Dept. of Agriculture, P.F.R.A.; 1940 (July-Sept.), asst. to engr. i/c works, Dept. of National Defence, "Air Force," and Sept. 1940 to date, engr. i/c works, No. 5 E.F.T.S., Lethbridge, Alta.

References: A. Griffin, F. G. Cross, G. S. Brown, P. M. Sauder, B. Russell.

FOR TRANSFER FROM JUNIOR

BENTLEY—KENNETH EARL, of Dartmouth, N.S. Born at Billtown, N.S., Sept. 27th, 1912; Educ.: B.Sc. (Civil), N.S. Tech. Coll., 1934; from 1934 to date, with the Imperial Oil Limited, at the Imperoyal Refinery as follows: 1934-36, gen. lab. work, 1936-37, dftsman., 1937-38, engrg. estimator, 1938, mtce. engr., 1938-40, engrg. inspr., and at present, mtce. engr. (St. 1934, Jr. 1939).

References: R. L. Dunsmore, C. Scrymgeour, S. Ball, A. D. Nickerson, G. W. Christie.

BOUCHER—RAYMOND, of Montreal, Que. Born at Stanbridge, Que., July 21st, 1906; Educ.: B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1933. M.Sc., Mass. Inst. Tech., 1934; 1928-31 (summers), surveying, Quebec Streams Commn.; 1934-38, asst. professor and 1938 to date, associate professor of Hydraulics, Ecole Polytechnique, Montreal, Que. (St. 1932, Jr. 1934).

References: A. Frigon, O. O. Lefebvre, A. Circé, A. Duperron, J. A. Lalonde, J. B. Macphail.

BRADLEY—JOSEPH GERALD, of Mackenzie, Rio Demerara, British Guiana. Born at Sydney, N.S., May 13th, 1904; Educ.: 1925-26, first year engrg., McGill Univ., not completed; 1927-28, first year, School of Commerce at McGill, completed; 1926-27, cost accting. and mech. dfting., Fraser Brace Engrg. Co., Gatineau, Que.; 1928, R.C.A.F., Prov. Pilot Officer; 1928-29, supervision of 75 mile freight route, Island Falls, Sask., and 1929-30, inspn. of pipe and pump installn. of concentrator plant, Copper Cliff, Ont., for Fraser Brace Engineering Co.; 1931-38, asst. supt., i/c of mtce., Sherwin Williams Co. of Canada Ltd., Red Mill, Que.; 1938 to date, i/c machine shop and all plant repairs, Demerara Bauxite Co., Mackenzie, British Guiana. (Jr. 1938).

References: J. H. Fregeau, J. M. Mitchell, P. H. Morgan, K. S. LeBaron, F. L. Lawton, A. W. Whitaker, Jr.

COLPITTS—GORDON L., of Barranca-Bermeja, Colombia. Born at Moncton, N.B., Sept. 6th, 1909; Educ.: B.Sc. (Mech.), N.S. Tech. Coll., 1933; 1928-30, instr'man. and chief of party on forest surveys, Canada Power & Paper Corpn., Laurentide Divn.; 1933-40, with Imperial Oil Limited, as follows: 1933-34, dftsman., 1934-36, constrn. engr., 1936-37, metal inspr. on cracking coils, 1937-38, asst. engr. and metal inspr., 1938-39, acting chief engr., 1939 (June-Nov.), asst. engr., Dec., 1939 to Oct., 1940, acting chief engr., all of above at Halifax Refinery; Nov. 1940 to date, chief engr., Barranca-Bermeja Refinery, Tropical Oil Company, Colombia, S.A. (Jr. 1934).

References: R. L. Dunsmore, C. Scrymgeour, W. B. Scott, J. S. Misener, G. W. Christie.

DALE—JAMES GRAHAM, of Edmonton, Alta. Born at Cranbrook, B.C., Jan. 7th, 1910; Educ.: B.Sc. (Elec.), Univ. of Alta., 1934; 1926 (summer), rodman, B.C. land surveys; 1927-28, electrn's helper, Cons. Mining & Smelting Co. of Canada Ltd.; 1929 (summer), and 1930-31, Sullivan concentrator at Chapman Camp, B.C.; 1934-36, inspr., and 1937 to date, installn. engr., Northwestern Utilities Limited, Edmonton, Alta. I/c installn. of large gas burning equipment for commercial and industrial loads and in power boilers; also design and installn. of many types of automatic control systems for above. (Jr. 1939).

References: J. Garrett, E. Nelson, B. W. Pitfield, W. E. Cornish, R. C. McPherson.

TAYLOR—FRANKLIN THOMAS, of 230 Edward St., London, Ont. Born at Watford, Ont., Dec. 24th, 1910; Educ.: B.A.Sc., Univ. of Toronto, 1933; R.P.E. of Ont.; 1930 (summer), Richards Wilcox Canadian Co., London, Ont.; 1932 (summer), machinist, Wells Motors, London; 1936-37, demonstrator, dfting. room, Univ. of Toronto; 1937 to date, dftsman., Richards Wilcox Canadian Co., London, Ont. (Jr. 1939).

References: H. F. Bennett, D. S. Scrymgeour, G. F. Fry, J. J. Spence, M. B. Watson.

FOR TRANSFER FROM STUDENT

BEACH—JOHN EDWARD, of Pointe a Pierre, Trinidad, B.W.I. Born at Calgary, Alta., May 15th, 1913; Educ.: B.Sc. (E.E.), Univ. of Alta., 1935; summers, 1928, rodman, 1934, checker, Northwestern Utilities Ltd., Edmonton; 1935-37, constrn. and mtce., Royalite Oil Company, Turner Valley, Alta.; 1937 (summer), rodman and instr'man., City of Edmonton; 1937-40, constrn. and dftsman., H.E.P.C. of Ont.; at present, asst. engr., Trinidad Leaseholds Ltd., Trinidad, B.W.I. (St. 1935).

References: H. J. MacLeod, R. S. L. Wilson, S. G. Coultis, P. L. Debney, E. Nelson, E. B. Dustan, H. E. Brandon.

HAMMOND—ROWLAND ERNEST, of Montreal, Que. Born at Toronto, Ont., Aug. 16th, 1911; Educ.: B.A.Sc., 1933, M.A.Sc., 1934, Univ. of Toronto; 1934-35, lab. asst., Stromberg-Carlson Co., Toronto, Ont.; with the Northern Electric Co. Ltd., Montreal, as follows: 1935-38, radio engr., 1938-39, purchasing agent, 1939-40, sales engrg. dept., 1940, production planning, and at present, order service supervisor. (St. 1931).

References: H. J. Vennes, J. J. H. Miller, W. H. Eastlake, A. B. Hunt, J. S. Cameron.

McMILLAN—COLIN BROCK, of Arvida, Que., Born at Toronto, Ont., March 13th, 1913; Educ.: B.Sc. (Civil), Queen's Univ., 1936; 1936 (summer), instr'man. on survey party; 1937-38, junior engr., Aluminum Co. of Canada, Ltd.; March, 1938 to date, civil engr. with the Saguenay Power Co., Arvida, 1939, field engr. and from May, 1940 to date, i/c of gen. property surveying. (St. 1936).

References: C. Miller, F. L. Lawton, N. W. Brittain, W. L. Malcolm, R. A. Low

SCOBIE—ALEXANDER GORDON, of 320 Tarneaud St., Sudbury, Ont. Born at Hamilton, Ont., July 13th, 1910; Educ.: B.Sc., Queen's Univ., 1937; 1926-33, analyst, Proctor & Gamble Co., Hamilton; 1935 (4 mos.), analyst, Burlington Steel Co., Hamilton; 1937 to date, chemist, copper refining divn., International Nickel Co., Copper Cliff, Ont. (St. 1934).

References: W. F. Miller, F. A. Orange, L. F. Goodwin, L. M. Arkley, L. T. Rutledge.

LIBRARY NOTES

(Continued from page 46)

GRAPHICAL TREATMENT of VIBRATION and AIRCRAFT ENGINE DAMPERS

By C. H. Powell. Bookcraft, 135 Johnson St., Brooklyn, New York, 1940. 288 pp., diagrs., charts, tables, 9½ x 6 in., cloth, $7.50.

The first part of this text presents a concise method of graphical solution for complex vibrating systems, by geometrically combining the more easily obtained solutions of simple elemental systems. Part II is a more particular application of the methods developed in Part I to various forms of engine dampers for torsional oscillation. Optimum conditions for all known types of dampers, the amplitude of the damper and the phase relations of the individual vibrating members are dealt with in detail. There are many charts and diagrams.

Great Britain, Department of Scientific and Industrial Research. BUILDING RESEARCH

Wartime Building Bulletin No. 9, CONSERVATION of CEMENT and of CLAY BRICKS. His Majesty's Stationery Office, London, 1940. 22 pp., diagrs., charts, tables, 11 x 8½ in., paper, 1s. (obtainable from British Library of Information, 50 Rockefeller Plaza, New York, $.30).

This pamphlet calls attention to ways in which substitutes can be used for cement and clay brick in many cases and to ways in which these materials can be used most economically where no alternative is available. Specifications are given for tar macadam roadways, for economical concrete floors and for methods of making walls.

Great Britain. Home Office. AIR RAID PRECAUTIONS. SPECIFICATIONS, etc., in regard to PERMANENT LINING of TRENCHES

H. M. Stationery Office, London, 1939. 8 pp., diagrs., 13 x 8½ in., paper, (obtainable from British Library of Information, 50 Rockefeller Plaza, New York, $.10).

The composite specification and bill of quantities are given for precast concrete trench lining units, accompanied by diagrammatic drawings. There are also a general specification for the permanent lining of trenches and a Home Office circular letter giving basic information on trench construction.

HANDBOOK of CHEMISTRY and PHYSICS

Edited by C. D. Hodgman and H. N. Holmes. 24 ed. Chemical Rubber Publishing Co., Cleveland, Ohio, 1940. 2,564 pp., diagrs., tables, 7½ x 5 in., cloth, $3.50.

This valuable handbook of data frequently needed by physicists and chemists becomes more comprehensive as new editions appear. The present issue contains over three hundred pages more than its immediate predecessor. The principal changes include rearrangement of the table of physical constants of organic compounds and the inclusion of several hundred new ones, a thorough revision of the table giving the properties of commercial plastics, a tabulation of the physical constants of four hundred industrial organic compounds and a table of induced radioactivities. In addition, minor changes and additions have been made throughout the book.

INDUSTRIAL MANAGEMENT

By R. H. Lansburgh and W. R. Spriegel. 3 ed. John Wiley & Sons, New York, 1940. 666 pp., illus., diagrs., charts, maps, tables, 9 x 6 in., cloth, $4.50.

General organization technique is stressed in this discussion of the principles, problems, ideals and successful methods of industrial management. In the several chapters on fundamental considerations, the plant, the product, personnel, wage payment, managerial controls and operating procedures, an effort has been made to show the relationships of each major portion of the business to the others and to outside influences. There is a bibliography.

INTRODUCTION to ABSTRACT ALGEBRA

By C. C. MacDuffee. John Wiley & Sons, New York, 1940. 303 pp., diagrs., charts, tables, 9 x 6 in., cloth, $4.00.

This book is planned for a full year's course, with problems furnishing laboratory material and concrete instances of the abstract concepts. The subject is developed logically from the system of rational integers to linear associative algebras. A selected body of facts from number theory, group theory and formal algebra is offered, to provide a background for understanding and appreciating the generalized facts of abstract algebra.

PULP and PAPERMAKING Bibliography and United States Patents 1939.

Compiled by C. J. West, Technical Association of the Pulp and Paper Industry, New York, 1940. 252 pp., 9 x 6 in., cloth, $3.00.

This comprehensive bibliography covers the articles upon pulp and papermaking which appeared during the year 1939 and the United States patents issued during that year which are of interest to the industry. Both sections are classified; the articles by a subject arrangement and the patents by the Patent-office classification. Subject and author indexes are included.

TREATISE on ADVANCED CALCULUS

By P. Franklin. John Wiley & Sons, New York, 1940. 595 pp., diagrs., charts, 9 x 6 in., cloth, $6.00.

Although the reader is assumed to be familiar with the fundamental methods of the calculus, these are briefly reviewed together with the prerequisite parts of algebra and analysis. The text then continues with an exposition of infinitesimal calculus, including those parts of the theory of functions of real and complex variables which form the logical basis of the infinitesimal analysis and its applications to geometry and physics. A group of exercises accompanies each chapter.

TURRET LATHE OPERATOR'S MANUAL

By J. R. Longstreet and W. K. Bailey; published by The Operators' Service Bureau of The Warner & Swasey Co., Cleveland, Ohio, 1940. 240 pp., illus., diagrs., charts, tables, 10½ x 7 in., cloth, $2.50.

This book, prepared by experienced engineers, provides an unusually comprehensive and detailed description of principles and practice. Tools and accessories, methods of working, short cuts and special problems are discussed with the help of over 350 excellent illustrations and drawings. The book is designed expressly for the lathe operator.

Employment Service Bureau

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party. Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted upon request after a lapse of one month. All correspondence should be addressed to THE EMPLOYMENT SERVICE BUREAU, THE ENGINEERING INSTITUTE OF CANADA, 2050 Mansfield Street, Montreal.

SITUATIONS VACANT

ENGINEER with pulp and paper experience to become Assistant Chief Engineer in a large mill. Either a man who can fit into the position immediately, or a younger man who has the training and ability to work into it gradually. The initial salary to be paid will depend upon the qualifications of the applicant. This position holds an interesting future for the right man. Send applications with full particulars to Box No. 2209-V.

ELECTRICAL ENGINEER, fully experienced in design of large modern power transformers. Give full details of education, experience, and salary expected. Applications not considered from persons now employed with firms producing war supplies or equipment. Apply to Box No. 2231-V.

MECHANICAL ENGINEER, with thorough knowledge of manufacturing, preferably in electrical apparatus. Supply complete information, education and previous experience. Applications not considered from persons now employed with firms producing war supplies or equipment. Apply to Box No. 2232-V.

DRAUGHTSMAN required by electrical manufacturer experienced in layout and detail work on power transformers. State experience and salary expected. Applications not considered from persons now employed with firms producing war supplies or equipment. Apply to Box No. 2233-V.

ENGINEER for fabricating plant, must be experienced in the detail and design of structural steel. This is a permanent position for the man with the necessary qualifications. Apply to Box No. 2234-V.

GRADUATE in metallurgical engineering required by large manufacturing plant in Montreal. Excellent opportunity for experience and promotion. Apply giving education, experience and salary expected to Box No. 2235-V.

YOUNG MECHANICAL ENGINEER, recent graduate, required for preparation of specifications and performance data on steam generating equipment and accessories. Previous experience in this line preferred but not essential. Excellent opportunities for advancement. Applications from persons at present employed in war industries will not be considered. Apply to Box No. 2239-V.

GRADUATE CHEMIST with digestion sewage disposal plant experience. Applicants to state experience, salary required and when at liberty. Apply Box No. 2244-V.

RECENT ENGINEERING GRADUATE, preferably mechanical, with some drafting experience. Work will consist of machinery and piping layouts and other general engineering work in a paper mill near Ottawa. Permanent position and excellent prospects for suitable man. Men now employed in war industry will not be considered. Apply Box No. 2245-V.

MECHANICAL DRAUGHTSMAN, for layout of power plant equipment, piping systems, etc., preferably university graduate with three or four years' experience. State age, experience, salary desired. Location Toronto. Apply to Box No. 2247-V.

ENGINEERING DRAUGHTSMAN required for centrally located mill. Preferably a graduate engineer with several years' experience. Applications from men employed in war industries will not be considered. Apply Box No. 2249-V.

REQUIRED for large gold mining organization in West Africa, several mill shiftmen, mill men and electricians. Salaries up to £40, £32 and £40 respectively per month, free living quarters. Ocean passage paid and three months' leave granted per year at half pay. Yearly renewable contracts. Defence regulations do not permit wives to accompany husbands at this time. Apply Box No. 2258-V.

SENIOR ELECTRICAL ENGINEER with from five to eight years experience required by large industrial concern. Apply with full details to Box No. 2261-V.

YOUNG CIVIL ENGINEER not more than two years out of college with field and office experience. Apply giving full particulars to Box No. 2259-V.

MECHANICAL DRAUGHTSMAN with some experience immediately required by a large industrial firm. Apply giving full particulars to Box No. 2262-V.

SITUATIONS WANTED

CONSTRUCTION ENGINEER, University graduate experienced in Power Plants, Transmission lines, gunite construction, etc. Available on short notice. Apply to Box No. 1527-W.

CIVIL ENGINEER AND SURVEYOR—Experienced in general building and war plant construction. Also installation of mechanical equipment. Immediately available. Apply to Box No. 2153-W.

ELECTRICAL ENGINEER, graduate, Age 47, married. Experience covers draughting, construction, maintenance, and operation. For the last ten years employed as electrical superintendent in a large industrial plant. Apply to Box No. 1718-W.

ENGINEER—M.E.I.C. Age 49. Desires change. Experience covers all types structural steel and plate work, rivetted and welded construction, as estimator. Designing, shop drawings. Available two weeks notice. Apply Box No. 2208-W.

MECHANICAL ENGINEER, Draughtsman, Specification Writer, Supervisor, specializing in Heating, Ventilating, Power Plants and Plumbing, available immediately. Will go anywhere. Apply Box No. 2285-W.

ENGINEERS FOR THE AIR SERVICE

The following communication is printed at the request of Air Marshal L. S. Breadner, Chief of Air Staff. Members of the Institute and other engineers are requested to give it careful consideration. Any persons remote from recruiting centres are welcome to write to Headquarters for additional information.

DEPARTMENT OF NATIONAL DEFENCE
"AIR FORCE"

Ottawa, Canada, November 29th, 1940.

MR. L. A. WRIGHT, *Secretary,*

ENGINEERING INSTITUTE OF CANADA, MONTREAL, QUE.

Dear Sir:

The development of the British Commonwealth Air Training Plan and the absorption of Technical personnel in war industry, has resulted in a shortage of available men with engineering qualifications.

At the present time the Royal Canadian Air Force is in urgent need of personnel for training as Aeronautical Engineer Officers. There is also an immediate requirement of Technical Engineers with practical experience in aircraft production or maintenance. Qualifications required of candidates for appointment under these two classifications are as follows:

(a) **Technical Engineer Officers**

Candidates must be suitable in personal respects to hold commissioned rank and must have the following qualifications:

Thorough knowledge in engineering, applicable to aeronautical requirements.

Adequate experience in aricraft repair work or extensive aircraft factory experience.

Age limit—up to 50 years (highly qualified candidates will be considered up to age 55).

While graduate engineers are preferred, it may be necessary to accept candidates with lesser academic standing provided they have extensive practical experience.

(b) **Potential Aeronautical Engineer Officers**

These officers will be required to undergo a very thorough course in aeronautical engineering before they are assigned to duties.

Candidates must be of good character, suitable in all personal respects for appointment to commissioned rank and above average in mental alertness.

An applied science degree in aeronautical, mining, mechanical, civil, chemical, or electrical engineering is desirable.

A candidate having extensive practical experience but with a lower standard of education may be accepted. He must, however, have attained a standard not lower than senior matriculation. University graduates should have at least one year's practical experience along any of the several mechanical lines. Candidates with less than university graduation standing will be required to have a correspondingly greater practical experience.

The preferred age for appointment in this category is 25 to 40 years.

It would be greatly appreciated if you would make our needs known to the several branches of your organization throughout Canada and through this medium, to the individual members of the Institute. It is felt that an appeal of this nature may be instrumental in directing to the Royal Canadian Air Force, men who possess engineering qualifications which may be of value to this service.

Prospective candidates should make application at the nearest R.C.A.F. Recruiting Centre, so that it may be ascertained whether they are physically fit and suitable in all respects. This action will not necessitate a severence of their civilian employment before they are appointed and will entail no obligation on their part until actually called for duty.

Your co-operation in this matter is earnestly requested and it is hoped that if you have knowledge of any suitable prospective applicants you will find it possible to acquaint them with our urgent need and the procedure for submitting their application. Might I also ask that you forward their names and addresses, together with your recommendation in each case, to the nearest R.C.A.F. Recruiting Centres or, if more convenient, to these Headquarters.

Assuring you that your assistance in this matter will be most sincerely appreciated.

I am, yours very truly,

(*Signed*) L. S. BREADNER, AIR VICE MARSHAL,
Chief of the Air Staff.

Industrial News

Industrial development — new products — changes in personnel — special events — trade literature

THREADING AND TAPPING EQUIPMENT

Landis Machine Co. Inc., Waynesboro, Pa., have issued an interesting 116-page handbook entitled "Landis Handbook" which contains instructions covering the use of various Landis machines including the grinding of chasers, operation of threading heads and machines, the grinding of tap chasers and the operation of collapsible taps. Data covering special threads used in the manufacture of modern transportation equipment is also included.

BALING PRESSES

Climax Baler Co. Ltd., Hamilton, Ont., have issued a four-page folder which illustrates various types of "Climax" hand and electric presses for baling wipers, clothing, fabrics, waste paper, excelsior, wool, etc. Special features and specifications are given in each case.

CARBOLOY STANDARD TOOLS

Carboloy Co. Inc., Detroit, Mich., represented in Canada by Canadian General Electric Co. Ltd., Toronto, Ont., have issued a twelve-page booklet No. GT-128 in the form of an instruction manual (3 ins. by 4¼ ins. in size) for operators. It contains complete information on speeds and feeds to be used with different materials and varying depth of cut; machine recommendations for machining steel; proper use of coolants; tool grinding instructions; standard tool angles; design and grinding of chip breakers and general operating hints.

BUILDING NECESSITIES

The 32-page Catalogue No. 40 recently issued by The Majestic Co., Huntington, Ind., covers the Company's extensive line of 44 specialties for the modern home. Among the items illustrated and described are various types of coal chutes, fire place equipment, garbage receivers, incinerators, heating equipment, etc. Included with each item are specifications.

SIRENS

Northern Electric Co. Ltd., Montreal, Que., describe and illustrate in their four-page bulletin No. 22-235004 "Federal" vertical sirens for municipal fire alarm, airport crash alarm and air raid warning; and industrial sirens for fire and burglar alarm and start and dismissal signal in industrial plants, mines, public buildings, warehouses, construction projects, etc. "Federal" vehicle sirens, compressed-air whistles and industrial vibratory horns are also included.

SNOW FENCE AND POSTS

"Stelco" snow fence and "Tee" rail snow fence post for use in drift prevention on highways, municipal roads, railways, industrial property, airports, parade grounds, mines and fur farms, are featured in a two-page pamphlet issued by The Steel Co. of Canada Ltd., Montreal, Que. Full details and specifications are included with a description of the Company's "one-man" post driver.

TEMPERATURE INSTRUMENTS

In their 32-page catalogue N-33-161, Leeds & Northrup Co., Philadelphia, Pa., describe "Micromax Temperature Instruments for Electric Power Equipment" for those concerned with the operation of electric power plant equipment, to show how knowledge of operating temperatures enables operators to act promptly, at the first sign of a rise, to protect units against overheating and provide a reliable guide for maximum safe loading. These recorders provide automatic and continual temperature checks at selected points in power units, and sound alarms if temperature at any point exceeds safe limits.

ELECTRIC ETCHING

Taylor, Taylor & Hobson Ltd., Leicester, Eng., are distributing in Canada through their representative, The Empire Engineering Co., Toronto, Ont., an 8-page bulletin entitled "The Javelin Etching Process," It describes this process of electric etching, illustrating the single etching unit and the multiple etcher, as well as the standard equipment included with each unit.

VIBRATING SCREENS

Link-Belt vibrating screens for the effective screening of a great variety of materials, such as sand, gravel, cinders, grain, clay, crushed stone, coke, fertilizer, feldspar, coal, ore, etc., are described and illustrated in a 20-page catalogue No. 1762 issued by Link-Belt Ltd., Toronto, Ont.

TIMBER HIGHWAY BRIDGES

The advantages of timber bridges and 12 typical designs of timber bridges with "Teco" joint connectors for spans of 30 ft. to 70 ft. are presented in a 14-page booklet issued by Timber Engineering Co., Washington, D.C. This company's Canadian distributor is V. H. McIntyre Ltd., Toronto, Ont.

TIMBER CONNECTORS

Timber Engineering Co., Washington, D.C., represented in Canada by V. H. McIntyre Ltd., Toronto, Ont., have issued an 8-page bulletin entitled "Installing Teco Timber Connectors in Light and Heavy Structures." This bulletin contains detailed illustrated description of the Company's various types of timber connectors designed to increase the joint strength of timber structures. Also shows fundamental steps necessary for installing timber connectors.

JOINS STAFF OF CANADIAN ENGINEERING PUBLICATIONS LIMITED

John M. Thom, formerly with the Montreal branch of the James Fisher Advertising Agency, has been appointed to the staff of Canadian Engineering Publications Limited, and will represent The Engineering Journal, the official organ of The Engineering Institute of Canada, The Engineering Catalogue, and New Equipment News. Mr. Thom will be located at the Company's head office in the Confederation Building in Montreal.

John M. Thom

TEMPERATURE AND PRESSURE RECORDERS

Bulletin DMF 814 entitled "Foxboro Instruments for Bottlers," made available by The Foxboro Co. Ltd., Montreal, Que., gives an illustrated description of the Foxboro single-pen and double-pen carbonating recorders featured with equipment supplied by the Liquid Carbonic Canadian Corp. Ltd., Montreal, Que. Detailed specifications and illustrations of a typical installation and charts showing actual operating records are included.

GAS ANALYZER

"The Modernized Hays Orsatomat—The Automatic Orsat," is the title of a 4-page bulletin No. 40-366 in which The Hays Corp., Michigan City, Ind., illustrate and describe the Orsat type of gas analyzer with full details of design, construction and method of operation of both the single unit for furnace testing and the double unit for exhaust gas analysis.

GRINDING FIXTURE

Industrial Engineering Co. Inc., Minneapolis, Minn., features in a 4-page bulletin the "Quick-way" grinding fixture for high speed power hack saw blades, and illustrates the fixture attached to a universal grinder.

"LIQUID" VIBRATING SCREENS

In a 4-page folder No. 1877, Link-Belt Ltd., Toronto, Ont., describes a specialized adaptation of the Company's variable high-intensity vibrating screen for the removal of solids from liquids to recover products formerly wasted. Illustrates and describes the unit and shows typical installations handling fish oil, fine rubber, asparagus, vegetable refuse and phosphate rock.

REFRIGERATION COMPRESSORS

A sectional illustration of Worthington-Carbondale refrigeration compressors of the vertical two-cylinder type, sizes 5 ins. by 5 ins. and smaller, with photographs of various parts, specifications and dimensional drawings is given by Carbondale Div., Worthington Pump and Machinery Corp., Harrison, N.J., in their 6-page bulletin No. C-1100-B11.

ROLLER BEARINGS

The Shafer aircraft type self-aligning roller bearings are described by Shafer Bearing Corp., Chicago, Ill., in their 6-page bulletin No. 531. A general description contains details of radial thrust capacity, integral self-alignment, load ratings, materials and lubrication. Dimensional drawings with tabulated data are included.

WELDING

An interesting 56-page booklet entitled "The Lincoln Weldirectory," has been issued by Lincoln Electric Co. Ltd., Toronto, Ont. This booklet contains carefully prepared detailed information covering the numerous products of this company used in arc welding and is well illustrated throughout.

DRILLS AND TAPPERS

Featured in the eight-page bulletin No. 2963-C of Canadian Blower & Forge Co. Ltd., Kitchener, Ont., are the "Buffalo" No. 15 heavy duty production drill, the No. 15 manufacturing type drill, the No. 15 tapping machine, and accessories. Completely illustrated with photographs and sectional drawings, this interesting bulletin also contains full specifications.

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CONSTRUCTION OF THE HYDRO-ELECTRIC DEVELOPMENT AT LA TUQUE

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Paper to be presented before the General Professional Meeting of The Engineering Institute of Canada, at Hamilton, Ont., on February 7th, 1941.

The LaTuque development has an installed capacity of 178,000 hp. at the point of maximum efficiency and is capable of delivering 192,000 hp. at full gate. It is located in the province of Quebec, on the St. Maurice river 104 miles from its mouth. The river at this point flows through a narrow gorge three-quarters of a mile long in which it dropped 90 ft. between the upper and the lower pools. Throughout the gorge the river bed was generally less than 350 ft. wide between high water marks and during periods of normal flow most of the current was confined to a deep, narrow channel that had been eroded in the bed of the river near the west bank. The dam is built near the lower end of this gorge, its west abutment ending in a low corewall that penetrates the heavy layer of overburden on the west bank, and its east abutment terminating against the vertical face of a cliff that rises more than 100 ft. above the top of the dam.

As with many of the power sites on the St. Maurice, the river here occupies a different channel from that followed by the pre-glacial streams that drained this region. It is apparent that before the last glacial period the river flowed through a deep valley that lies beneath the plain on which the town of La Tuque now stands. We know that the depth to bed rock here is very great. As the ice receded, this valley was filled with glacial deposits, and the river took its new course through a saddle between the hills to the west of the buried valley and two granite knobs that protrude through the surrounding gneissic structure and from the eastern wall of the present gorge. The larger and more northerly of these knobs was known to the voyageurs as La Tuque. The river quickly cut down through the glacial drift to bed rock and then, over a long period of time, gradually carved for itself a steep, narrow channel. Glaciation and extensive faulting that has occurred in the rock of the gorge assisted the river in its work of erosion.

The development at La Tuque is the fifth built on the St. Maurice since the construction of the first power house at Shawinigan Falls forty years ago. With its completion the installed capacity of the plants on the river has reached a total of more than a million horse power. It is hard to realize that in the short period of forty years the St. Maurice valley has developed from little more than a wilderness to one of the important industrial regions of the Dominion. In 1900, Three Rivers was a small community of few industries, Shawinigan Falls was a construction camp where a group of young men was engaged in the "visionary" scheme of harnessing the falls and transmitting power to Montreal, 90 miles away, and Grand'Mère, the last outpost of civilization on the river, except for a few Hudson's Bay posts farther up, was a little pulp mill town.

Preliminary Studies

A partial development of the falls at La Tuque was made in 1909 by the Quebec & St. Maurice Industrial Company, predecessor of Brown Corporation. This development consisted of a wing dam at the head of the falls and a wood stave penstock leading to the power house at the lower end of the gorge. Two hydro-electric units of 3500 hp. capacity at 90 ft. head were installed in the power house and served the town and the pulp mill until 1931 when the Shawinigan Water & Power Company, in anticipation of the construction of the Rapide Blanc development, built a transmission line from Grand'Mère.

In 1929 Mr. Hardy S. Ferguson, M.E.I.C., reported to the Brown Corporation on the complete development of the falls. In his studies he investigated seven possible arrangements of the dam and power house with locations of the dam at various points between the head and the foot of the falls. His comparative estimates showed that the most economical arrangement would be with dam and power house located about 600 ft. above the foot of the falls. Independent studies carried out the following year by the Shawinigan Engineering Company confirmed this conclusion and also that the site could be developed economically. An agreement was entered into between the Shawinigan Water & Power Company and Brown Corporation for a joint development of the falls, the St. Maurice Power Corporation being formed for this purpose.

Between the years 1933 and 1938, when the construction of the development was begun, further studies and investigations were carried out by the Shawinigan Engineering Company. These consisted, in general, of topographical surveys, preliminary designs and estimates, studies of methods of construction and hydraulic studies of river flow, capacity of units and testing of model turbine runners.

The topographical surveys were a continuation of the work done in 1927 and 1928 by the Brown Corporation during which they made a detailed survey of the gorge, taking advantage of periods of low water to map exposed portions of the river bed. This topography was extended to cover all of the area above the falls that would be flooded by the construction of the development. It was apparent from a study of the data thus obtained, that the highest level to which the water could be raised without causing serious damage from flooding would be El. 498, Quebec Streams Commission datum. As the pool at the foot of the falls, at normal flow, is at El. 384, this would provide a head of 114 ft.

In studying the capacity of the units to be installed advantage was taken of the experience gained in the operation of the Rapide Blanc power house, thirty miles above La Tuque, and of some studies of river regulation made in 1927 and 1929 by Mr. R. G. Swan, M.E.I.C., of the Water Resources Department of the Shawinigan Company. These studies indicated that a flow at La Tuque of 12,500 c.f.s. could be depended upon for 90 per cent of the time and that the corresponding flow at Rapide Blanc would be 11,000 c.f.s. The drainage area between the two plants is 3,500 sq. mi. A flow of 11,000 c.f.s. at Rapide Blanc corresponds to the full load discharge of three of the four units installed in that plant. Owing to the large volume of the Rapide Blanc pond and to the comparatively small pondage at La Tuque, it is evident that, for maximum economy in the use of the water, the discharge of the La Tuque units should be closely correlated with that of the units at Rapide Blanc and the full load discharge of the units was accordingly fixed at 4,200 c.f.s. making their capacity 48,000 hp. at 114 ft. head.

Testing of Model Turbine Runners

Each summer since 1929 the Shawinigan Company has carried out a series of tests of model turbine runners at the Turbine Testing Plant at Shawinigan Falls. This testing has been done under the direction of Prof. Ernest Brown, M.E.I.C., Dean of the Engineering Faculty of McGill University, and in co-operation with the Dominion Engineering Works, of Montreal, who supplied the model runners. The first objective of these tests was a study of the serious pitting and erosion that was taking place in both the runners and the throats of the propellor-type turbines at La Gabelle plant, on the St. Maurice between Shawinigan Falls and Three Rivers. The results of tests made during the first two years were embodied in the installation of No. 5 unit in 1931, which showed marked improvements over the original units, Nos. 1 to 4, both in efficiency and in freedom from pitting. The knowledge gained from still later tests has led to the replacement of all of the original runners, with a resultant increase in both power and efficiency, and the complete elimination of the difficulties previously experienced.

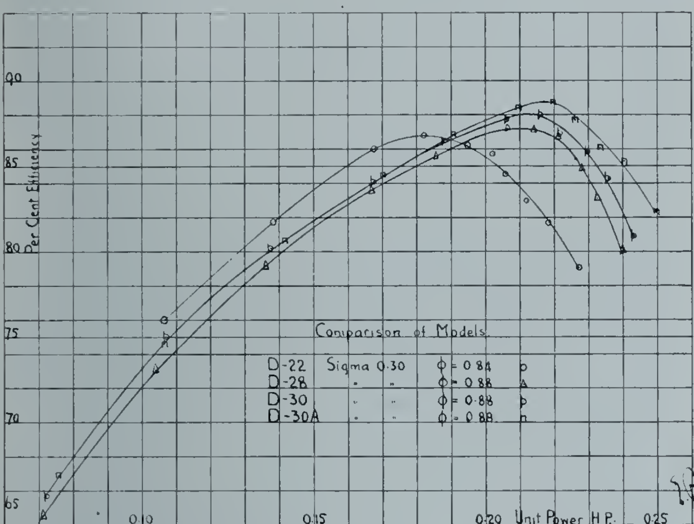

Fig. 1—Unit power-efficiency curves, Models D-22, D-28, D-30, D-30A.

The success that attended upon the search for an improved type of runner for the turbines at La Gabelle led in 1934 to examining the possibility of developing a propellor-type runner for higher heads with the prospect of its being available for use at La Tuque. The primary advantage to be gained, would be the higher r.p.m. speed with consequent reduction in the cost of the generators and possibly also in that of the turbines themselves. The summer of 1934 was devoted to the testing of five propellor runners designated D-14 to D-18 inclusive. From these, D-17 was selected as having the best characteristics for heads up to 110 ft. The following year complete tests of this model and of two Francis-type models, D-22 and 125-B, were made. Table I shows some preliminary general comparisons of dimensions, speed and settings for models developing approximately 39,000 hp. at peak efficiency, at a head of 114 ft.

TABLE I.

Model No.	Type	Approx. dia. of runner, inches	R.P.M.	Elev. discharge tips relatively to tailwater	Notes on runner
D-22	Francis	160	109.1	4.0′ above	Used at Chelsea, 94 ft. head; and at Rapide Blanc, 108 ft. head.
125-B	Francis	134	144	4.0′ above	New model; higher powered than D-22. Not yet used in practice.
D-17	Propellor	152.5	180	6.3′ below	New model; 8 blades, similar to but longer than improved blades at La Gabelle.

The table shows that the propellor wheel would have to be submerged below tailwater level, its setting being more than ten feet lower than that of the Francis runners. Its diameter would be smaller than that of D-22 and larger than that of 125-B, and it would run at a much higher speed than either of the Francis wheels. An evaluation of the relative merits of the three models was made by means of comparative estimates, taking into consideration the speeds and diameters and the cost of additional excavation made necessary by the lower setting of Model D-17. These estimates showed a probable saving, over D-22, in favour of both of the other models, the relative saving being the greater in the case of Model 125-B. Because of this and in view of some characteristics of the propellor runners tested that made their use for heads of 114 ft. questionable, it was decided to abandon the idea of using this type, at least for the time being. Model 125-B, while high powered, had a poor cavitation characteristic and some undesirable features in the power-efficiency curve. The marked increase in speed, however, which it showed over that for D-22 led to the hope that a runner having a somewhat smaller increase of speed and more satisfactory characteristics might be evolved by further testing.

The summers of 1936 and 1937 saw more intensive testing of models of the Francis type. During this period, tests were carried out on nine different models of which all but two were eliminated, D-22, the Rapide Blanc model, and a model developed by the Dominion Engineering Works for the Gatineau Power Company and designated D-28, a higher-powered runner than D-22.

Early in the following summer two other models, modifications of D-28 designated D-30 and D-30A, were tested and found to have very satisfactory characteristics and the latter model was chosen as the basis of the La Tuque runners. A comparison of the unit power-efficiency curves of these four models is shown in Fig. 1. The curves show, for corresponding conditions, a progressive increase in unit power of the models from D-22 up to D-30A, and also a progressive increase in peak efficiency. Model D-22 is clearly much lower-powered than the others and its peak efficiency is about two per cent below that of D-30A. The effect of increasing the out-flow area of D-30 to give D-30A is shown in the increased unit power and efficiency near and beyond the peak. At the smaller unit powers the curves

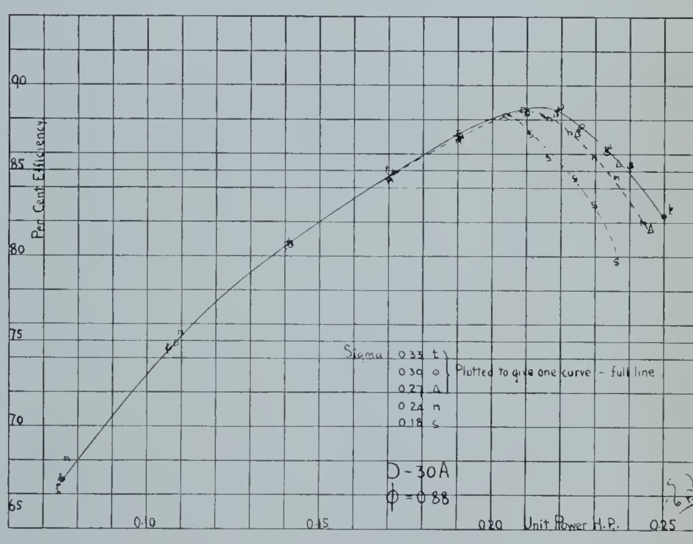

Fig. 2—Comparison of tests of Model D-30A for $\phi = 0.88$ and various values of σ.

are identical. These comparisons show that for a given rated output at a specified head, a runner based on D-30A will be of smaller diameter and run at a higher r.p.m. speed than one based on any of the other models.

Three points are of major importance in the selection of a runner:

1. The envelope of the speed-efficiency curves at different gate openings, which determines the speed corresponding to maximum efficiency.

2. The form of the power-efficiency curves at practicable speeds under the actual operating conditions and, in particular, the corresponding unit powers, since unit power determines the diameter of a runner for a given output and operating head.

3. The form of the power-efficiency curves at these practicable speeds in relation to the cavitation factor.

The coefficient ϕ, in Fig. 1, is a speed characteristic given by dividing the peripheral speed of the runner, in ft. per sec., by $\sqrt{2g}\,H$, in which H is the operating head. It will be noted that for Model D-22 the practicable value for ϕ, as determined by other tests, is 0.84 and that its value for the other models is 0.88. The factor "sigma" (σ) is known as the cavitation factor and is given by the formula $\frac{B\text{-}S}{H}$ in which B = barometric height; S = height of runner

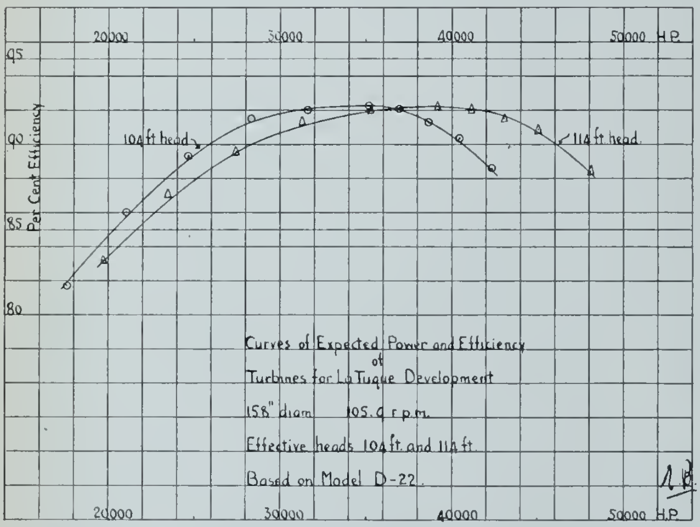

Fig. 3—Power-efficiency curves for runner based on D-22 at heads of 104 ft. and 114 ft.

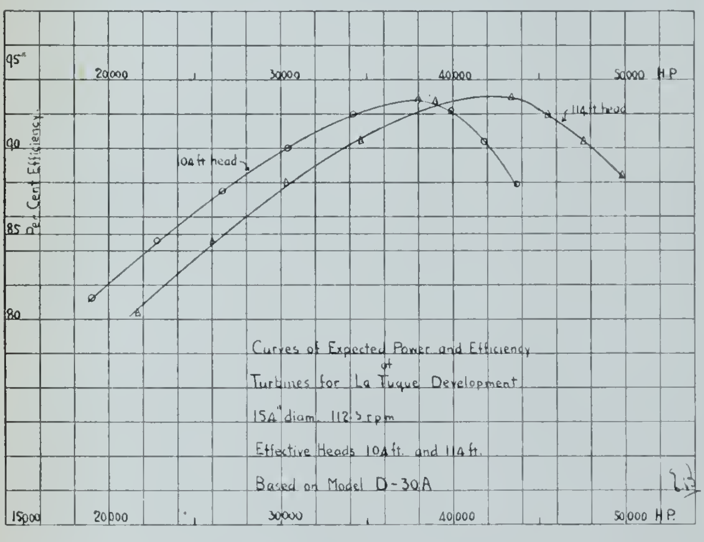

Fig. 4—Power-efficiency curves for runner based on D-30A at heads of 104 ft. and 114 ft.

above tailwater level and H = operating head. In the comparison made, the setting was the same for all models. The actual tests of any model include complete power-efficiency measurements over a wide range of speeds at progressively decreasing cavitation factors, usually five or six in number. The cavitation factor is controlled by regulating the tailwater level. Figure 2 shows comparisons of such tests for D-30A at ϕ = 0.88. It will be noted that one curve of unit power-efficiency fits all experimental points for cavitation factors 0.33, 0.30 and 0.27 and that there is a characteristic break in the curve when the tailwater is lowered further to correspond to a factor of 0.24. This is accentuated when the factor is 0.18. The breaks in the curve indicate cavitation and such a series of curves determines the practicable setting of the runner. A difference of 0.03 in the cavitation factor corresponds to a difference of 3.4 ft. in runner elevation for a head of 114 ft. Progressive lowering of the runner increases the margin of protection against cavitation but it also tends to increase costs.

A large number of additional tests were run at the Shawinigan Falls plant dealing with (a) the shape of the draft tube; (b) distribution of pressure in the draft tube; (c) effect of introducing air in the draft tube to reduce vibration, surges of pressure and noise in operation; (d) the erosion of paint from painted surfaces of runners to determine zones in which pre-welding might be desirable. In addition, the Dominion Engineering Works, at its testing plant at Lachine, Que., carried out a comprehensive series of tests on the effect of lengthening the draft tubes and on various designs for the scroll cases.

As noted above, a runner based on Model D-30A was adopted. Typical results to be expected at heads of 104 ft. and 114 ft. from runners based on D-22 and on D-30A are shown in Fig. 3 and Fig. 4 respectively. Model D-22 was the starting point in the testing of models of the Francis type. The curves are based on the Moody step-up formula and on information available on the performance of large units as compared with that of the small models on which they were based. It appears that a runner 158 in. dia. based on D-22 and operating at 105.9 r.p.m. would have an output some 3 to 4 per cent smaller than that of a runner 154 in. dia. based on D-30A and operating at 112.5 r.p.m. For a frequency of 60 cycles per sec. the latter speed requires a 64-pole generator as against a 68-pole generator at 105.9 r.p.m. There is also the expectation that the runner based on D-30A will show a somewhat higher peak efficiency. Outstanding differences of this kind have an important bearing on the cost of the development. The results of such a series of tests, providing as they do, a large amount of information on problems of design and operation, are the justification, if any were needed, for a long term programme of testing such as is being carried out by the Shawinigan Company.

Description of the Development

A view of the development, taken from a point on the west bank below the dam, is shown in Fig. 5 and a general plan in Fig. 6. The dam is 1,337 ft. long from end to end. It consists, in general, of the west bulkhead and corewall, the sluice section, the intake section and power house, and the east bulkhead. All sections of the dam are gravity type concrete structures and were designed for the following conditions:

1. Horizontal pressure on the upstream face due to water in the forebay at El. 498.

2. Horizontal pressure due to ice, assumed to be 10,000 lb. per lin. ft. applied at El. 497.

3. Uplift on the base of the dam over the whole area, assumed to be the full head at the upstream face and decreasing uniformly to zero or to tailrace pressure, if any, at the toe.

4. The weight of concrete was taken at 150 lb. per cu. ft.

5. The assumed uplift on the intake section was modified to two-thirds of the above and a more extensive drainage system was provided under the base.

The sluice section of the dam contains five main sluices, two regulating sluices and a log sluice. The main sluices are each 50 ft. wide and have their sills at El. 467, thirty-one feet below normal headrace level. The two regulating sluices are each 21 ft. wide by 21 ft. deep. The sill of the log sluice is at El. 492 and it has a width of 26 ft. All of the sluiceways are provided with motor-operated, fixed-roller steel gates. The discharge capacity of the sluiceways is 170,000 c.f.s. with fore-bay at El. 498 and more than

200,000 c.f.s. when the water is at El. 500. Figure 8 shows a cross section through one of the main sluiceways. The paving shown at the foot of the spillway is continued downstream a distance of about 600 ft. in order to protect the flood channels against erosion.

A cross section of the intake section and the power house is shown in Fig. 9. The intakes for six turbines have been provided, each intake consisting of two water passages 15 ft. wide, connected to a 22 ft. steel penstock. The penstocks are completely embedded in the concrete. The intakes are closed by means of steel head gates with fixed rollers, the head gates being operated, through line shafting, by two motor reduction units. By means of jaw-clutches, either of the motor reduction units can raise any one of the head gates. The lowering and the raising of the gates is actuated by push buttons in the gate house, with lowering buttons also in the control room of the power house. The 36-ton gantry shown on the top of the intake section has been provided to lift the gates out of their slots for painting and other maintenance and also for handling the racks and emergency gates which are installed in slots on the upstream face of the dam.

Four hydro-electric units are installed in the power house, with settings for two additional units for future installation. At 114 ft. head each unit has a rated capacity of 44,500 hp. at point of maximum efficiency and is capable of delivering 48,000 hp. at full gate. The turbines are connected to 11,000 V., 60 cycle generators rated at 40,000 kva. at 90 per cent power factor, which were manufactured by the Canadian General Electric Company. The generators are fully enclosed and water cooled. Louvres are provided in the housing for the purpose of heating the power house in cold weather. With the louvres closed the air is circulated through cooling coils supplied with water from the forebay. Enclosing the generators is a new departure for the Company. It was done principally for the purpose of reducing the accumulation of dust in the air passages around the generator windings and of maintaining the coils at a fairly uniform temperature at varying loads, but it has the added advantage of reducing both noise and heat in the power house.

Fig. 5—General view of the development.

The generator leads are carried through a tunnel to the switch building, which is located a short distance from the power house, and connected to an 11,000 V. bus which is segregated into four sections. The bus sections are connected, through air blast circuit breakers, to the Brown Corporation's 11,000 V. transmission line and to the Shawinigan Company's transformers which step the voltage up to 230,000 V. for transmission to the terminal station at Three Rivers. Three transformers are at present in

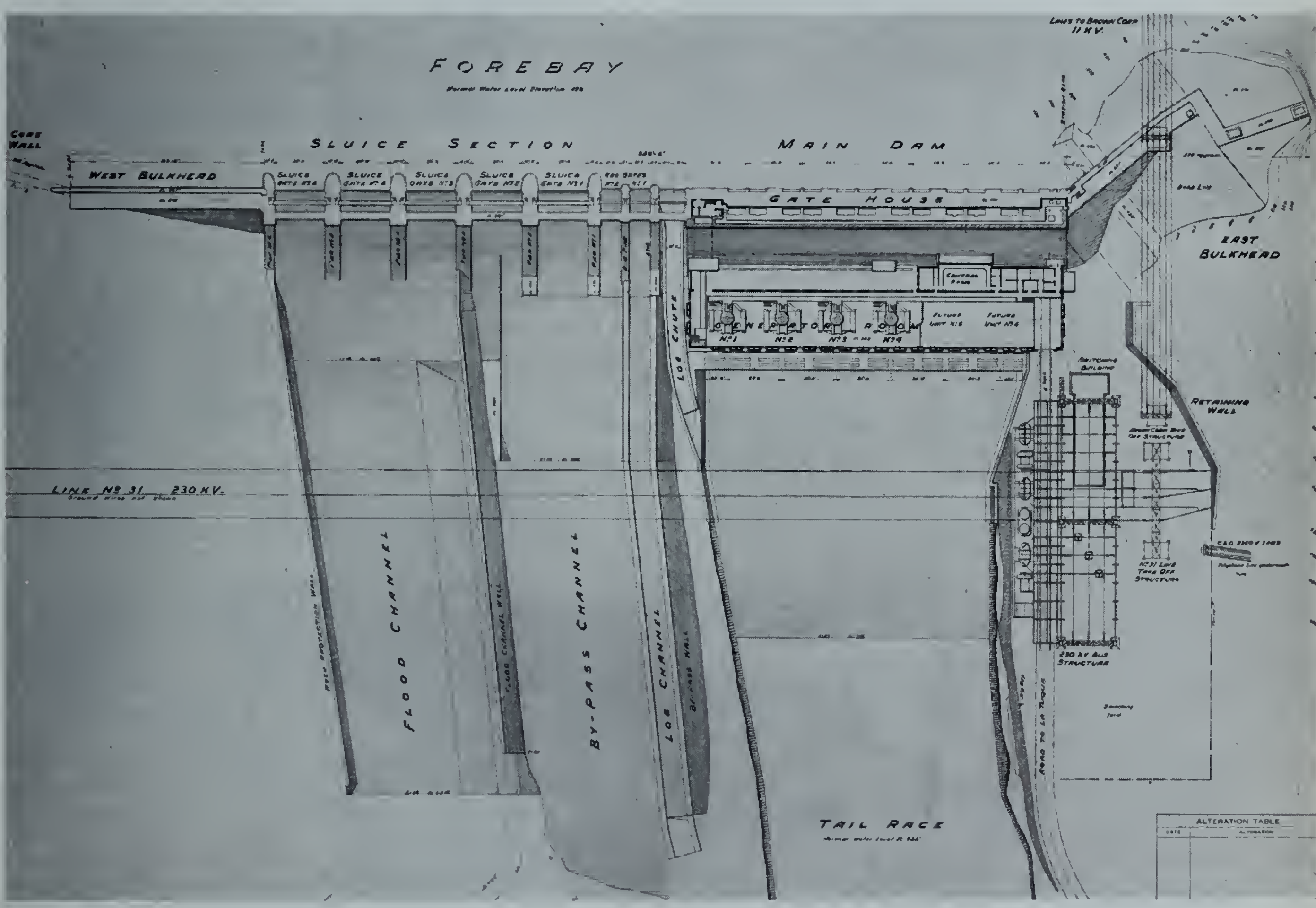

Fig. 6—General plan of the development.

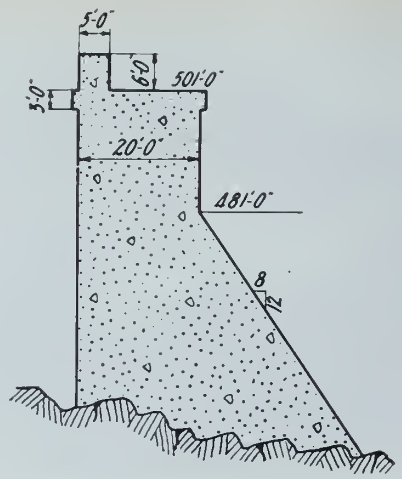

Fig. 7—Cross section of west bulkhead.

service, two rated at 36,000 kva. and one at 40,000 kva., while a fourth, at 40,000 kva. is in course of manufacture. The generators and transformers are connected in parallel on the high voltage bus only, through motor operated disconnecting switches. Provision has been made for the future installation of a high voltage circuit breaker for the line, which at present is directly connected to the high voltage bus.

Figure 10 shows a single-line diagram of the main electrical connections.

Preparation of the Foundation

The bed-rock at the dam site consists of a granitic gneiss, the foliation, or apparent bedding, of which varies considerably over different parts of the foundation. In the vicinity of the west bulkhead and the sluice section, the foliation strikes diagonally across the line of the dam and dips toward the northeast at an angle of about 20 deg., while under the intake section the strike is transverse to the dam and the dip at a slight angle to the east. A fault near the western end of the intake section divides the two areas of different geologic structure. The strike of this fault is almost normal to the axis of the dam and it dips toward the east at an angle of 48 deg. It showed up on the surface as a small gorge, about ten feet deep, that had been eroded in the bed of the river. Near it two parallel faults were encountered, one to the east and the other to the west.

The most important feature of the geologic structure in relation to the dam is a fault zone under the east bulkhead. The fault planes in the river are nearly parallel to this zone and are related to it. The footwall was encountered about 50 ft. east of the end of the intake section dipping toward the east at an angle of about 47 deg. to the horizontal. The hanging wall intersects the face of the cliff at about El. 470, thirty feet below the top of the dam. The faulted zone, 200 ft. wide, that lay between, was composed of thick strata of hard, grey rock alternating with strata of badly fractured red rock, some parts of which, near the surface, were so decomposed that they could be dug by a power shovel. In order to obtain rock sufficiently sound for the foundation of the east bulkhead it was necessary to carry the excavation down along the footwall of the fault to below El. 380. At the inner end of the cut its depth was more than 80 ft. below the surface. Excavation for a cutoff wall along the upstream face of the structure was continued to a further depth of about 50 ft.

As a precaution against seepage of water along the horizontal joints underneath the dam, a programme of grouting the foundation was followed. Diamond drill holes were put down along the whole upstream face of the dam at intervals of about 30 ft., except at the east bulkhead where more extensive grouting was done. Along the intake section of the dam these holes were drilled to a depth of 100 ft.; at the sluice section and west bulkhead the depth was 50 ft. Many of the holes were tested for tightness with water at a pressure of 90 lb. per sq. in. and all were grouted to refusal at pressures varying from 90 to 50 lb. per sq. in. depending on the depth at which the grouting was done. Where any evidence of open joints was found, sufficient additional holes were drilled and grouted to assure the complete sealing of the foundation. Very little grout was taken in any of the holes except in the vicinity of the fault planes at the junction of the intake and the sluice sections.

Although the stratum of rock which was finally reached in the excavation for the east bulkhead and on which the structure was built was sound, it was badly broken by the faulting and it was considered advisable to consolidate it by grouting. Holes were drilled to a depth of 20 ft. on five foot centres each way over the whole surface and grouted at a pressure of 90 lb. per sq. in. In addition to this, in order to eliminate the possibility of percolation beneath the structure, a row of diamond drill holes on five foot centres, parallel to the upstream face, was put down into the footwall and grouted at a pressure of 200 lb. per sq. in. after the concrete structure was built. The deepest of these holes, near the face of the cliff, penetrated the footwall at about El. 270. The inspection tunnel in the east bulkhead is built with sufficient head room to permit additional drilling and grouting if evidences of undue percolation should be discovered in the future.

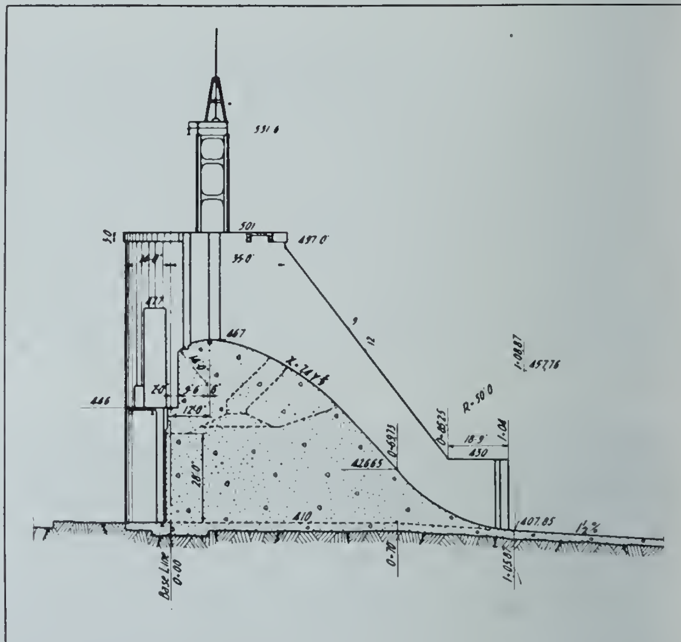

Fig. 8—Cross section through sluiceway.

The excavation and preparation of the foundation for the east bulkhead would not have been such a serious matter had it not been for rock falls that began to occur from the face of the cliff after the work had progressed well into the cut. The cliff had been carefully scaled and appeared to be perfectly safe, but it is probable that the heavy blasting that had been carried on over the rest of the job for a period of almost two years had loosened some of the joints. The first warning came with the fall of a mass of rock from a point about 100 ft. up that almost buried a shovel working in the cut. Fortunately the shovel runner had swung the boom toward the open end of the cut and was not injured, but the shovel had to be dragged out and sent to the shop for major repairs. Various scaling operations were tried in an effort to remove the hazard from this source but finally the whole face of the cliff, from top to bottom, had to be sliced off to a depth of about ten feet, removing 15,000 cu. yd. of solid rock in the process, before it was considered safe enough to resume work. The author has a great deal of admiration for the men who worked on that job. Realizing, as they did, the danger of the work, in spite of all the precautions taken and safeguards provided, they carried on day after day without hesitation until the job was done.

The east bulkhead, like the rest of the dam, is built in sections about 50 ft. long. The most westerly section rests on undisturbed rock. The fractured rock under the other sections is progressively deeper toward the east end owing to the slope of the footwall of the fault. For this reason the Company's geologist, Mr. Irving B. Crosby, M.E.I.C., in view of the possibility of unequal settlement between the sections, recommended that some form of seal should be provided in the vertical construction joints to prevent seepage through the joints should such settlement occur. After giving the matter some consideration it was decided that the type of seal provided in the other vertical joints throughout the dam would be adequate for this purpose. These seals were adapted from those used in the Chonchas dam in New Mexico where the possibility of unequal settlement was anticipated, and were constructed as follows:

1. A six in. dia. vertical hole was formed in the concrete centered on the joint and six feet back from the upstream face of the dam.
2. Twenty-ounce copper sheets were formed around the upstream semi-circumference of the hole and projected into the concrete on each side a distance of 12 in. The horizontal joints of the sheets were soldered together and the vertical edges were reinforced with two 1 by 1/4 in. steel bars.
3. The hole was filled with a plastic asphalt compound that retains its plasticity at relatively low temperatures. Numerous tests were made on various plastic materials until one was found that filled the various requirements.

To uncover the bed rock at the site of the sluice section and the west bulkhead and along the discharge channels, it was necessary to excavate 230,000 cu. yd. of overburden. This material was stripped by power shovels and trucked to spoil banks on the hillside a short distance downstream. Owing to the great depth of the overburden at the end of the west bulkhead the excavation for the corewall, which projects beyond the bulkhead a distance of 90 ft. was made

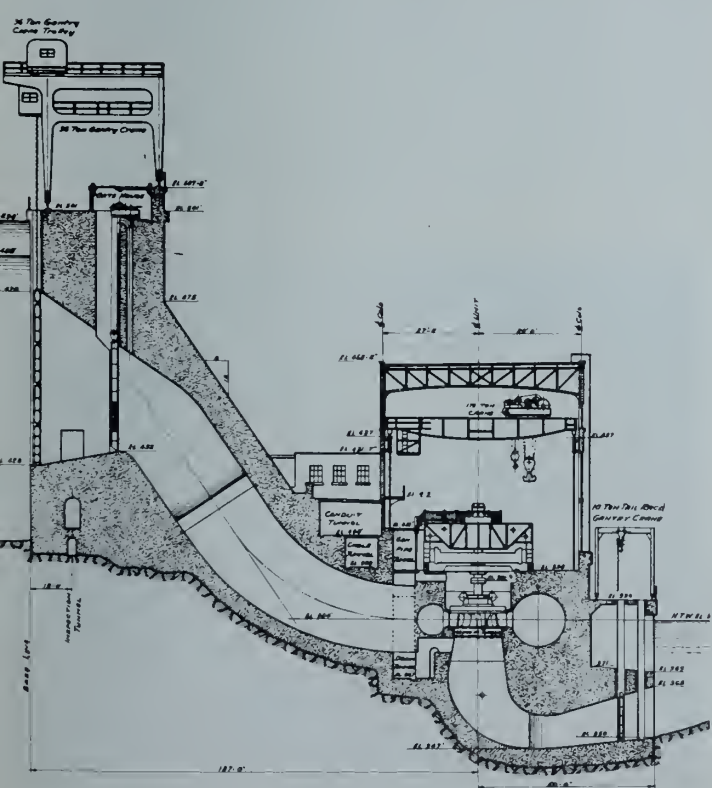

Fig. 9—Cross section of intake and power house on centre line of generator.

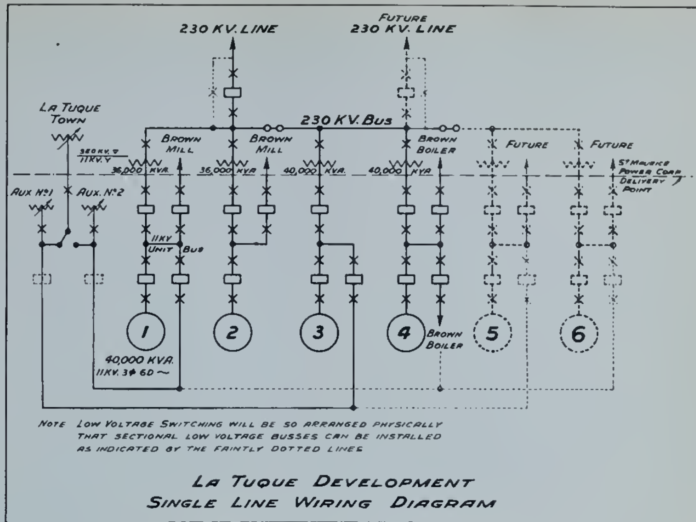

Fig. 10—Single line diagram of electrical layout.

by tunnelling. The tunnel was driven along the gradually rising rock to the point where the rock surface was about four feet above normal headrace level. The foundation of the corewall was prepared by barring off any loose rock encountered. The concrete was poured against the sides of the tunnel cut by removing the sheathing just ahead of the pouring, care being taken to fill with concrete any caves that had occurred in the tunnel walls. The corewall was brought up to the level of the top of the dam and the upper part of the tunnel was backfilled.

Construction

Probably the most important change that has taken place in the Company's construction procedure, during the past few years, has been in connection with the planning of the work. In the old days the head office planning was confined largely to an outline of the general construction methods, leaving to the field organization the task of filling in the details. Frequently, especially during the busy Twenties, the superintendent was hustled onto the work from another job, with little time for preparation and only the specification drawings and a few sketches to give him an idea of what he was supposed to build, and was expected to form an organization and make a good guess as to what his requirements would be for the next two or three years. It was a good bit to expect of a superintendent, no matter how experienced, and the result was that he usually grabbed all the construction equipment he could lay his hands on, in the hope that he would find it useful, and sometimes found, later on that he had placed some of his temporary structures in positions that interfered with the permanent works. The method was not conducive to economical construction.

Beginning with the Toro storage dam on the Mattawin, in 1929, a change in procedure was initiated by laying out part of the construction plant in the office. This process was further extended in 1931 when beginning the construction of Rapide Blanc development, with such good results that, when the final design and detailing of the La Tuque development was begun in the fall of 1937, the layout of the construction plant and the scheduling of the various operations was begun at the same time and carried out in complete detail. The decision of the Corporation to proceed with the construction raised the problem of making a 1935 estimate fit 1938 conditions. In the face of an increase that had occurred, in the meantime, both in labour rates and in the cost of materials and equipment, this could not have been accomplished without the most careful planning of construction plant and procedure and the closest supervision of the work. Figure 11 shows one of the 205 construction plant drawings. It illustrates the plant layout for excavating the power-house cut and the tailrace.

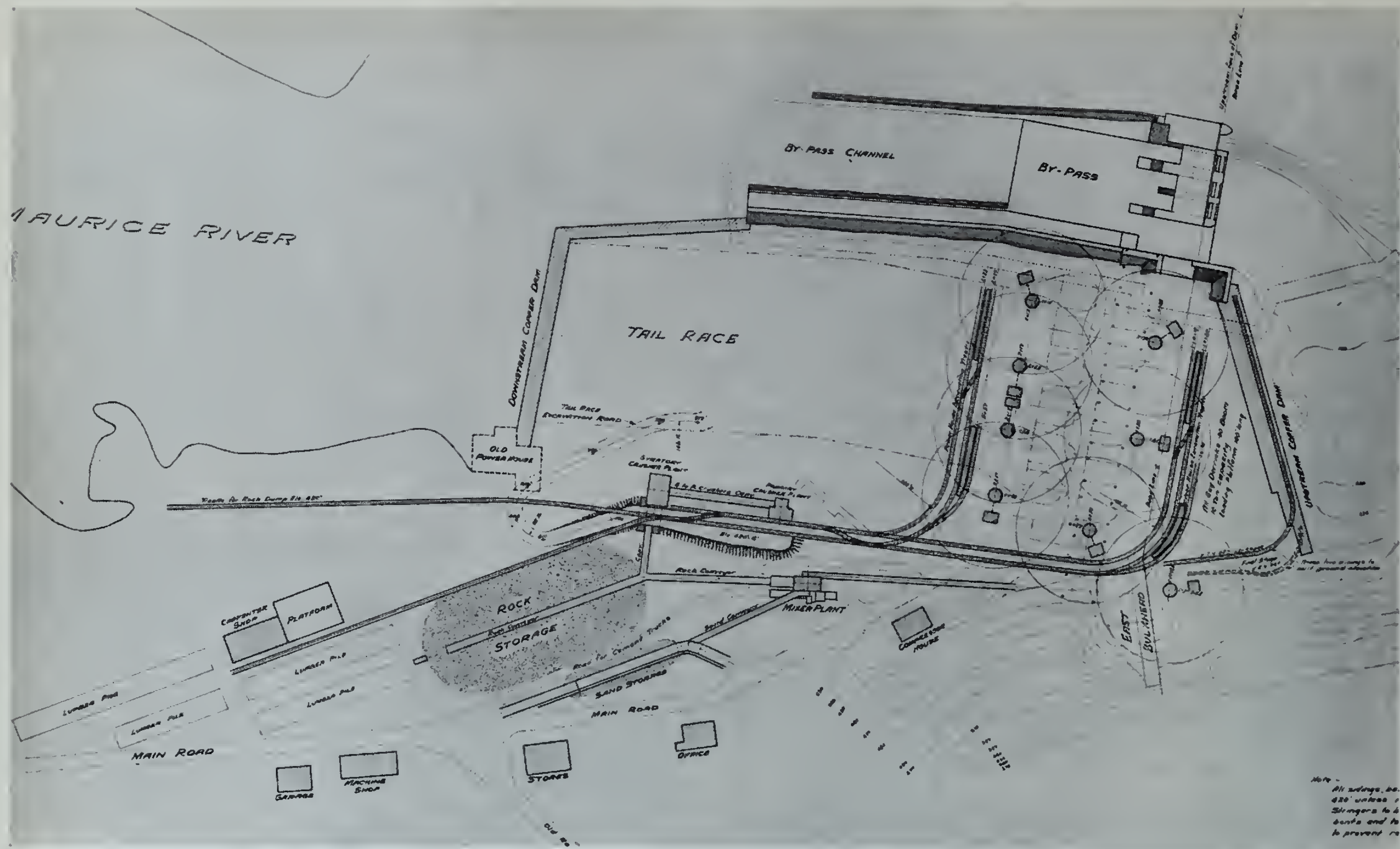

Fig. 11—Plan showing layout of construction plant for excavation of power house and tailrace.

The results of this careful planning are well illustrated by a brief comparison of an earlier job with the La Tuque job. La Gabelle development was built in 1924. It was considered to be a well built job and the unit costs, for the period, were low. However, if the unit costs for concrete and excavation at La Tuque had been the same as those for La Gabelle, these two items alone would have increased the cost of La Tuque project by almost $1,500,000.00. This is not entirely due to the advantages of more careful planning, however, but reflects also the improvement that has been made in construction plant and the difference in construction methods.

The construction plant used at La Gabelle was typical of the period. Transportation on the job was by dump car and steam dinkey, with tracks, more than 11 miles of them, radiating from the construction yard to all parts of the job. Most of the mucking was done by hand. The concrete was carried from the central mixer plant, in hoppers on flat cars, to wooden concreting towers located at various points on the job and distributed from these to the forms by chutes. At La Tuque, on the other hand, transportation was mostly by motor truck, with a small amount of rock hauled by gasoline locomotive. Most of the mucking was by means of power shovels. The concrete was carried from the mixer plant by belt conveyors to hoppers located at various points along the dam and handled by derricks to the point of deposit in the forms in two-yard, bottom-dump buckets. The location of derricks and of the various temporary structures was very carefully studied so that they would be of use in as many operations as possible without unnecessary shifting.

One of the first and most important steps in determining the type and the layout of the equipment consists in the preparation of the construction schedule. This is prepared in reverse to the order of construction. Assuming that the construction is to be started early in 1938 and that the date of completion is set for January 1, 1941, in order that the fourth generator will be erected, dried out and tested by that date its erection should be begun by November 1, 1940. Six weeks allowed for each generator would place the beginning of erection of Generator No. 1 about June 15th. At this time, in order to avoid congestion in the power house the erection of the four turbines and the concreting inside the power house should be completed. An allowance of a month for each turbine will mean that turbine erection should start February 15th. This fixes the date of the closing in of the power house superstructure, and so on until the schedule is complete. After this first key schedule has been drawn up the sequence of operations on the various parts of the work is outlined in detail and finally, knowing from the estimate the quantities of construction materials to be handled in the time allotted by the schedule, the type, duty and location of each piece of construction equipment is determined and the dates fixed for the ordering and delivery of construction materials and of the permanent equipment. This planning of the construction procedure in co-ordination with the design of the permanent structures enables the field organization to concentrate on the economical operation of the job and on the quality of the workmanship, which keeps them busy enough, and at the same time permits modifications to be made in the arrangement of the permanent structures that may be conducive to more economical construction.

The construction of La Tuque development was begun in March 1938 with the clearing of the site of the construction plant and the erection of some of the construction buildings. One of the first operations was the building of No. 1 cofferdam for the unwatering of the diversion channel on the west side of the river. The swift current in the deep channel near the west bank presented a problem in that it was necessary to construct the first cofferdam across this channel. The first crib of the cofferdam was located in a comparatively quiet eddy formed by a point of rock that projected into the river a few hundred feet upstream from the line of the dam. This crib served as an anchor for the rest of the cofferdam and from it the cofferdam was built diagonally downstream across the deep channel, gradually crowding the current to the other side of the river bed. The east end of this part of the cofferdam rested on a ridge of rock some points of which projected above the water to form small, rocky islands. From these islands the cofferdam was continued downstream parallel to the shore to the lower end of the by-pass channel, a distance of about 800 ft.

The control works of the by-pass channel consisted of four water passages through the lower part of a portion of the sluice section. One of these passages had a clear width of 50 ft. and the other three were each 21 ft. wide. The rock excavated from the by-pass channel was crushed by two 16 in. gyratory crushers set up temporarily on the west bank, and transported across the river to the mixer plant on a belt conveyor carried by a light steel truss bridge consisting of three 115 ft. spans supported on timber crib piers. In addition to the conveyor, the bridge carried a walkway. Concrete for the control works was brought across the river on the same conveyor, transported to the structure in two-yard bottom dump buckets on cars drawn by gasoline locomotives and handled into place by derricks. In order to prevent scour in the by-pass channel, the bottom is paved with concrete for a distance of 600 ft. below the dam. Upon completion of the control works, the upstream section of No. 1 cofferdam was blown up and the water diverted through the by-pass channel by the construction of cofferdam No. 2.

The construction programme was based on a period of two years and nine months beginning in March 1938 with completion of the project by December 31, 1940. In order to direct and control the work, a comprehensive schedule was prepared at the beginning showing the amount of work to be done, with the starting and completion dates for each item. Construction of the development may be divided into three main sections or periods each representing a definite phase.

The primary phase includes all work from the beginning of construction to the diversion of the river through the by-pass channel in November 1938. During this period the site was cleared, the railway siding completed, the permanent and temporary roads and bridges finished and the construction of all temporary buildings, as well as provision for water supply, fire protection, communication power supply and distribution completed. To complete the installation of derricks and shovels and of the rock crushing and concrete mixing plants with their conveying systems, storage piles and bulk cement-handling facilities in time to meet the excavating schedule of July 15 and the pouring of concrete on September 1 was a difficult and strenuous task but was successfully accomplished. Other work completed in the initial stage of construction was the stripping and opening of the sand pit, the installation of adequate facilities for the handling and transportation of all material from the railway siding to the job, the building of wharves and scows for the transporting of construction plant and other necessary material to the west bank of the river, the construction of the light steel bridge with conveying system for the handling of rock from the temporary crushing plant on the west bank to the rock storage pile near the mixer plant and for the transportation of concrete to the diversion channel structures as well as numerous miscellaneous details to make this portion of the installation a well-integrated layout.

Fig. 12—General view of construction plant.

Fig. 13—Interior of power house.

The construction buildings consisted of an office building, machine shop, carpenter shop, electricians' shop, concrete laboratory, drill sharpening shop, stores building, dynamite store, which was located on the west bank half a mile from the dam site, and garage. The main units of construction plant were the mixer, the crusher and the compressor plants.

The mixer plant housed two Smith mixers of two cu. yd. capacity each. Cement and aggregates were fed to the mixers from bins located in the upper part of the building. The designed proportion of the aggregates was maintained by means of weighing hoppers, the feed to the cement hopper being actuated by a photo-electric cell. Consistency of the mix was closely watched by inspectors under the direction of a concrete technician and the strength was checked by samples taken at regular intervals during the day and tested in the laboratory.

The concrete, as has been mentioned before, was transported from the mixer plant by a belt conveyor to hoppers located at various points along the line of the dam. From the hoppers it was handled by derricks to the point of deposit in the forms, in two-yard bottom-dump buckets. The concrete was placed very dry and compacted by vibrators. Our experience with vibrators was not entirely a happy one. This was not due to any fault of the vibrators themselves but to the ease with which the foremen found they could move the concrete from one part of the form to another and their tendency on this account to have the concrete deposited at one point, possibly more easy of access than others in the form, and to use the vibrators to make it flow to the corners and other less accessible places.

The crusher plant contained a 42 by 48 in. jaw crusher and the two 16 in. gyratories already mentioned as having been installed temporarily on the west bank during the excavation of the by-pass channel. The first cut to be made after the completion of the power-house cofferdam was the excavation for the draft tubes. This cut was more than 40 ft. deep. The rock was mucked by power shovels into skip boxes and hoisted by derricks to side-dump cars on a trestle along the downstream side of the cut. The cars were drawn by gasoline locomotives to the crusher plant where the rock was reduced to a maximum size of four inches. At the crusher plant it was screened and then carried to and distributed along the storage pile by belt conveyors. From the storage pile the rock was taken by belt conveyor,

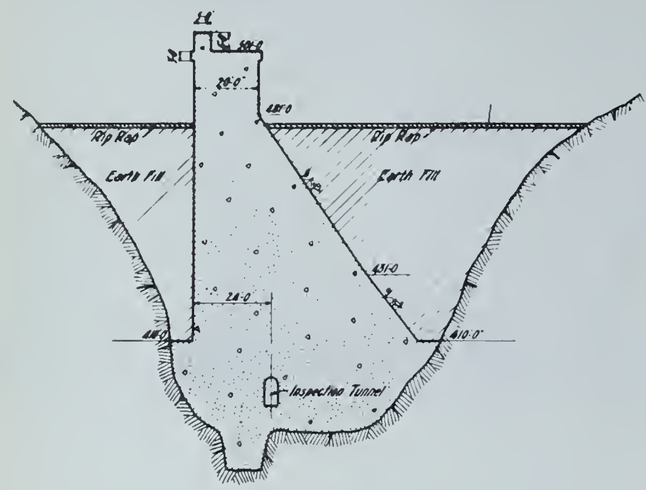

Fig. 14—Cross section of east bulkhead.

operating in a tunnel underneath the pile, to bins at the top of the mixer plant.

Upon completion of the draft tube cut the excavating equipment was moved to the tailrace and to the west bank, these two parts of the job being carried on simultaneously. The tailrace excavation was begun about 750 ft. below the power house and carried level at El. 374 for a distance of 480 ft., from which point it sloped down on about a 10 per cent grade to meet the outlet of the draft tubes at El. 350. From the tailrace cut the rock was transported by trucks to the crusher plant or to a spoil bank a short distance downstream.

The compressor plant had an installed capacity of 2,300 cu. ft. of free air per minute when operating against a pressure of 100 lb. per sq. in. The two larger units (1,040 c.f. per min. each) were of the horizontal reciprocating type, two-stage compression with inter-coolers and after-coolers. Each unit was direct connected to a 200 hp. synchronous motor. The small compressor was of the rotary type (220 c.f. per min.) direct connected to a 50 hp., S.C. motor. The installation was complete with control equipment, intake filters and air receivers.

Owing to the proximity of the job to the town of La Tuque it was not necessary to build camps for the men except at the peak of the work when additional accommodation had to be provided for about two hundred. During the thirty months when the work was in full swing, La Tuque was a boom town as in that period more than $2,000,000.00 was paid out in wages, most of which was spent in the town.

La Tuque is on the National Transcontinental Division of the Canadian National Railways. A siding from this line was built to serve the job about one and one-quarter miles from the dam site and connected with the construction yard by a road which was surfaced for a width of 20 ft. with a hot-mix asphaltic-concrete pavement. Facilities were provided at the siding for unloading and handling of construction materials and of equipment. Cement came to the siding in bulk and was unloaded by a conveyor into two steel silos with a capacity of 350 tons. From the silos it was drawn to the job as needed in special tank-body semi-trailers. More than 1,200 car loads of miscellaneous materials and 1,400 car loads of cement were received at the siding during the course of the job.

The provision of good sand in sufficient quantity for a job of this size is usually a serious problem on the Upper St. Maurice. However the region around La Tuque is exceptional in this respect, as prospection showed. Several large deposits of sand suitable for the concrete were found within reasonable trucking distance of the job, the one having the best grading and the most uniform quality being located within two miles of the site and about three-quarters of a mile from the siding. The sand was dug from this pit by a gasoline shovel and transported by trucks to the sand storage pile from which it was carried by a belt conveyor to a bin at the top of the mixer plant.

The construction of cofferdams in 1938, which is designated as auxiliary work, amounted to 35,000 cu. yd. or to 70 per cent of the total built. The only permanent work done prior to the passing of water through the by-pass during the primary phase was the removal of 125,000 cu. yd. of excavation and the pouring of 39,800 cu. yd. of concrete equivalent to 18 per cent and 14.7 per cent respectively of the total quantities involved. The diversion of the river from its regular course into the by-pass channel on the scheduled date of November 29th by the removal of a cofferdam in one blast completed the initial phase of the work.

The secondary phase involved the substantial completion of excavation and mass concrete work and the closing-in of the power-house and gate-house superstructures ready for the installation of equipment by the end of November 1939. This period is usually regarded as one of "operation" and, outside of the uncertainty of unwatering and the danger of flooding, causes no particular worry. It is the phase of mass production when various units of construction plant have an opportunity to demonstrate their efficiency and adequacy as an operating unit. The volume of excavation removed in this period amounted to 500,000 cu. yd. or 70 per cent of the total. The pouring of concrete could not be started until June 15 when unwatering of the main river sections following the spring flood was completed. In the following five months, 150,000 cu. yd. or more than 55 per cent of the total concrete of 270,000 cu. yd. was poured, an average rate of 1,200 cu. yd. per day.

The scheduling and control of this portion of the work was comparatively simple as the plant installed during the early stages of the job was designed for a given purpose and no difficulty was experienced in keeping the work up to schedule, with the single exception of the east bulkhead where the extensive faulting, previously mentioned, increased the volume and difficulty of excavating the foundation considerably and doubled the quantity of concrete. This forced the work into the first quarter of 1940.

The final stage consisted of installing the hydraulic, electrical and auxiliary equipment, closing the by-pass channel and raising the water to normal operating level, the pouring of final concrete and the finishing of a host of details to properly complete the job.

The various schedule dates were maintained with the exception of the by-pass closure which could not be started until after the 1940 spring flood had dropped off to 25,000 c.f.s. While this date was based on an average of a 13-year record of river flow plus ten days for contingency, the flood was late in starting and of longer duration than previously experienced.

Immediately after the spring flood, the closure of the 50 ft. opening in the control works of the by-pass channel was made by means of the sluice-gate stop logs. Some doubt was expressed as to whether the stop logs would go down of their own weight through the swift current that was flowing through the openings to a depth of 15 ft. Several years before, when one of the sluice gates at La Gabelle got stuck in the open position, it had been found necessary to close the 50 ft. opening with similar stop logs and no difficulty was experienced. Recently published results of tests n models showed that, under the conditions at La Tuque, the stop logs would not go down without assistance and accordingly pile hammers were provided at each end to force them down if necessary. The hammers were not used. The closure of the other three openings was made by means of special fixed-roller gates which were left in place after the concreting of the openings was completed. The closure was delayed by ten days and as a result the turning over of No. 1 unit was nine days behind schedule. The remaining three units went "on the line" slightly ahead of schedule with the final unit producing power on November 26 against a scheduled date of December 1.

The detailed schedule worked out at the beginning of the project was an indispensable tool in controlling and directing the work at all times. It was followed in detail for specifying the delivery of all material and equipment and gave constant warning to the drawing office of the dates on which drawings would be required in the field. One of its most valuable uses was in estimating the monthly expenditures in advance of requirements in order that suitable arrangements could be made for financing.

The dismantling of construction plant and temporary buildings is a mournful operation for the construction forces for they realize that it is the beginning of the end of a project which has absorbed their whole attention for many months and in which each one has played an important part. Their feeling is truly genuine and when they ask "where next" those who planned the project can appreciate their regret for they too have been a part of it.

Conclusion

In 1937, as the time set for the construction of La Tuque development approached, there was considerable discussion as to whether it should not be postponed for a year or two. The rate at which the load of the Shawinigan Company was growing indicated that power from this development would not be needed before the spring of 1942 and it was difficult to see how very much could be absorbed before then. However, certain commitments that had been made rendered it desirable to proceed with the construction in 1938 and it was then suggested that a four year construction programme be adopted instead of the three year programme on which the estimate was based and which, in our opinion would result in the most economical construction. Comparative estimates showed that both in first cost and in the long term results of the operation of the plant the three year programme would be the more economical from the standpoint of the St. Maurice Power Corporation but that the other would have decided advantages for the Shawinigan Company on account of its contract to take certain blocks of power when the plant came into production. During the past few months, the author has often thought how fortunate it was that the directors of the Company took the attitude that they did and decided to proceed with the construction on the basis of the most economical first cost, that is on a three year construction programme. To bring almost 200,000 hp. of additional capacity into production at this time has been of vital importance to the war effort of the Dominion.

Three units at La Tuque have been operating at full load almost continuously since the power house was put into service delivering 37,000 kw. each, and at times all four units have been in operation with a total load of 142,000 kw.

Associated with the Shawinigan Engineering Company on the work were, Mr. Hardy S. Ferguson, M.E.I.C., Consulting Engineer, Mr. Irving B. Crosby, M.E.I.C., Consulting Geologist and Mr. J. Cecil McDougall, M.E.I.C., Architect. The author is indebted to Dean Ernest Brown, M.E.I.C., of McGill University, for his assistance in the preparation of the section of turbine testing and to Mr. R. E. Heartz, M.E.I.C., Assistant Chief Engineer of Shawinigan Engineering Company, in the preparation of the section dealing with construction.

ENGINEERING TRAINING FOR NATIONAL DEFENSE IN THE U.S.A.

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Paper to be presented before the General Professional Meeting of The Engineering Institute of Canada, at Hamilton, Ont., on February 6th, 1941.

The United States of America has set out upon an armament program which has as its objective the doubling of its Navy and the quintupling of its Army in addition to large quantities of armaments for Great Britain. All facilities are being mobilized to insure speed and efficiency in carrying out this program. It is realized that the production of modern mechanized armaments on the scale contemplated requires not only millions of people who are skilled as mechanics but also large numbers of engineers who are competent in a wide variety of technical and supervisory services. One out of every ten employees of the aeroplane industry must be an engineer, as 250,000 man-hours are required to design a modern military plane. It takes about 25,000 blueprints for the construction of a medium size tank, and a modern battleship costs five to eight million dollars to design and involves drawings which weigh tons. Already an acute shortage of technical engineering talent exists in certain of the industries as well as in the Army and Navy of the United States of America. The aeroplane industry reports serious shortages in engineers who can design, test and maintain aeroplanes. Needed also are thousands of additional engineers who are competent as designers of tools, dies, jigs, or in part analysis, shop layout and cost estimates of labor and materials. Additional engineering inspectors are needed by industry as well as by the Army and Navy with knowledge of materials, physical testing, X-ray inspection, radiographic technique and explosives, and automotive and electric communication equipment. There is also a substantial shortage of machine designers, metallurgists, naval architects and marine engineers. Besides the needs for technical engineering specialists, industry is confronted with a shortage of industrial engineers and engineering supervisors to speed up the production of equipment necessary to the present armament program—engineers who are familiar with industrial organization, time and motion study techniques, production control, material handling and storage, inventory, budgetary and accounting control, industrial safety and industrial relations.

During the first World War the engineering schools of this country were responsible for the major portion of the vocational training program for the U.S. Army. The Vocational Division of the Students' Army Training Corps was mainly concerned with the training of mechanics and little attention was given to defense training on the engineering school level. During the past twenty-three years, the U.S. Government has co-operated with the various states in the development of a nation-wide program of vocational education of less than college grade. As a result of this, there are available in the U.S.A. over 1,000 public vocational schools with a plant valued at more than one billion dollars. The Congress of the U.S.A. has appropriated to the U.S. Office of Education for the present fiscal year, ending June 30, 1941, a total of 66½ million dollars for a vocational education program of "less than college grade." This vocational educational program is being administered in every state under the State Board of Vocational Education and is carried on mainly in secondary schools and trade schools. Much of this program is concerned with supplementary evening courses for individuals now employed in industry. Pre-employment full-time courses are also administered to increase the supply of workers essential in the National Defense Program. It is expected that, during the present fiscal year, the skills of more than 500,000 people will be increased through this vocational educational program of "less than college grade." No tuition is paid by those receiving instruction.

Engineering colleges realize that their greatest contribution to our armament program will come by undertaking the type of training for which they are best equipped, that is, training on the "engineering school level," rather than vocational trade courses which can ordinarily be taught more effectively by trade and vocational schools. By college level is meant instruction comparable in difficulty and prerequisites with courses included in engineering curricula. The leaders in the engineering profession as well as in the Army and Navy of the United States of America are insistent that the engineering schools of this country should maintain during the present emergency the strongest possible programs of undergraduate and graduate instruction and should increase their research efforts so that an adequate supply of well trained and creative engineers is assured. It is felt, however, that many of our engineering schools have special facilities which may be utilized advantageously, without interrupting their regular programs, in making available to our defense industries and to our Army and Navy additional and more competent engineering specialists. Congress has appropriated on October 9, 1940, to the U.S. Office of Education nine million dollars to be used in reimbursing engineering schools up to June 30, 1941, for the administration of the following programs:

1. In-service training programs for the purpose of upgrading the engineers and supervisors now employed in industry. More than 30,000 of the engineering and supervisory staffs, employed in defense industries, are now enrolled, mainly outside of working hours, in classes which meet two or more times every week. Some of these classes are in the nature of refresher courses and cover subjects ordinarily given during the first three years of an engineering college curriculum. The majority, however, are enrolled in advanced classes in design and industrial engineering. Present indications are that this in-service training program will have to be greatly extended and enlarged during the next few months. Through this type of training, engineering schools are in a position to speed up the armament program and to improve the product of defense industries without interrupting their regular collegiate engineering instruction on the campus.

2. Intensive resident program of study are being set up for the benefit of commissioned officers of the Army and Navy and for those who are interested in preparing for the specialized engineering positions now open in the defense industries or in government employ under the regulations of the U.S. Civil Service Commission. These intensive courses are about three months in length and are open to those who have had some formal engineering education, usually about three years, and considerable experience. As a concrete illustration: The Air Corps of the U.S. Army has at present fifty cadets, in each of two engineering schools, who are being given an intensive three-month course in aerodynamics, airplane structures, airplane power plants and airplane instruments. The majority of these cadets are engineering college graduates and are being prepared for commissions in the Air Corps of the U.S. Army as squadron engineering officers. It is expected that about 600 of such squadron officers will be trained during the next few months. Due to the fact that nearly all of the engineering college graduates are well placed in industry, the resident intensive

program is not developing as rapidly as is the in-service program. It is expected, however, that at least 10,000 will benefit by this program between now and June 30, 1941.

Up to December 30, 1940, a total of 444 engineering defense training programs have been approved to be administered by 91 engineering colleges in 44 states, the District of Columbia and Puerto Rico.

The engineering defense training program is administered under the Chief of the Division of Higher Education of the U.S. Office of Education, Dr. Fred J. Kelly, with Dean R. A. Seaton on leave from the Kansas State College as Director of the program. An Advisory Committee on Engineering Defense Training, which is representative of the engineering and engineering teaching profession, has been set up by the U.S. Office of Education to aid in formulating policies for the in-service and intensive training program on the engineering school level. Contacts between Washington and the engineering colleges and the defence industries are maintained by twenty-two regional advisers appointed by the U.S. Office of Education.

Present world conditions demand that technology operates at full speed. The engineer's initiative as well as his creative and managerial talents must be used most extensively in the gigantic armament program of the U.S.A. It is hoped that the in-service and pre-service intensive program on the engineering school level described will prove helpful in meeting the present acute shortage for engineering specialists and will also improve the competence of employed engineers and engineering supervisors so that they may be in a position to design and build better armaments in the shortest possible time.

APPRENTICESHIP TRAINING IN INDUSTRY

The following material is sent to the *Journal* by the chairman of the Committee on Student Selection and Guidance of the Engineers Council for Professional Development (E.C.P.D.). Although the conditions described refer to the United States, the article is generally applicable to Canada.—*Editor.*

Dr. Robert A. Milliken, president of California Institute of Technology, said in part in his Phi Beta Kappa address for 1940:

"Let the point be emphasized as strongly as possible that steering students away from an attempt to enter that higher educational system when they do not show any capacity for solving analytical problems with success is not only the most kindly but it is also one of the highest forms of civic duty, since the success of our democracy depends upon it."

"But someone asks, 'What is to be done with the rest ?' It is a most amazing thing that in the development of our American educational system so little attention has been paid to the making of any provision for *the apprenticeship training in industry* of our manual and commercial workers who must constitute a large fraction of our population. We are far behind the whole of Europe, England, Australia, and New Zealand in this respect. That is the reason so many of our skilled mechanics and other workers are imported from abroad. Fortunately within the past few years some of our educational agencies have been waking up to this problem so that what is probably the greatest deficiency in the educational development of the United States is now being given some attention. In consequence what to do with the boy who wants to become a really skilled mechanic is now being attacked through the industrial apprenticeship plan so well developed in other countries."

The Engineers' Council for Professional Development is concerned with the organization of committees and engineers to counsel with high school boys as a community duty as well as a professional service.

REPORT OF COUNCIL FOR THE YEAR 1940

General

No organization can come through a war year such as 1940 without having its normal activities seriously affected. Such a convulsion, world wide in its interest and influence, fraught with the greatest of consequences for all mankind, reaches down to the basis of civilization itself, and naturally touches everything man-made that has grown up out of that civilization. The very existence of societies such as the Institute—in fact of all societies—may depend upon their abilities to prove themselves specially useful in such national emergencies and times of crises.

In reporting to the membership on another year's activities, Council has these facts seriously in mind, and is happy to record a twelve months period of unusual activity, special services and continued success. There remain many things to do—some of them already under way and others just emerging from the planning stage and doubtless others not yet conceived, before this Institute will be rendering its maximum of service to its members and to its country. Council acknowledges the favourable position to render national service, in which the Institute now finds itself; and is confident that with the continued and perhaps increased support of the members, much can be done that will be of material assistance in the conduct of the war.

Branch Activities

A perusal of the reports of branches which are appended to this report will indicate a successful year in each of the twenty-five separate organizations. The programme of papers has been excellent, and in several instances innovations have been introduced which have added materially to the general interest. Some branches have shown substantially increased activity both in their programmes and in their acquisitions of new members. It is not necessary to mention any branch specifically as all have set up a splendid record, and their activities are reported separately herein.

Visits to Branches

The president visited branches in all zones except the Maritimes. It was part of his original plan to call at branches from coast to coast, but the increased demands upon his time brought about by the great emergency and industrial expansion made it necessary to curtail the programme. This has been a disappointment to the branches that were omitted, but it has been an even greater disappointment to the president. In all, the president visited fourteen branches.

The general secretary made thirty visits to branches including Halifax and Victoria.

There was also considerable visiting of councillors and officers between branches, a conspicuous example of this being the visit of Councillors Vance of London and McLeod of Montreal to the western branches in the company of the president. Past President Lefebvre of Montreal was also a member of this party. The value of the exchange of speakers between branches and the visits between members and officers cannot be over-estimated. It is to be hoped that every member will take advantage of any such opportunity that is presented, as in this way the life of branches is considerably stimulated.

Council Meetings

Council held eleven meetings including three away from Headquarters. All meetings were well attended, and it was very gratifying to see so many out of town councillors present. The interest shown in the regional meetings would seem to justify the continuation of this practice. These meetings were held at the following branches and the bracketted figures show the attendances, including guests as well as councillors: Toronto (55), Windsor (33), Calgary (39).

Co-operation

In addition to the co-operation mentioned later under "International Relations" considerable progress has been made on "domestic" co-operation. This falls into two classifications (a) that with provincial professional associations, and (b) that with other engineering institutes.

Under "a" there are two agreements to be recorded. In January, President McKiel and the general secretary visited Halifax to participate in the ceremony of signing the co-operative agreement with the Association of Professional Engineers of Nova Scotia. This has been operative throughout the year, and already has gone a long way towards "total" co-operation for the engineers of Nova Scotia.

The other agreement was signed in December, at Calgary, between the Association of Professional Engineers of Alberta and the Institute. President Hogg was the Institute's senior signing officer and was also the principal speaker at the joint dinner which marked the occasion. This agreement became effective in January 1941 and is expected to do much for the profession in that province.

Acknowledgment is made of the courtesies and aid afforded the Institute by the officers of both these provincial bodies. The consummation of the agreements is due entirely to the tireless and intelligent efforts of these officers associated with the Institute officers within the province. The breadth of vision and the sincerity of purpose in both cases is exceedingly commendable.

Under "b" there is to be considered the relationships with other engineering bodies in Canada. Based on a desire for genuine co-operation between all engineers, every effort has been made to retain close relationships with other engineering organizations. Beyond a doubt common interests should promote common efforts, and common efforts should produce that community of spirit which is so desirable throughout the profession. Two common interests have developed out of the war to produce common efforts that have brought all engineering bodies much closer together. These are the registration of technical personnel in Canada which was carried out with the co-operation of fifteen organizations, and the evacuee proposal which has been referred to elsewhere. It has been not only interesting but pleasant to work with these other societies, and it is to be hoped that the co-operation thus developed will find many more problems that will permit the continuation of this splendid spirit. The two Institutes which have been most closely associated with the Engineering Institute in these proposals are the Canadian Institute of Mining and Metallurgy and the Canadian Institute of Chemistry.

By-Law Changes

The abolition of the grade of Associate Member was accomplished with very little disturbance to the usual routine. The ballot authorizing the change was one of the most emphatic that has been recorded, and there appears to be no doubt but that the simplification in nomenclature was strongly desired by the membership. Thus the way to further co-operation with provincial professional associations has been simplified.

International Relations

It is doubtful if the Institute ever has been more closely associated with engineering societies in England and the United States, than it is at the end of 1940. Several circumstances have brought this to pass. The close relationships and the new contacts established through the negotiations and arrangements for the ill-fated British American Engineering

Congress in the fall of 1939 were carried forward to last year, and were further augmented by similar negotiations leading up to the organization established in Canada for the care of children of English engineers who might desire to send them here for the duration. These plans, like those for the engineering congress, were never put to the test due to the heinous methods of the Hun who ruthlessly destroyed the children rather than permit them sanctuary in Canada.

The one good thing that has already come out of all these negotiations is the closer relationship between the societies. The Institute in company with the other Canadian organizations that were associated in the evacuee proposals, has made many friends in the Old Country, and numerous letters have been received testifying to the warmth of the new relationships and expressing the desire that they should be continued and extended.

Our good neighbours to the south have continued their beneficial interest in our organization and have done much to reduce the international boundary to its mere geographic significance. The attendance of the chief officers of the American Society of Civil Engineers and the American Society of Mechanical Engineers at our Annual Meeting in Toronto was greatly appreciated, as it has always been. The assistance received from the executive officers of these societies has been of great value and, in company with the interest of the chief officers, has promoted very close relationships between the organizations—a matter of more than usual importance in these days of threatened agression, when understanding and co-ordination are so necessary if we are to preserve the precious privileges of life in North America.

Engineering Council for Professional Development

Certainly one of the most significant events of the year was the acceptance of the Institute's application for membership in the Engineers' Council for Professional Development (E.C.P.D.). This body is made up of the leading technical societies in the United States and has a most significant programme for the development of the professional spirit in engineering, and for the guidance and assistance of young engineers. Its field of influence is increasing constantly and beyond a doubt the welfare of the individual engineer and the entire profession will be greatly and favourably affected by it in the future. The Institute is happy to associate itself with its sister societies in carrying out such a splendid work.

Voluntary Service Registration Bureau

One of the most far-reaching proposals with which the Institute has been associated is the register of technically trained men, which was undertaken late in 1938 at the request of the Department of National Defence, and in association with the Canadian Institute of Mining and Metallurgy and the Canadian Institute of Chemistry. In 1939 these records were turned over to the Voluntary Service Registration Bureau, and were designated the "technical section" of that bureau. During 1940 the Joint Committee of Secretaries made several endeavours to have more use made of these records but in spite of appeals to various officials who it was thought would be interested, no changes were made, and in the opinion of the committee the great volume of vitally important information continued to be neglected.

Just at the close of the year, an approach to the Institutes was made and there is now the possibility that new and increased avenues of national service may be opened up. If arrangements now under discussion are completed a great responsibility will fall on the shoulders of these three national bodies, which will require the loyal and active support of every member.

Radio Programme

An innovation was added to the year's normal prorgamme, in the form of a series of six trans-Canada broadcasts arranged by the Radio Committee. The speakers were all prominent members of the Institute and, each spoke on a phase of engineering in which he was specially qualified. Reports from members and from the Canadian Broadcasting Corporation indicate that the series was well received, and made a real contribution to the "literature of the air" for 1940.

Annual Meeting

A review of the year's activities would not be complete without special comment on the conduct of the Annual Meeting held in Toronto. From every angle the meeting was a real success, and Council is particularly appreciative of the policy adopted by the committee whereby the cost to the Institute was so substantially reduced. The quality of the papers and discussions was excellent; the luncheon speakers were unusually interesting and the principal of McGill University as special guest at the banquet provided a thought provoking discussion on a timely and interesting topic. Toronto certainly maintained its reputation of doing things well.

Finances

It is a source of much gratification to the Finance Committee that in spite of war conditions, the auditors statement for the year shows that both income and expenditure are slightly more favourable than last year. Actually the committee had budgetted for the reverse of this. The report of the committee and of the treasurer are appended and both refer with satisfaction to the annual statement. Great credit is due the Finance Committee for its conservative budget and its actual handling of the Institute finances.

Headquarters

There have been few changes in the personnel of the Headquarters staff. With the increase in membership and the assumption of additional activities, an increase in the volume of work has developed but this has been handled without any increase in staff. The entire organization has participated in an unusually heavy year, and has rendered an excellent service which is appreciated by Council.

The general secretary and his assistant have endeavoured to attend branch meetings as frequently as possible. This has resulted in an increased number of visits, and it is hoped that this practice can be maintained throughout the coming year.

Roll of the Institute

The membership of all classes now totals 5,120—the highest figure in fifteen years. The year 1940 saw the addition of 436 names to the roll, although deaths, resignations and removals reduced this to a net gain of 307. It is heartening to see a substantial increase in the student membership, and to note the increased number of transfers to higher classifications. If this acceleration can be maintained for one more year, the total of membership will reach a a new all time "high." The details are submitted herewith.

During the year 1940, four hundred and thirty-six candidates were elected to various grades in the Institute. These were classified as follows: one hundred and forty Members; eleven Associate Members; fifty-four Juniors; two hundred and five Students, and twenty-six Affiliates. The elections during the year 1939 totalled three hundred and fifty-four.

Transfers from one grade to another were as follows: Associate Member to Member, three; Junior to Member, twenty-five; Student to Member, nineteen; Junior to Associate Member, six; Student to Associate Member, twelve; Student to Junior, eighty-seven, a total of one hundred and fifty-two.

The names of those elected or transferred are published in the *Journal* each month immediately following the election.

Removals from the Roll

There have been removed from the roll during the year 1940, for non-payment of dues and by resignation, forty-eight Members; twelve Associate Members; thirteen Juniors; twenty-two Students, and three Affiliates, a total of ninety-eight. Twenty reinstatements were effected, and sixteen Life Memberships were granted.

Deceased Members

During the year 1940 the deaths of fifty members of the Institute have been reported as follows:

Honorary Member

Tweedsmuir, The Right Honourable Lord

Members

Ashworth, John Kershaw
Baldwin, Robert Archer
Barnum, John Baylor
Barr, Shirely
Bertrand, J. N. Têtu
Bridges, Frederick
Burpee, David William
Carson, William Harvey
Cartmel, William Bell
Chambers, Edward Coulthurst Gibbons
Chapman, Walter Peck
Evans, Edward Arthur
Gates, Archibald Bland
Gzowski, Casimir Stanislaus
Hay, Alexander Loudon
Howard, Stuart
Jamieson, James A.
Johnston, John Thomas
Macdonald, Arthur Cameron
Mackenzie, Howard Archibald
MacPherson, Duncan
McCulloch, Andrew Lake
McNab, James Veitch
McRae, John Bell
Mitchell, Samuel Phillips
Monsarrat, Charles Nicholas
Naish, Theodore Edward
Ogilvie, William Morley
Owens, Edward James
Palmer, Robert Kendrick
Paterson, Alexander Wilson
Potter, Alexander
Routly, Herbert Thomas
Sabourin, Alexandre Georges
Salter, Ernest Milton
Seymour, Horace Llewellyn
Smart, Valentine Irving
Smith, Frank Lawrence
White, James Alexander Gordon
Wilgar, William Percy

Associate Members

Bright, David Mussen
Gordon, James Lindsay
Logan, William Allison
McColl, Samuel Ebenezer
Sammett, Matthew Alexander
Shearer, George Wyman
Woods, Joseph Edward

Students

Allan, Robert Gage
Lalonde, Jean A.

Total Membership

The membership of the Institute as at December 31st, 1940, totals five thousand, one hundred and twenty. The corresponding number for the year 1939 was four thousand, eight hundred and thirteen.

1939	
Honorary Members	16
Members	1,057
Associate Members	2,287
Juniors	496
Students	914
Affiliates	43
	4,813

1940	
Honorary Members	15
Members	3,465
Juniors	588
Students	985
Affiliates	67
	5,120

Respectfully submitted on behalf of the Council,

T. H. Hogg, M.E.I.C., *President.*

L. Austin Wright, M.E.I.C., *General Secretary.*

TREASURER'S REPORT

The President and Council:

It is gratifying to see that notwithstanding our war effort plus the losses the Institute has sustained due to war service, the financial statement is still better than last year.

Care should be taken to conserve our resources through these favourable years, as it is possible that a prolonged war or a sudden cessation of hostilities may affect our financial position seriously.

Unfortunately, the recent damage to our building by settlement will necessitate spending a sum considerably larger than anticipated, but I feel confident that the membership at large will be willing to give some special help.

Evidently the Institute should have a much larger amount laid aside for depreciation on the building.

Respectfully submitted,

deGaspé Beaubien, M.E.I.C., *Treasurer.*

FINANCE COMMITTEE

The President and Council:

The statement of revenue and expenditure for the past year, which is presented herewith, reflects a continuation of the healthy growth of the previous year, and of the keen interest being maintained by the branches in Institute affairs. The revenue and expenditures have been maintained at practically the same level as 1939, again reflecting the loyal co-operation of the general secretary and the Headquarters staff, as well as the executive officers of the various branches.

The balance of revenue over expenditures will liquidate the moneys borrowed some time ago from the special funds, so that the incoming Finance Committee will commence work with a clean sheet. It has also been recommended by your committee that the sum of $1,000.00 be placed in reserve for building maintenance. Recent events have shown this to be imperative, and it should be continued in the future, whenever conditions permit.

Particular mention should be made of the policy of the Toronto Branch in assuming a much larger portion of the cost of the Annual Meeting than is ordinarily taken by a branch. This action has materially assisted the Finance Committee in rendering a favourable report for the year.

The recognition of the Institute in public affairs and by our sister societies to the south during the past year is an indication of our outstanding position in the country, and it behooves us to give our full and continued financial support to all its activities.

Respectfully submitted,

Fred Newell, M.E.I.C., *Chairman.*

PUBLICATION COMMITTEE

The President and Council:

During the year your committee has made one or two changes in the *Journal*, the most important of which we think is the substituting of our Month-to-Month page for Editorial Comment. In view of the nature of our organization it was found difficult to maintain a sufficiently interesting editorial comment without the danger of introducing controversial matter. It was, therefore, considered wise to discontinue the practice of editorials as a regular feature and to substitute our Month-to-Month column, in which is included news of the affairs of the Institute and engineering matters of general interest to the membership.

Your committee has frequently to consider papers of importance which are too long and too expensive to publish in the *Journal*. One of these was "Some Developments in Alloys During the Last Twenty Years," by O. W. Ellis, and your committee decided to print this as a supplement. This was made available to the members and published at a moderate charge, and at the same time was reviewed in the *Journal*. The immediate response to this has not been entirely satisfactory but it is felt that if the practice of publishing a few of these a year were continued that the membership would become acquainted with the idea and that it might become more popular.

As will have been noticed we have also instituted the practice of using a photograph on the cover page, which we feel has made an improvement in the general appearance.

Frequently we have referred papers to various members to obtain their opinion on the value for publication, and we wish to thank them for their kind co-operation. We also wish to acknowledge the assistance of the secretary emeritus, whose work on the *Journal* is invaluable.

Respectfully submitted,

C. K. McLeod, M.E.I.C., *Chairman.*

PAPERS COMMITTEE

The President and Council:

The activities of the Papers Committee during the past year were somewhat curtailed by the fact that most of the members are very busy as the result of the war. It was finally considered advisable not to arrange meetings to accommodate the itinerary of speakers visiting various branches. However, the branches have been active with meetings. They have had good speakers and interesting and instructive papers.

There has been a marked increase in the visits of members to other branches and inter-branch meetings.

During the year, the Papers Committee, wherever possible, has promoted more direct contacts between branches. It is found difficult to maintain an effective clearing house at Headquarters or any other point to assist with speakers, papers, films and branch programmes in general. A more direct exchange of ideas between branch secretaries and other branch executives is advocated. By broader exchange of notice-of-meeting cards, by invitations to near-by branches and by travelling engineers visiting other branches, a healthy impetus can be given to the activities of the Institute.

Respectfully submitted,

James A. Vance, M.E.I.C., *Chairman.*

COMMITTEE ON THE TRAINING AND WELFARE OF THE YOUNG ENGINEER

The President and Council:

Subsequent to the submission of the last annual report, as published on pages 70 and 71 of the February, 1940, *Journal*, several members of the Committee met informally at the time of the 1940 Annual Meeting at Toronto. We agreed on the need for the continuance of our investigations along the lines already adopted.

The Committee had the opportunity of presenting its findings to a very largely attended meeting of Council in Toronto, on February 7th, 1940, when constructive suggestions were offered by leading educationalists present. The incoming Council authorized the re-appointment of the Committee, and it has continued its studies.

Branch Activities

The Institute branches were circularized on April 9th, 1940, to ascertain, generally, what activities were carried out especially for the younger members, and what suggestions could be offered. The replies received were encouraging, and on July 8th, a circular was issued to the branches, through the general secretary, urging:

(a) More attention to the preparation of papers for the prizes available to Students and Juniors, and the need for additional prizes.

(b) The organization of Junior Sections in the larger branches, and Young Engineer Committees in all other branches, to stimulate activities among the young men, and to improve the contacts with University students and Faculties.

(c) The encouragement of self-development groups for the study of technical, cultural and economic subjects.

(d) The necessity for maintaining the dignity, the social and cultural standards of the profession, as an example for the younger men.

Members of the Committee have addressed the branches on the young engineer problem, and the discussions have indicated a continuing interest.

Student Selection and Guidance

Our attention has been directed to the preparation of a suitable brochure for prospective engineering students, their parents and teachers. We were ready to proceed with this, when Council decided to apply for association with our American friends in the Engineer's Council for Professional Development.

The E.C.P.D. was then preparing a revision of its booklet "Engineering—A Career—A Culture." The proofs were forwarded to this Committee and certain changes were suggested to make it more suitable for Canadian distribution.

After the Institute was regularly admitted to membership in the E.C.P.D., the final proofs were edited and the new booklet "Engineering As A Career," will be published shortly. This will be available for distribution by the E.I.C. It is possible that this Committee may propose the preparation of a small pamphlet for distribution with this booklet, giving more information for Canadian students.

Members of your Committee have discussed student guidance with educationalists, and we are definitely aware that the Institute can give leadership in this important phase of engineering education. We shall discuss this matter at the meeting, in February, 1941, when a definite programme will be adopted.

Engineers' Council for Professional Development

The action of the Institute in applying for membership in the E.C.P.D., and the formal acceptance of that application on October 24th last, will make available to your Committee the information gained by that body in the study of similar problems in the United States. It is a pleasure to be permitted to associate with them in the activities of their several committees.

The E.I.C. and the Adaptation of the Young Engineer to the Profession

There is an indication that many of the branches of the Institute are extending their activities among the younger engineers. It is expected that evidence of these activities will be presented at the Annual Meeting.

Your Committee is following, closely, the progress being made by the E.C.P.D. Committee on Professional Training. Their findings indicate that success in this field will depend on the skill, patience and enthusiasm of the older members of the profession who are willing to give their time to this problem.

The Young Engineer and the War

Some members have suggested that the work of this Committee might be suspended during the war period. They base their conclusions on the fact that engineers generally should devote their spare time to furthering the war effort, and that many young engineers are in the several services.

These conditions do exist, but it should be noted that we are part of a rapidly changing social order, in which the engineer must play a more active part. Young men are entering the profession each year, despite the war, and many others are passing from the secondary schools to the universities for training.

It will be recalled that some of the branches of this Institute were organized during and just following the last war, despite the fact that many of our members were on active service. It is our opinion that we must be ready to assume a greater obligation to society after this war is over, as then the studies of this Committee will be increasingly valuable, and their conclusions more definitely necessary.

Plenary Meeting

Your Committee appreciates the action of Council in making it possible to convene a plenary meeting at the Annual Meeting in Hamilton. Questions which have been studied will be thoroughly discussed and our conclusions will be presented to the Annual Meeting, at the afternoon session, on Thursday, February 6th, 1941.

Respectfully submitted,

Harry F. Bennett, M.E.I.C., *Chairman.*

LIBRARY AND HOUSE COMMITTEE

The President and Council:

Your Committee reports as follows. The Committee was continued with the same personnel as during the previous year. It met on four occasions in the last half of the year.

Early in the summer a crack appeared in the masonry of the rear wall of headquarters building and this developed slowly. There was no danger involved, but developments were watched and during the fall the matter was considered. We reported to Council and were authorized to spend $150.00 to investigate conditions and bring in definite recommendations.

Test pits were excavated and we recommended the underpinning of the auditorium section in whole or in part. Council authorized the Committee to prepare detailed plans on the basis of using open caissons or piers. They decided that the general situation warranted the underpinning of the whole building at one time rather than face the probability that all of the work would have to be done sooner or later and that there might be further cracking and damage to the superstructure if a part of the work was delayed. Council authorized the signature to a contract on whatever basis the House Committee and Finance Committee might jointly agree. They also arranged for the Finance Committee to suggest ways and means of providing necessary funds.

Tenders were called and received shortly after Christmas. The contract was awarded to A. F. Byers & Company Limited, who were the lowest bidders. The work at present is almost 50 per cent complete. Conditions uncovered during construction have confirmed the information and deductions provided by the test holes.

The above item has been the only major item of work and as it represents a considerable expenditure for the Institute, other minor points have been delayed. Small

COMPARATIVE STATEMENT OF REVENUE AND EXPENDITURE

For the Year Ended 31st December

Revenue

	1940	1939
Membership Fees:		
Arrears	$ 3,332.75	$ 3,459.52
Current	26,295.10	26,581.91
Advance	505.21	406.11
Entrance	2,238.00	1,894.00
	$32,371.06	$32,341.54
Publications:		
Journal Subscriptions and Sales	$ 7,539.39	$ 7,390.68
Journal Advertising	13,566.35	13,660.24
	$21,105.74	$21,050.92
Income from Investments	$ 458.93	$ 457.89
Refund of Hall Expense	465.00	520.00
Sundry Revenue	66.80	5.60
Total Revenue for Year	$54,467.53	$54,375.95

Expenditure

	1940	1939
Building Expense:		
Property and Water Taxes	$ 2,074.28	$ 2,020.56
Fuel	557.28	492.25
Insurance	120.36	229.67
Light, Gas and Power	329.15	311.05
Caretaker's Wages and Services	878.00	913.00
House Expense and Repairs	385.74	766.59
	$ 4,344.81	$ 4,733.12
Publications:		
Journal Salaries and Expense	$16,483.47	$15,244.69
Sundry Printing	494.23	457.40
	$16,977.70	$15,702.09
Office Expense:		
Salaries	$12,420.57	$12,534.07
Telephone, Telegrams and Postage	1,901.04	1,848.45
Office Supplies and Stationery	1,557.36	1,094.11
Audit and Legal Fees	290.00	250.00
Messenger and Express	89.59	93.79
Miscellaneous	430.25	555.74
Depreciation—Furniture and Fixtures	370.87	368.70
	$17,059.68	$16,744.86
General Expense:		
Annual and Professional Meetings	$ 1,284.39	$ 2,316.89
Meetings of Council	612.32	449.62
Travelling	1,693.51	1,244.01
Branch Stationery	194.58	242.06
Students Prizes	58.71	46.35
E.I.C. Prizes	250.00	286.25
Gzowski Medal	34.50	34.50
Library Salary and Expense	999.92	1,056.36
Interest, Discount and Exchange	149.57	181.45
Examinations and Certificates	*84.42*	22.75
Committee Expenses	255.65	167.08
National Construction Council	50.00	100.00
Sundry	61.00	92.15
	$ 5,559.73	$ 6,289.47
Rebates to Branches	$ 6,304.00	$ 6,695.48
Total Expenditure	$51,245.92	$50,165.02
Surplus for Year	3,221.61	4,210.93
	$54,467.53	$54,375.95

repairs were made to the roof over the caretaker's quarters. There are one or two minor repairs yet to be done in this section of the building. It will also be necessary to repair the plaster and do some re-decorating in the auditorium during the coming year after all possible settlement due to shifting loads has been completed.

The photographs of all past general secretaries of the Institute have been placed in the library as authorized last year.

The library has been used about the same as last year. It it hoped that the necessary clearing out of the basement to permit the construction work being carried out will provide an opportunity to rearrange the physical set-up of the library accommodations to the advantage of the Institute and the staff.

The Committee would like particularly to acknowledge the interest and support of Messrs. Jamieson, Lalonde and McCrory who were called in to assist in connection with the discussions about underpinning the building. These special appointments to the personnel of the House Committee were made at the suggestion of Council when this work was authorized.

Respectfully submitted,

Bryan R. Perry, *Chairman*

COMMITTEE ON INTERNATIONAL RELATIONS

The President and Council:

It is the considered opinion of your committee that the external relations of the Institute have been strengthened and extended during the year.

The entry of the Institute into constituent membership of the Engineers' Council for Professional Development is an event which should greatly increase the Institute's ability to render service to the engineering profession. The committee believes that the consistent policy of the Council in maintaining as close and continuous a connection as possible with the Founder Societies of the United States is in the best interests of Canadian engineers, and it notes with appreciation that opportunities have been afforded the general secretary to confer with the secretariat of these societies.

Although the preoccupation of the engineering Institutions of Great Britain in the present crisis has hindered further development of fraternal relationships between them and the Institute, the committee believes that no better opportunity for serving these institutions is open to the Institute than the chance to look after their members' families who may find sanctuary in Canada.

Respectfully submitted,

J. M. R. Fairbairn, m.e.i.c., *Chairman.*

COMPARATIVE STATEMENT OF ASSETS AND LIABILITIES

As at 31st December

Assets

		1940	1939
Current:			
Cash on hand and in Bank		$ 2,043.18	$ 432.38
Accounts Receivable	$2,732.60		
Less: Reserve for Doubtful Accounts	136.17	2,596.43	3,059.76
Arrears of Fees—Estimated		2,500.00	2,500.00
		$ 7,139.61	$ 5,992.14
Special Funds—Investment Account:			
Investments	$9,260.14		
Cash in Savings Accounts	4,422.25		
		13,682.39	13,881.82
Investments at Cost:			
$4,000 Dominion of Canada, 4½%, 1959	$4,090.71		
200 Dominion of Canada, 4½%, 1958	180.00		
100 Dominion of Canada, 4½%, 1946	96.50		
1,000 Montreal Tramways, 5%, 1941	950.30		
2,000 Montreal Tramways, 5%, 1955	2,199.00		
500 Province of Saskatchewan, 5%, 1959	502.50		
2 Shares Canada Perman't Mortgage Corporation	215.00		
40 Shares Montreal Light, Heat & Power, N.P.V.	324.50		
		8,558.51	8,558.51
Advance Travelling Expenses		—	100.00
Advances to Branches		100.00	100.00
Deposit—Postmaster		100.00	100.00
Prepaid and Deferred Expenses		700.00	804.23
Gold Medal		45.00	45.00
Library—At cost less depreciation		1,448.13	1,448.13
Furniture and Fixtures—At cost less depreciation		3,414.33	3,708.75
Land and Buildings—At cost		91,495.22	91,495.22
		$126,683.19	$126,233.80

Liabilities

		1940	1939
Current:			
Accounts Payable		$ 2,321.54	$ 2,494.13
Rebates due Branches		641.81	722.03
Amount due Special Funds		—	3,314.98
Library Deposit		—	5.00
		$ 2,963.35	$ 6,536.14
Special Funds:			
As per Statement attached		13,682.39	13,881.82
Reserve for Building Maintenance		1,350.00	350.00
Surplus Account:			
Balance as at 1st Jan., 1940	$105,465.84		
Add: Excess of Revenue over Expenditure as per Statement attached.	3,221.61		
		108,687.45	105,465.84
		$126,683.19	$126,233.80

Audit Certificate

We have audited the books and vouchers of The Engineering Institute of Canada for the year ended 31st December, 1940, and have received all the information we required. In our opinion, the above Statement of Assets and Liabilities and the attached Statement of Revenue and Expenditure for 1940 are properly drawn up so as to exhibit a true and correct view of the Institute's affairs as at 31st December, 1940, and of its operations for the year ended that date, according to the best of our information and the explanations given to us and as shown by the books.

(Sgd.) Ritchie, Brown & Co.,
Chartered Accountants.

Montreal, 20th January, 1941.

COMMITTEE ON PROFESSIONAL INTERESTS

The President and Council:

Much progress has been made during 1940 in promoting the declared policy of the Institute—close co-operation with the provincial professional associations. At Calgary, on December 14th, 1940, the president and the general secretary signed an agreement with the Association of Professional Engineers of Alberta which should go a long way to clarify and simplify the organization of the profession in the province of Alberta.

Active negotiations are under way with the Association of Professional Engineers of the Province of New Brunswick which promise an early and satisfactory conclusion.

It is expected that the discussion the committee has had with the officials of the Institute in the province of Manitoba will result in a basis for an agreement between the Institute and the Association of Professional Engineers of the Province of Manitoba that can be brought to fruition before long.

The relationship between the Institute and the Corporation of Professional Engineers of Quebec continues very close and friendly. No attempt has as yet been made to evolve a formal agreement between the two bodies.

The results in Saskatchewan and Nova Scotia indicate that the co-operative agreements in those provinces are working out in the best interests of the profession.

Your committee notes with satisfaction that in Ontario and British Columbia there are many evidences of an increased interest on the part of the profession in general regarding the aspirations of both the Institute and the Associations.

Respectfully submitted,

J. B. Challies, m.e.i.c., *Chairman.*

LEGISLATION COMMITTEE

The President and Council:

In view of the fact that no issues involving Institute legislation developed during the year, there remained no work for the committee to do. Doubtless this is a healthy sign, for the work of the committee is similar to the work of the lawyer of which the average citizen avails himself only when in trouble.

The committee would have been very happy to be of assistance had any issue arisen, but rejoices with the rest of the membership in the fact that there were no legislative difficulties to detract from the year's operations.

Respectfully submitted,

J. Clark Keith, m.e.i.c., *Chairman.*

RADIO BROADCASTING COMMITTEE

The President and Council:

Your Committee was appointed in February last, in order to arrange for a series of Dominion-wide broadcasts indicating the contribution being made by the engineers of this country toward the national war effort.

At first there was some uncertainty as to the possibility of giving the broadcasts, due to war conditions, but later the Canadian Broadcasting Corporation was able to allot six suitable fifteen-minute periods. Your Committee met on August 29th and drew up a tentative programme which was approved by the C.B.C., on September 5th. It was arranged that six addresses should be delivered on consecutive Wednesdays at 7.45 p.m. Eastern Daylight Saving Time, beginning October 16th.

Invitations were accordingly issued to the speakers on September 11th, and although these outstanding engineers were already occupied in work for the national emergency, all undertook this additional effort, in the interests of the Institute. Appreciating this fine co-operation, your Committee would ask that Council extend to the speakers of this series the thanks of their fellow-members, of the Institute, with compliments on the fine results attained.

The speakers and their subjects were as follows:—

Oct. 16th—T. H. Hogg, c.e., d.eng., (Toronto), President of The Engineering Institute of Canada.
Engineers in the War.

Oct. 23rd—Dean C. J. Mackenzie, m.c., m.c.e., (Ottawa), Chairman, National Research Council.
War Research—An Engineering Problem.

Oct. 30th—Miss Elizabeth M. MacGill, m.s.e., (Fort William), Chief Aeronautical Engineer, Canada Car and Foundry Co. Ltd.
Aircraft Engineering.

Nov. 6th—Augustin Frigon, c.e., d.sc., (Montreal), Assistant General Manager, Canadian Broadcasting Corporation.
Radio in Canada.

Nov. 13th—William D. Black, b.a.sc., (Hamilton), President, Otis-Fensom Elevator Co. Ltd.
Industrial Development in Canada to Meet the War Emergency.

Nov. 20th—Armand Circé, (Montreal), c.e., Dean of the Ecole Polytechnique, Montreal.
The Training of Engineers at the Ecole Polytechnique.

The Committee is grateful to the officers and secretaries of the Institute branches throughout the country for their active and effective co-operation in connection with newspaper publicity and the Branch notices calling attention to these addresses.

Our thanks are also due to the Canadian Broadcasting Corporation for the use of its facilities and for many helpful suggestions; more especially to the Manager, Mr. W. Gladstone Murray, the Assistant Manager, Dr. Augustin Frigon, and Mr. H. W. Morrison, the Supervisor of Talks.

We would also thank the press throughout the country, and especially the Canadian Press for the publicity given the series.

The general appreciation accorded to these talks has encouraged a good friend of the Institute to provide the funds necessary to print the series in a brochure for circulation to interested persons. We appreciate this favour very much.

In the event of the Institute contemplating a similar undertaking in the future, we would recommend that the hour for the broadcasts should not be earlier than 10 p.m., Eastern Daylight Saving Time, in order that a more convenient opportunity may be provided our members in the West to enjoy the programmes.

Respectfully submitted,

G. McL. Pitts, m.e.i.c., *Chairman.*

COMMITTEE ON DETERIORATION OF CONCRETE STRUCTURES

The President and Council:

Your Committee has continued during the year just past the policy of confining its efforts largely to studies of methods for the repair of concrete rather than to the causes of deterioration. To this end the committee has submitted to the Institute a paper "Concrete Repair Methods" prepared by one of its members, Mr. Claude Gliddon, m.e.i.c., describing methods developed by the Gatineau Power Company of which he is chief engineer, which were adopted after experimenting with other procedures. The paper is important, therefore, as a record of practical experience.

At the present time, two other papers are being reviewed for publication in the *Journal*—one on Sea Water Repairs, and the other on the Effect of Natural Waters on Concrete.

A third has been promised on the recently completed repair of an important structure.

The Committee thanks all those who have so generously given of their time to further its work, and welcomes suggestions both as to sources of data or reports on repair jobs which may be of interest to the Institute.

Respectfully submitted,

R. B. Young, M.E.I.C., *Chairman.*

MEMBERSHIP COMMITTEE

The President and Council:

Your committee on membership has to report that the war restricted its normal activities to a very great extent. This restriction was caused by longer work hours and the absorption of its members in war work.

Your committee has, however, endeavoured to start a system of registering guests attending Institute activities, especially Branch meetings, the registration being made either by signing a guest book or filling up a guest card.

This registration is not aimed at preventing non-members from attending Institute functions but rather to make more apparent the value of membership in the E.I.C.

Respectfully submitted,

K. O. Whyte, M.E.I.C., *Chairman.*

BOARD OF EXAMINERS AND EDUCATION

The President and Council:

Your Board of Examiners and Education for the year 1940 has had prepared and read the following examination papers with the results as indicated:

Schedule B

	Number of Candidates	Number Passing
I. Elementary Physics and Mechanics	4	3
II. Strength and Elasticity of Materials	4	2

Respectfully submitted,

R. A. Spencer, M.E.I.C., *Chairman.*

PAST PRESIDENTS' PRIZE COMMITTEE

The President and Council:

Your Committee on the Past-Presidents' Prize has carefully read and considered the two papers entered in this competition this year.

It is the opinion of your Committee that neither of these papers is of sufficiently high calibre to warrant awarding the Past-Presidents' Prize to its author. We therefore unanimously recommend that this prize be not awarded this year.

Respectfully submitted,

R. DeL. French, M.E.I.C., *Chairman.*

DUGGAN PRIZE COMMITTEE

The President and Council:

In the opinion of the Committee appointed to consider the award of the Duggan Medal and Prize for the year 1939-40, there were only two papers eligible for the prize.

The members of the Committee are unanimous in recommending that the award be made to Mr. M. S. Layton for his paper on "Electric Welding."

Mr. Layton's paper presented material of a useful and timely nature which, although possibly not entirely new to those specializing in this subject, affords a comprehensive survey of its recent developments. This should be of especial benefit to those engaged in the study and practice of modern structural engineering and consequently interested in all practical methods of carrying out the various operations incident thereto.

Respectfully submitted,

F. P. Shearwood, M.E.I.C., *Chairman.*

GZOWSKI MEDAL COMMITTEE

The President and Council:

Your Committee takes pleasure in recommending unanimously that the award be made to Miss E. M. G. MacGill, M.E.I.C., for her paper "Factors Affecting Mass Production of Aeroplanes."

The Committee desire to express themselves as being impressed with the large number of meritorious papers which were eligible for consideration, but feel that the author selected is specially entitled to this recognition of esteem from her fellow engineers.

Respectfully submitted,

A. O. Wolff, M.E.I.C., *Chairman.*

PLUMMER MEDAL COMMITTEE

The President and Council:

Your Committee has considered the various papers eligible for the Plummer Medal award for the current year. Mr. Harkom, as author of one of the papers under consideration, preferred not to take part in the voting, but the remaining members have voted unanimously for the award to be given to Mr. O. W. Ellis for his paper "Some developments in alloys during the last twenty years."

One of the Committee members has summed up very adequately the feeling of the Committee in saying: "The subject has been given masterly treatment and the paper is well written and comprehensive in scope. It is an excellent contribution to the literature on the more important alloys and should prove of lasting value, both to the engineer and the metallurgist."

It should be noted that several of the Committee members also thought very well of Mr. Harkom's paper, as it reported original work done by the author.

Respectfully submitted,

F. G. Green, M.E.I.C., *Chairman.*

LEONARD MEDAL COMMITTEE

The President and Council:

Your Committee, consisting of Mr. Victor Dolmage, Mr. F. W. Gray, Professor W. G. McBride, Mr. George E. Cole, with myself as chairman, are unanimous in the opinion that the Leonard Medal for this year should be awarded to Mr. R. G. K. Morrison for his paper "Points of View on the Rock Burst Problem," published in the August, 1939, Bulletin of the Canadian Institute of Mining and Metallurgy.

The Committee is of opinion that the paper is well written and shows much originality in its treatment of a difficult and important problem of deep mining. In dealing with the fundamental principles causing rock bursts in deep mines, the author, in advancing the theoretical aspects of the problem, balances these against his practical experience.

The Committee, therefore, has much pleasure in recommending that the Engineering Institute of Canada grant the Leonard Medal to Mr. Morrison.

Respectfully submitted,

A. D. Campbell, M.E.I.C., *Chairman.*

STUDENTS' AND JUNIORS' PRIZES

The reports of the examiners appointed in the various zones to judge the papers submitted for the prizes for Students and Juniors of the Institute were submitted to

Council at its meeting on January 18th, 1941, and the following awards were made:

H. N. Ruttan Prize (Western Provinces). No papers received.

John Galbraith Prize (Province of Ontario), to W. C. Moull, S.E.I.C., for his paper "The Electrification of a Modern Strip Mill."

Phelps Johnson Prize (Province of Quebec—English), to Léo Brossard, S.E.I.C., for his paper "Geology of the Beaufor Mine."

Ernest Marceau Prize (Province of Quebec—French), to Marc R. Trudeau, S.E.I.C., for his paper "Points Fixes et Lignes d'Influence."

Martin Murphy Prize (Maritime Provinces). No papers received.

EMPLOYMENT SERVICE

The President and Council:

The comparative figures of placements effected by the Employment Service Bureau, during the past six years, are evidence of the greater activity displayed during 1940 in this department.

1935	1936	1937	1938	1939	1940
77	110	181	61	88	147

The work done during the year is summarized in the following table and the corresponding figures for 1939 are given for purposes of comparison.

	1939	1940
Registered members	114	129
Registered non-members	92	89
Number of members advertising for positions	76	41
Replies received from employers	31	21
Vacant positions registered	153	260
Vacancies advertised in the Journal	50	43
Replies received to advertised positions	219	143
Men's records forwarded to prospective employers	325	179
Men notified of vacancies	310	178
Placements definitely known	88	147
Registered vacancies cancelled	6	2
Registered vacancies still open	23	33

It will be noted that the number of men registered with the Bureau during the year has been fairly high. It should be remembered that these figures do not include the number of applications revived from the inactive file. This heavy registration has involved the handling of an unusually high number of records and the interviewing of several men every day.

Most of the members requiring the services of the Bureau were actually employed but they desired either to improve their position or to ensure that their qualifications were used to the best advantage in the present emergency. It is appropriate to mention here the unselfishness of several members who were willing to accept severe reductions of salaries provided they could serve in some position directly connected with the war effort.

Graduating classes in the universities have readily been integrated into the profession and the comparatively small number of graduates registered with the Bureau during the year indicates that the majority had secured positions previous to graduation.

The number of vacancies registered reflects the large demand for engineers in all branches. The enquiries came from industry and, in a larger measure than was usual before, from the various government departments. Personnel problems affecting the entire staff of new industries have been placed before the Bureau.

With the first hand information contained in our employment files it has been possible to effect several placements and to cause moves from non-essential industries to war services. The range goes from dollar-a-year positions to situations with stipends in the five figures. The activity of the Bureau has embraced work from Halifax to Vancouver.

The facilities of the Employment Service have also been used extensively by the departments of government in the preparation of confidential reports which have ultimately led to placements in important positions. In this connection, it should be mentioned that Headquarters have received valuable assistance from the branches all over the country in securing accurate information.

In several instances, the Bureau has issued special calls from the active services. The latest of these appeals came from the Royal Canadian Air Force for engineer officers, and was published in the *Journal* and circularized among the branches. Officials from the Department at Ottawa have expressed their pleasure at the splendid response received. If it had been possible to record the enlistments which have resulted from these calls, the placements figure would be substantially increased.

It is felt that the Employment Bureau, within its field, has rendered a worthwhile service to the membership and to the country.

L. Austin Wright, *General Secretary.*

NOMINATING COMMITTEE

Chairman: R. A. Spencer, M.E.I.C.

Branch	*Representative*
Border Cities	C. G. R. Armstrong
Calgary	H. B. LeBourveau
Cape Breton	S. C. Mifflen
Edmonton	C. E. Garnett
Halifax	I. P. Macnab
Hamilton	W. J. W. Reid
Kingston	A. Jackson
Lakehead	E. L. Goodall
Lethbridge	C. S. Donaldson
London	V. A. McKillop
Moncton	R. H. Emmerson
Montreal	A. Duperron
Niagara Peninsula	A. W. F. McQueen
Ottawa	J. G. Macphail
Peterborough	W. M. Cruthers
Quebec	A. O. Dufresne
Saguenay	M. G. Saunders
Saint John	A. A. Turnbull
St. Maurice Valley	A. C. Abbott
Saskatchewan	A. M. Macgillivray
Sault Ste. Marie	J. S. Macleod
Toronto	J. M. Oxley
Vancouver	E. Smith
Victoria	K. Moodie
Winnipeg	J. W. Sanger

Abstracts of Reports from Branches

Note—For Membership and Financial Statements see pages 16 and 17.

BORDER CITIES BRANCH

The Executive Committee met eight times during the year for the transaction of branch business.

Nine branch meetings were held during the year, including the annual meeting and the joint meeting of the Councils of the Institute and the Association of Professional Engineers of Ontario.

Information on the various meetings follows, attendance being given in brackets:

Jan. 12—Joint meeting of the Border Cities Branch and the Detroit Section of the American Society of Mechanical Engineers. Mr. Henry G. Weaver, Director of General Motors Customer Research Division spoke on **Sampling Public Opinion.** (133).

Feb. 19—**Streamlining Industry with Electrical Control Equipment,** by Geo. Chute of the General Electric Company, Detroit. (26).

Mar. 15—**The Nickel Industry,** by J. H. Clark of the International Nickel Company. (39).

April 12—Junior meeting. **Maintenance of Boiler Control,** by J. A. Ferrier, and **The History, Production and Uses of Salt,** by A. H. Pask. (26).

May 11—Meetings of the Councils of The Engineering Institute of Canada and Association of Professional Engineers of Ontario. Separate meetings were held during the forenoon followed by a joint luncheon. In the afternoon inspection trips were made to plants of the Canadian Bridge Company and the Ford Motor Company, followed by a reception and banquet. (93).

June 1—Meeting in Sarnia. C. M. Baskin of Imperial Oil Limited spoke on **Field Technology, A New Approach to Industrial Development.** (37).

Sept. 21—Meeting in Chatham. An inspection of the plant of Libby, McNeil and Libby was followed by a dinner meeting at the William Pitt Hotel. T. V. Proctor and C. K. Rowland of Libby McNeil and Libby spoke on **The Canning Industry.** (49).

Nov. 15—**Superfinish and Fluid Drive,** by M. W. Petrie, Chief of Production Research Department, Chrysler Division of Chrysler Corporation, Detroit. (37).

Dec. 6—Annual meeting and election of officers. Complimentary dinner to J. Clark Keith, Vice-President Zone B. A history of the Branch was given by O. Rolfson, commemorating the twenty-first anniversary of its formation. (25).

Branch Photograph Album

The Branch is indebted to Geo. A. McCubbin of Chatham, Ont., for reproducing photographs of members of the Branch and for presenting the Branch with two indexed albums of the photographs.

CALGARY BRANCH

The Branch held twelve meetings during the year. The following summary gives particulars. Attendances are shown in brackets.

Jan. 11—**The Development of the Combustion Chamber of the Internal Combustion Engine,** by Prof. A. E. Hardy. (53).

Feb. 1—**Development of the North West Territories,** by Dr. J. A. Allan. (61).

Feb. 15—**Engineering Law,** by E. J. Chambers, K.C.. (60).

Feb. 29—**Review of Surveys of Storage Projects in Southern Alberta,** by W. L. Foss; **Progress of P.F.R.A. Programme,** by J. Vallance; and P.F.R.A. motion pictures, by M. L. Jacobson. (78).

Mar. 9—Annual meeting following luncheon. (35).

May 14—**Ceramic Engineering,** by Prof. W. G. Worcester. (46).

Oct. 10—**Power Plants in Bolivia,** a paper prepared by J. K. Sexton, of the Montreal Engineering Company, was presented by G. Horspool. A smoker followed. (64).

Oct. 24—**Problems encountered in the formation and operation of the Trans-Canada Air Lines,** by W. A. Straith. (36).

Nov. 6—**Conservation,** by R. E. Allen, Chairman of the Alberta Petroleums and Natural Gas Conservation Board. (40).

Nov. 21—**Coal handling plant at the Murray Collieries Ltd.,** by A. Baxter; **Some considerations in the design of castings,** by L. R. Brereton; **Standardization of paper sizes in Switzerland,** by C. Lattman, and **The importance of Economics to the Engineer,** by the Rev. R. J. Donovan.

Dec. 5—Annual ladies night. **Illustrated talk on familiar western Scenery,** by S. R. Vallance. (80).

Dec. 14—Annual joint dinner of the C.I.M. & M., A.P.E. and E.I.C. at which function the signing of the agreement between the Institute and the Association of Professional Engineers took place. The president, Dr. T. H. Hogg, and many other visitors from East and West were present.

During the year, the Branch Executive committee met nine times.

CAPE BRETON BRANCH

During the year, the Branch held three general meetings; the papers presented were as listed below:—

Jan. 9—**Oxygen—its Fabrication and Service in Modern Industry,** by F. G. Kerry, Canadian Liquid Air Co., Montreal.

May 14—**Some New Sidelights on Refractories for the Coal and Steel Industries,** by J. W. Craig, Canadian Refractories Ltd., Montreal.

June 11—**Highway Engineering,** by F. A. Crawley, Dept. of Highways, Sydney, accompanied by moving pictures of highway machines shown by R. F. McAlpine, of Wm. Stairs, Son & Morrow, Halifax.

We were also pleased to have the General Secretary with us for a dinner meeting with the Executive Committee in April. Matters of general interest to the Institute were discussed and particularly the agreement with the Association of Professional Engineers of Nova Scotia.

EDMONTON BRANCH

During the past very successful year nine meetings were held, each preceded by a members' dinner.

Programmes are listed below with attendance given in brackets.

Jan. 10—**The Development of the Combustion Chamber of the Internal Combustion Engine,** by E. A. Hardy, Professor of Agricultural Engineering, University of Saskatchewan. (48).

Feb. 9—**Soil Corrosion and Cathodic Pipe Protection,** by F. A. Brownie, Canadian Western Natural Gas, Light, Heat and Power Co. Ltd., Calgary, Alta. (36).

Mar. 12—**Modern Communication Channels,** by W. Mason, Assistant Transmission and Equipment Engineer, Alberta Government Telephones (32).

April 16—**Arctic Adventure.** A colour motion picture of northern Canada photographed by Chairman C. E. Garnett (30).

May 13—**Ceramics and the Ceramic Engineer,** by W. G. Worcester, Professor of Ceramic Engineering, University of Saskatchewan (22).

Oct. 11—**Design and Operation of Instrument Transformers,** by Dr. J. M. Thomson, Vice President, American Institute of Electrical Engineers (40).

Oct. 25—**Some Problems in the Establishment of a Modern Air Transportation System,** by W. A. Straith, District Traffic Manager, Trans-Canada Air Lines, Winnipeg, Man. (42).

Nov. 26—**Construction of a Large Eastern Industrial Plant,** by W. E. Cornish, Department of Electrical Engineering, University of Alberta. **Soil Mechanics and Foundation Engineering,** by R. M. Hardy, Department of Civil Engineering, University of Alberta (49).

Dec. 10—**Some Aspects of Oil Conservation in Alberta,** by R. E. Allen, Chairman of the Petroleum and Natural Gas Conservation Board of Alberta (25).

The Executive Committee held five regular meetings and two luncheon meetings, one to meet the General Secretary and one for Professor W. G. Worcester who came from Saskatoon to address a general meeting of the Branch.

E. O. Greening, M.E.I.C. and W. C. Wild, Jr.E.I.C., left Edmonton during the year to see active service with His Majesty's Forces.

The Co-operative Agreement between the Engineering Institute of Canada and the Association of Professional Engineers of Alberta has met with the approval of the members of both organizations.

HALIFAX BRANCH

Since the last annual meeting which was in the nature of a reception in honour of Dean McKiel, then president of the Institute, we have had four dinner meetings as follows:

On February 29th at the Halifax Hotel, our guest speaker was Dean Vincent C. McDonald of Dalhousie University, who spoke on **The Legal Aspects of Transportation in the Dominion.** Following Dean McDonald's address and the usual discussions of its major topics, the retiring vice-president for the Maritimes, Mr. R. L. Dunsmore, gave an illuminating outline of the activities of the annual meeting of the Institute held in Toronto. Also at this meeting it was our extreme pleasure to present prizes to four senior students of the N.S. Technical College for papers submitted at our November 1939 meeting.

On April 22nd, also at the Halifax Hotel, we welcomed to our meeting, three representatives of the Headquarters of the Institute, three members whom we regard as old friends in the persons of Past President Dr. Challies, Mr. G. A. Gaherty and the Secretary, Mr. L. A. Wright. Addresses were given by all three guests, chiefly relative to problems arising from the co-operation of the E.I.C. and the Association of Professional Engineers.

At the third meeting of our branch, held on October 23rd, our guest speaker was Mr. Bernard Allen, Chief Economist of Canadian National Railways, whose address on a subject of present day importance was well received and afforded the members ample scope for discussion.

The Executive Council has had a particularly busy season and held ten regular meetings during this past year, also in addition one special meeting in August was held to meet with Mr. Harry F. Bennett, Chairman of the Young Engineer Committee, who outlined the aims and objects of his Committee.

HAMILTON BRANCH

The Executive Committee held six business meetings with an average attendance of six members.

Ten Branch meetings were held as follows, attendance being noted in brackets.

Jan. 12—Annual business meeting and dinner held at the Rock Lodge. **The Historians Debt to the Engineer,** by W. A. Aitken. Chairman J. R. Dunbar closed the evening by introducing the incoming chairman, Alex. Love (58).

Feb. 19—**Engineering in Public Health Activities,** by Dr. A. E. Berry, held at McMaster University (39).

Mar. 12—**Development of the Tin Plate Industry,** by W. D. Lamont, Chief Metallurgist, Dominion Foundries and Steel Co. Held at MacMaster University (42).

April 12—**New Lighting Tools for To-morrow's Jobs,** by Samuel G. Hibbins, Director of Applied Lighting, Westinghouse Electric and Mfg. Co., Bloomfield, N.J. Joint meeting of the Toronto Section, Illuminating Engineers Society, the Toronto Section, American Institute of Electrical Engineers and the Hamilton Branch of the Institute; held at the Canadian Westinghouse Auditorium (339).

May 14—**Gypsum Limes and their Uses,** by T. B. Buckley, Manager, Canadian Gypsum Company Ltd. Held at McMaster University (57).

May 16—**Insulation and Condensation in Buildings,** by W. W. Cullen, Chief Engineer, H. W. Johns-Manville Co. Held at McMaster University. Joint meeting with the Hamilton Chapter, Ontario Association of Architects, and the Hamilton Branch of the Institute (39).

Sept. 20—Branch members joined in a visit to the **Shand Dam,** during construction. Organized by the Grand Valley group of the Professional Engineers of Ontario. Dinner in evening at the Trails End Inn, Conistoga (70).

Oct. 8—**The British Commonwealth Air Training Plan,** by Stuart Armour, Deputy to Minister of Air, Ottawa. Held at McMaster University (45).

Nov. 7—**Electricity at Work,** by Phillips Thomas, Ph.D., of the Research Laboratories of the Westinghouse Electric and Mfg. Co., held in the Ball Room of the Royal Connaught Hotel. This was a joint meeting of the Advertising and Sales Club of Hamilton, the Hamilton Group of the American Institute of Electrical Engineers, and the Hamilton Branch of the Institute (795).

Dec. 16—Students' Night in competition for the Branch prizes. **Working Stresses in Machine Members,** by L. D. Sentance, and **The Effect of Wet Coal on Pulverisers and Boiler Performance,** by M. D. Stewart. After the papers, Professor C. R. Young, of Toronto University gave an interesting talk, entitled **The Engineer and the Technologist.** Held at McMaster University (45).

KINGSTON BRANCH

The Branch met three times during the year.

Jan. 18—Dinner meeting at Students' Union. Immediate Past Chairman, H. W. Harkness presided. Twenty-three members and four guests were present. Report of Executive meeting on December 8, 1939, presented. Minutes of last meeting approved. The Secretary read a copy of a letter from the General Secretary of The Engineering Institute of Canada to Colonel Alexander Macphail, informing Colonel Macphail that, at the last meeting of the Council, he was made a Life Member of the Institute. Other correspondence read. Increase of membership noted. Dr. E. L. Bruce, Miller Memorial Research Professor, Department of Geology, Queen's University, gave a very interesting illustrated lecture on **Finland and the International Situation.**

Feb. 21—Dinner meeting at Students' Union. Vice-Chairman Phil Roy presided. Twenty-four members of the Kingston Branch and two guests were present. Minutes of last meeting approved. Report of Executive Meeting on February 14, presented. Professor W. P. Wilgar introduced Mr. L. Austin Wright, General Secretary, E.I.C., who addressed the Branch on activities and affairs of the Institute, including the Annual Meeting and the registering of technically trained men. By arrangement of the Kingston Branch, Mr. Wright, introduced by Dean A. L. Clark, addressed the Queen's University Engineering Society in Miller Hall, in the afternoon of February 21.

Oct. 31—Dinner and annual business meeting at Queen's Students' Union. Eighteen members and three guests were present. The Chairman, G. G. M. Carr-Harris presided. Report of the Secretary-Treasurer was presented and accepted. The following officers were elected:—Chairman—T. A. McGinnis; Vice-Chairman—P. Roy; Secretary-Treasurer—J. B. Baty; Executive: V. R. Davies, K. H. McKibbin, K. M. Winslow, A. H. Munro; Ex-Officio—G. G. M. Carr-Harris. General business and policy of the Branch was discussed. Major H. H Lawson paid fitting tribute to the memory of the late Professor W. P. Wilgar, pointing out the important role he had filled in the activities of Queen's University and of the Institute, and recalling that he had served as the first secretary of the Kingston Branch, E.I.C. Mr. Louis Trudel, Assistant to the General Secretary, from Headquarters, reported upon the war activity of the Institute, describing the work of the employment bureau and its close contact with both industry and the departments of government. He called special attention to the affiliation of the Engineering Institute of Canada with the Engineers' Council for Professional Development, and reported upon the good health and increased membership of the Institute. Major G. G. M. Carr-Harris, Mechanical Engineer, Royal Canadian Ordnance Corps delivered an interesting address on **Some Fundamental Engineering Principles as applied to Mechanization.**

LAKEHEAD BRANCH

The Branch held the following meetings during the year.

Jan. 17—Dinner meeting. **The Use of Echo Sounding Devices in charting Water Depths in Survey of Lake Nipigon,** by C. T. Anderson, Engineer at the Thunder Bay Paper Mill.

Sept. 26—Visit to the Aeroplane Factory of the Canadian Car and Foundry Co. Ltd., at Fort William, Ont. Dinner and address on **The Manufacture of Aircraft** by David Boyd, Works Manager of the Aircraft Division of the Montreal Plant.

Oct. 16—Dinner meeting at the Kakobeka Inn. Address on **The Training of Young Men for Industries,** by E. J. Davies, Principal of the Port Arthur Technical School.

Nov. 21—Dinner meeting at the Shuniah Club. Paper by J. M. Fleming, President of C. D. Howe Co. Ltd., Port Arthur on **The Grain Storage Situation in Canada.**

LETHBRIDGE BRANCH

During the year seven regular meetings with an average attendance of 37; four corporate members' meetings with an average attendance of 10; and six executive meetings with an average attendance of 6 were held.

All the regular meetings were held in the Marquis Hotel, preceded by a dinner during which numbers were rendered by George Brown's Instrumental Quartette, followed by vocal soli, interspersed with community singing. This fall, in an effort to build up attendance, the branch meetings have been held on Wednesday evenings at 8 p.m. with refreshments served after the address. A corporate members meeting precedes the regular meeting at 7.30 p.m. This idea has resulted in a noticeable increase in attendance.

The list of speakers and subjects follows; attendance is given in brackets.

Jan. 6—Ladies' Night. **1939 Trip Through Europe,** by Miss Hildur Sandquist. (55).

Feb. 17—**The Best Places in the West,** by H. J. McLean, Production Superintendent, Calgary Power Company, Calgary. (16).

April 10—Annual Meeting (Corporate Members only). (10).

May 15—Joint meeting of the Branch, and the Lethbridge Board of Trade. **Ceramics,** by Professor W. G. Worcester, University of Saskatchewan, Saskatoon. (60).

July 16—Special Meeting (Corporate Members only). L. Austin Wright, General Secretary, spoke on **Institute Affairs.** (14).

Oct. 23—**The Engineer as a Factor in Modern Warfare,** by Senator W. A. Buchanan (30).

Nov. 6—**Air Traffic Control,** by Edwin D. Boyd, Officer in Charge, Control Tower, Kenyon Airfield, Lethbridge. (30).

Nov. 27—**The Selection of the Correct Type of Motor for Various Loads,** by F. N. Rhodes, Institute of Technology and Art, Calgary (30).

Dec. 18—Ladies Night. Luncheon Meeting. Motion pictures were shown by J. G. Maxwell, Traffic Representative, Trans-Canada Air Lines, entitled **The Swift Family Robinson** and **African Skyways.** (40).

The Annual Meeting of the Branch was held on April 10th, when the officers were elected for the 1940-1941 season.

LONDON BRANCH

During the year 1940, the executive held seven business meetings. Six regular and special meetings were held as follows; attendance is given in brackets.

Jan. 26—Annual meeting and election of officers held at the Grange Tea Rooms, London. **Building Downwards,** by Professor R. F. Legget of the University of Toronto (60).

Mar. 27—Special meeting at Hotel London, London, held in conjunction with the American Water Works Association Convention. **Technical Social Progress,** by H. E. Jordon, Secretary of the Association (76).

May 1—Regular meeting held in the Auditorium of the City Hall, London. **Engineering Science as Applied to Soil Conservation,** by John S. Cutler of the U.S. Dept. of Agriculture, Dayton, Ohio (35).

Sept. 25—Regular meeting held in the Board room of the Public Utilities Commission, City Hall, London. **The Engineer and Public Health,** by Wm. Storrie, of Gore and Storrie, Consulting Engineers, Toronto (26).

Nov. 20—Regular meeting held in the board room of the Public Utilities Commission, City Hall, London. **The Distribution of Electricity,** by V. A. McKillop of the Public Utilities Commission (18).

Dec. 12—Regular meeting held in the Board Room of the Public Utilities Commission, City Hall, London. **Engineering in the Mackenzie River Basin,** by Professor R. F. Legget of the University of Toronto (23).

Average attendance of all meetings—39.

We regret to record the death of Major D. M. Bright, who had been an active member of the Branch for many years.

MONCTON BRANCH

The Executive Committee held four meetings. One technical and two business meetings of the Branch were held, as follows:

May 13—A meeting was held for the purpose of nominating branch officers for the year 1940-41.

May 31—Annual Meeting.

Dec. 19—A dinner meeting was held in the Brunswick Hotel. An illustrated paper on **Aerodrome Construction for the British Commonwealth Air Training Plan** was given by E. C. Percy, Assistant District Airways Engineer.

MONTREAL BRANCH

The Branch received the official visit of Dr. T. H. Hogg, president of the Institute, on May 2nd. An informal dinner was given for Dr. Hogg at the University Club. During the evening, Dr. Hogg addressed the members of the Branch at Headquarters on Institute matters and showed slides and films on the construction of a power line, during winter, in Northern Ontario. All members present were personally introduced to the president.

In response to an appeal made by the Honourable James A. Gardiner, Minister of National War Services, for volunteer workers to help with the National Registration during August, the Branch canvassed its members and received 190 offers of service.

Papers and Meetings Committee

The Papers and Meetings Committee has completed one of its most successful seasons under the chairmanship of Mr. R. S. Eadie.

The committee has continued the policy of co-operating with sister societies by having joint meetings with such organizations as the Institute of Radio Engineers and the Society of Cost Accountants and Industrial Engineers.

The following is a list of the papers delivered during the year and the attendance is given in brackets:—

Jan. 11—Annual Meeting of the Branch (75).

Jan. 18—**Television and Its Recent Developments,** by W. B. Morrison (300).

Jan. 25—**Hydro Electric Work in Bolivia,** by J. K. Sexton (175).

Feb. 1—Branch Smoker.

Feb. 8—**Welding Rods and their Coatings,** by M. S. Layton. (100).

Feb. 15—**Some Problems and Responsibilities of Industrial Management,** by W. F. Hosford (200).

Feb. 20—**Co-axial Cable Systems,** by M. E. Strieby (200).

Feb. 29—**Electricity in Railroad Maintenance,** by C. C. Bailey. (75).

Mar. 7—**Some Phases of the Work of the National Research Council,** by Dean C. J. Mackenzie (90).

Mar. 14—**Regulating the Load Distribution on Interconnected Power Systems,** by S. B. Morehouse (55).

Mar. 21—**Power System Communications,** by H. W. Haberl (60).

Mar. 28—**The Automobile Industry in Canada,** by Colonel Frank Chappell (100).

April 4—**The Hotel Vancouver,** by John Schofield (120).

April 11—**The Mathematics of Management,** by Paul Kellogg. (75).

April 18—**Planning Quebec Highways,** by Ernest Gohier (125).

April 25—**Plant Visit to Wire Drawing Mill, Steel Company of Canada Limited, Montreal** (120).

May 2—Visit to Branch of President, Dr. T. H. Hogg (160).

Oct. 3—**Aerodrome Construction in Canada for the British Commonwealth Air Training Plan,** by J. A. Wilson. (140).

Oct. 10—**The Atom—Its Place in Daily Life,** by I. R. McHaffie (80).

Oct. 17—**Colour Photography—An interesting and useful tool for Technicians,** by P. J. Croft (200).

Oct. 24—**Work Simplification as an Aid to Defence,** by Allan H. Morgensen (250).

Oct. 31—**Observations on Frequency Modulation Broadcasting,** by Paul A. de Mars (130).

Nov. 7—**Electrical Marvels,** by Dr. Phillips Thomas (440).

Nov. 14—**Montreal Citizens' Committee and the New City Council,** by R. Percy Adams (55).
Nov. 21—Annual Student Night (240).
Nov. 28—**The Romance of Water,** by Norman J. Howard (55).
Dec. 5—**Metallizing,** by A. Van Winson (75).
Dec. 12—**Hydraulic Model Experiments,** by Dr. Kenneth C. Reynolds (110).
Dec. 19—**High Voltage Insulators,** by J. J. Taylor (70).

Average attendance—137.

Junior Section

The Junior Section, which has carried on almost entirely under its own organization for the past number of years, has continued its good work also this year in spite of the fact that a large number of the younger engineers and students are devoting a large amount of time to military training. At the Annual Student Night on November 21st a very good attendance was noted and four excellent papers were presented on a competitive basis. It is very evident that students are interested in Institute affairs. As evidence of this fact it might be mentioned that the chairman had the honour of being invited to be present at the annual banquet of McGill University Engineering Undergraduates Society and to bring to this gathering a brief message from the Engineering Institute. Mr. L. Trudel, Assistant to the General Secretary, was also asked to bring a message from the Institute to a gathering of students at Ecole Polytechnique.

The Executive is of the opinion that all possible encouragement should be given to students. Future strength of the Institute is dependent largely on recruiting among the student bodies.

The following is a list of the Junior Section meetings with the attendance given in brackets.

Jan. 22—Annual Meeting. **The Young Engineer and the War,** by L. Austin Wright, General Secretary (60).
Feb. 5—**Gravel Road Surface Stabilization,** by Gilbert Coupienne (12).
Feb. 19—Student Night. **Architecture in Engineering,** by Stuart McNab (McGill) and **Examination of Welded Structures,** by Fernand Marchand (Ecole Polytechnique) (23).
Mar. 4—**Education Continued,** by Professor J. A. Coote (19).
Mar. 18—**Public Ownership of Electricity in St. Hyacinthe, Que.,** by Jean Bouchard (32).
April 1—**Network Broadcasting in Canada,** by J. A. Ouimet (23).
Oct. 21—Opening Fall Meeting. **The Engineering Institute,** by H. J. Vennes, Chairman, Montreal Branch. Film, **The Rapide Blanc Hydro-Electric Development.** (62).
Nov. 4—**Chlorine, the Germicide of a Hundred Uses,** by Jacques Benoit (20).
Nov. 21—Student Night. Speakers: V. G. Griffin (McGill); Bernard Beaupré (Ecole Polytechnique); W. C. Brown (McGill); Roger Lessard (Ecole Polytechnique). Motion picture, **Liquid Air.** (240).
Dec. 2—**Automatic Process Controls,** Georges L. Archambault. (16).

Membership Committee

The Chairmanship of the Membership Committee was again entrusted to Mr. K. O. Whyte who reports, that normal activities have been restricted due to war conditions, resulting in fewer personal contacts with prospective new members.

Reception Committee

The Reception Committee, under the Chairmanship of Mr. Willis P. Malone reports an active year and a very successful one.

The Smoker was organized by Mr. C. R. Lindsey and held at the Windsor Hotel on Thursday evening, February 1st. Four hundred and thirty-six tickets were sold.

The golf tournament was held at the Senneville Country Club on Tuesday, June 4th. An enthusiastic and representative gathering enjoyed the round of golf and the dinner and prize-giving that followed. Twenty-five played golf and thirty-two sat down to dinner.

At five meetings during the year, refreshments were served. These meetings were: the annual meeting on January 11th, the occasion of the visit of the president, Dr. Hogg, on May 2nd, the opening meeting of the Branch on October 3rd, the opening meeting of the Junior Section on October 21st, and the Junior and Students' Night on November 21st.

Publicity Committee

Mr. L. Jehu, Jr., chairman of this Committee, reports that through the courtesy of the headquarters staff, notices of the weekly meetings were sent to the Montreal Star, the Gazette and La Presse who published these notices in the "City Items." Before a meeting of unusual interest, the papers were telephoned and a special request for a report was made. This method of handling the publicity proved satisfactory.

Deceased Members

It is with regret that we record the following list of those members who died during the year, and wish to extend to their families the most sincere sympathy of the Branch.

Life Member

James A. Jamieson

Members

John Kershaw Ashworth	Stuart Howard
John Baylor Barnum	Howard Archibald Mackenzie
Shirley Barr	Charles Nicholas Monsarrat
Frederick Bridges	George Wyman Shearer
William Bell Cartmel	Joseph Edward Woods
Casimir Stanislas Gzowski	

Student

Flying Officer Jean A. Lalonde
(killed on active service)

NIAGARA PENINSULA BRANCH

During the year the Executive held seven business meetings and one electoral meeting.

The programme committee arranged the following professional meetings.

Jan. 31—Dinner meeting at the General Brock Hotel, Niagara Falls. An illustrated talk on **Modern Airports** was given by Wing Commander D. G. Joy, District Inspector of Civil Aviation.
Mar. 8—Meeting with ladies and friends followed by buffet lunch at the Welland House, St. Catharines, Ont. An illustrated talk on **Weather Forecasting,** by John Patterson, M.A., F.R.S.C., Controller of the Meteorological Division of the Air Service Branch, Dept. of Transport.
April 16—Dinner meeting at the Leonard Hotel, St. Catharines, Ont. The member societies of the Niagara District Technical Council listened to an interesting address and sound film on **Plastics** given by R. N. Slipp of the Plastics Department Technical Sales Service, E. I. du Pont, de Nemours & Co. Inc.
May 20—Annual Dinner meeting at the General Brock Hotel, Niagara Falls, Ont. Our President, Dr. T. H. Hogg, was chief guest and speaker and gave a few personal reminiscences of his engineering experience in this district followed by a short talk on the functioning and problems of several of the more important Institute committees. Mr. E. P. Muntz, vice-president for Ontario, also spoke on the relationship between provincial Professional Engineering Associations and The Institute.

Under the chairmanship of C. H. McL. Burns, the 1940-41 Programme Committee arranged the following two meetings.

Nov. 1—Joint dinner meeting with the Ontario Chapter of the American Society for Metals at the Leonard Hotel, St. Catharines. An illustrated lecture on **Cold Drawn Steels and their Application to Industrial purposes** was given by Thomas D. Taylor, Metallurgical Engineer, Bliss & Laughlin Inc.
Nov. 28—Dinner meeting at the General Brock Hotel, Niagara Falls, Ont. **Flame Hardening as applied to Steel and Cast Iron,** by A. K. Seeman, Research Engineer, Linde Air Products, New York. W. Duncan, Toronto, of the Dominion Oxygen Company, assisted Mr. Seeman.

OTTAWA BRANCH

During the year the Managing Committee held six meetings for the transaction of general business.

It is with deep regret that we report the deaths of ten of our members: J. B. McRae, A. G. Sabourin, J. E. Woods, H. L. Seymour, J. T. Johnston, W. H. Carson, V. I. Smart, Vincent Perrin, Lt. Col. E. C. G. Chambers, and J. T. Lawson.

As in previous years the Branch donated two sets of draughting instruments to the Ottawa Technical School for presentation as prizes for proficiency in draughting. A copy of "Machinery's Handbook" was presented to the Hull Technical School to be awarded to one of its students.

The following is a list of meetings held during 1940, with attendance figures in brackets. Unless otherwise stated, these were luncheon meetings at the Chateau Laurier.

Jan. 11—Evening meeting, National Research Council Bldg. Annual meeting, Ottawa Branch, E.I.C. **Some Pre-War Observations in Europe,** by Dr. R. W. Boyle, Director of Physics and Electrical Engineering Division, National Research Council (91).

Feb. 1—**Canada Spreads Her Wings,** by Flying Officer J. Fergus Grant, Royal Canadian Air Force (170).

Feb. 20—Evening joint meeting with the Ottawa Branch of the Canadian Institute of Mining and Metallurgy, at the Victoria Memorial Museum. Illustrated lecture, **Petroleum, the Keystone of Empire Defence,** by Dr. J. W. Broughton, National Research Laboratories, and Dr. George S. Hume, Geological Survey of Canada (140).

Mar. 7—**The Engineer in a Modern Theatre of War,** by Brigadier E. J. C. Schmidlin, M.C., Director of Engineer Services, Department of National Defence, Ottawa (132).

April 4—**The Pattullo Bridge,** by Major W. G. Swan, D.S.O., Director of Construction, War Supply Board, Ottawa. (87).

April 25—Evening meeting, National Research Council Bldg. **Metal Spraying and Its Industrial Applications,** by A. Van Winsen, National Research Laboratories. (150).

May 9—Luncheon meeting and inspection, Ottawa Technical High School (82).

Oct. 17—Evening joint meeting with the Ottawa Branch of the Canadian Institute of Mining and Metallurgy, National Research Council Bldg. Illustrated lecture, **Heat Treatment of Nickel Steel,** by Mr. H. H. Bleakney, Metallurgist, Department of National Defence. (80).

Nov. 7—**LaTuque Development and the St. Maurice River,** by J. A. McCrory, Montreal, Vice-President and Chief Engineer, The Shawinigan Engineering Company, Montreal. (100).

Nov. 21—**Development of Dual Lane Highways,** by C. A. Robbins, Toronto, District Engineer, Southern Ontario, Department of Highways of Ontario (73).

Dec. 5—**Naval Armaments,** by Captain C. S. Miller, R.N., Inspector of Naval Ordnance, British Admiralty Technical Mission, Ottawa (114).

Dec. 19—**Development of Mechanical Transport,** by Major M. M. Evans, Technical Staff Officer, Directorate of Ordnance Services, Department of National Defence, Ottawa. (61).

PETERBOROUGH BRANCH

The following meetings were held during the year. Attendance is shown in brackets.

Jan. 11—**Fundamentals of Metallic Arc Welding,** by H. Foster, Welding Specialist, Canadian General Electric Company, Peterborough (50).

Feb. 22—**Recent Developments in Concrete,** by R. A. Crysler, Canada Cement Company, Toronto (26).

Mar. 7—Junior and Student Night. Open Discussion (33).

April 4—**New Developments in Switchgear,** by B. I. Vurgess, Switchgear Engineer, Canadian General Electric Co., Peterborough (38).

May 1—**Annual meeting** and Election of Executive Committee. (40).

Oct. 19—Joint meeting of the Peterborough Branch and the Toronto Section, American Institute of Electrical Engineers. **Glass Insulation.** (109).

Nov. 20—**Annual Dinner.** Attended by the president, Dr. T. H. Hogg, and Mr. De Gaspé Beaubien (87).

Dec. 5—**Early Surveys and Land Surveyors in Peterborough,** by J. W. Pierce (33).

QUEBEC BRANCH

During the past year, the Executive Committee has held seven meetings. Eight general branch meetings were also held, they are listed below with the attendance at each given in brackets:—

Jan. 15—Luncheon meeting at the Chateau Frontenac. **La Radiodiffusion—Esquisse d'une Orientation,** by Aurele Séguin, Manager of CBV Radio Station in Quebec (30).

Feb. 12—Evening meeting at the Palais Montcalm. Films **Transport and Communications** were shown. Refreshments were served after the meeting (75).

Mar. 9—**Social Evening** held at the Quebec Winter Club for members and their wives, preceded by a dinner and followed by a dance, cards and games (126).

Mar. 18—Annual Junior Night at the Palais Montcalm. Illustrated papers, **Motor Controls and Their Applications,** by Yvon R. Tassé, Canadian General Electric Co., and **Winter Roads Maintenance in Quebec,** by Roland Lemieux, Highway Department of Quebec. Refreshments were served after the meeting (55).

April 15—Evening meeting at Laval University. Sound films, **Telephone Communications,** sponsored by The Bell Telephone Co., and a Technicolor film, **New-York World's Fair,** presented by Roger Morin of Radio station CBV, were shown. The members and their wives with guests were invited (300).

April 30—Dinner meeting at the Chateau Frontenac to welcome the President of the Institute, Dr. T. H. Hogg. Vice-President McNeely Du Bose and General Secretary L. Austin Wright, attended this meeting. Dr. Hogg spoke on **Appeal to Engineers to Co-operate fully in Wartime Work.** (45).

Nov. 25—Annual meeting and election of officers, at the Reception Hall of the Quebec Power Co. A film, **War and Warnings,** followed, and refreshments were served (40).

Dec. 16—Evening meeting at the Chateau Frontenac. **Britannia Mines,** their history, early development and present operations, by G. W. Waddington, recently appointed professor of mining engineering at Laval University (25).

It is with deep regret that we record the deaths of the following branch members:—

Edward Arthur Evans and Jos. Têtu Bertrand.

SAGUENAY BRANCH

The Branch held the following meetings during the year.

July 4—Annual meeting at the Saguenay Inn, Arvida. Reception and dinner previous to the meeting. The Branch was honoured by the presence of the President, T. H. Hogg, Vice-President E. P. Muntz and the General Secretary, L. A. Wright.

Aug. 15—Meeting at the Arvida Protestant School. **Ignitrons,** by by J. T. Thwaites of Canadian Westinghouse Company Limited, Hamilton, Ont.

Oct. 10—**The Manufacture of Alpaste in Arvida,** by E. F. Hartwick of the Aluminum Company of Canada Limited.

Nov. 14—**Water Filtration and Purification,** by Ross Watson. **The Shand Dam at Fergus, Ont.,** by Dr. H. G. Acres.

SAINT JOHN BRANCH

Ten meetings of the Executive Committee, and the following six general Branch meetings were held during the year:

Jan. 18—Annual joint dinner meeting with the Association of Professional Engineers of the Province of New Brunswick. An address on **The Place of the Engineer in the National Life** was given by President H. W. McKiel.

Feb. 15—Supper meeting. **The Oil Industry in Western Canada,** by H. G. Cochrane.

April 11—Supper meeting. **The St. Lawrence deep waterway project,** by C. H. Wright.

May 8—Annual dinner and election of officers of the Branch. Address on **Achievements of Engineering in wartime,** by T. C. Macnabb.

Aug. 29—Supper meeting. Address on the work of **The Committee on the training and welfare of the Young Engineer,** by Harry F. Bennett, its chairman.

Oct. 17—Supper meeting. Address on **Trends and Forces behind the Outbreak of the War,** by Norman A. M. Mackenzie, president of the University of New Brunswick.

Branches	Border Cities	Calgary	Cape Breton	Edmonton	Halifax	Hamilton	Kingston	Lakehead	Lethbridge	London
MEMBERSHIP										
Resident										
Hon. Members	..	..	..	..	..	..	1	..	..	..
Members	45	74	28	44	123	85	34	29	19	22
Juniors	10	14	4	11	17	16	9	2	2	4
Students	10	14	6	20	20	28	22	5	2	6
Affiliates	1	..	2	..	1	1	..	4	..	..
Total	66	101	40	75	161	130	66	40	23	32
Non-Resident										
Hon. Members	..	..	..	..	..	..	..	..	..	..
Members	17	15	17	5	62	18	4	17	9	16
Juniors	8	3	6	1	2	1	..	5	1	2
Students	6	9	6	2	8	2	..	2	7	4
Affiliates	..	..	1	..	..	..	3	..	..	..
Total	31	27	30	8	72	21	7	24	17	22
Grand Total December 31st, 1940	97	128	70	83	233	151	73	64	40	54
" December 31st, 1939	90	123	60	90	149	149	65	59	39	60
Branch Affiliates, December 31st, 1940	..	39	..	..	..	17	..	2	16	1
FINANCIAL STATEMENTS										
Balance as of December 31st, 1939	166.07	171.34	229.80	105.60	330.38	144.41	48.52	143.59	75.43	116.38
Income										
Rebates received during calendar year ①	170.85	194.52	59.20	155.48	271.55	284.23	97.71	..	100.00	129.90
Affiliate Dues	..	111.00	..	..	..	42.03	..	..	22.00	..
Interest	..	39.78	..	..	.34	52.44	..	..	.64	..
Miscellaneous	614.40	..	..	..	71.62	40.00	..	..	..	109.74
Total Income	785.25	345.30	59.20	155.48	343.51	418.70	97.71	180.66	122.64	239.64
Disbursements										
Printing, Notices, Postage ②	59.89	86.01	12.00	52.93	45.78	112.67	14.75	21.03	5.03	31.92
General Meeting Expense ③	438.70	115.20	18.43	27.80	144.40	14.00	2.25	117.30	87.66	3.00
Special Meeting Expense ④	239.24	78.90	..	11.45	91.90	118.00	6.05	..	4.55	15.60
Honorarium for Secretary	..	4.73	12.00	50.00	50.00	..	25.00	10.00	25.00	..
Stenographic Services	10.00	..	..	1.15	28.85	50.00	4.55	..	.70	10.00
Travelling Expenses ⑤	..	19.60	..	25.75	..	39.35	..	..	..	7.03
Subscriptions to other organizations	..	..	..	..	..	..	15.00	..	..	..
Subscriptions to The Journal	..	..	..	..	..	..	..	..	..	..
Special Expenses	13.65	..	..	..	65.00	..	..	..	..	..
Miscellaneous	..	6.37	5.00	3.39	3.40	48.75	..	13.05	13.80	32.80
Total Disbursements	761.48	310.81	47.43	172.47	429.33	382.77	67.50	161.38	136.74	100.35
Surplus or *Deficit*	23.77	34.49	11.77	*16.99*	*85.82*	35.93	30.11	19.28	*14.10*	139.29
Balance as of December 31, 1940	189.84	205.83	241.57	88.61	244.56	180.34	78.63	162.87	61.33	255.67

①Some of these figures differ from those published in February, 1940, because they do not include the rebates for the last quarter of 1938. In one or two cases other minor adjustments have been made in order to obtain uniformity.

②Includes general printing, meeting notices, postage, telegraph, telephone and stationery.

③Includes rental of rooms, lanterns, operators, lantern slides and other expenses.

④Includes dinners, entertainments, social functions, and so forth.

⑤Includes speakers, councillors or branch officers.

Moncton	Montreal	Niagara Peninsula	Ottawa	Peterborough	Quebec	Saguenay	Saint John	St. Maurice Valley	Saskatchewan	Sault Ste. Marie	Toronto	Vancouver	Victoria	Winnipeg
..	3	..	1	..	..	..	..	..	..	..	1	..	1	..
20	776	92	309	28	84	39	26	50	110	22	358	122	38	113
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
4	131	9	12	10	14	12	6	19	8	5	67	6	4	18
2	334	28	29	19	21	12	11	13	26	2	80	8	4	58
..	16	..	2	..	3	3	2	..	..	..	10	2	..	3
26	1260	129	353	57	122	66	45	82	144	29	516	138	47	192
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
3	46	4	56	23	12	5	23	5	43	39	13	48	9	16
4.	19	..	13	6	2	..	7	4	15	11	4	3	..	4
8	25	..	14	5	3	..	18	3	19	19	7	6	1	8
..	..	..	2	..	..	..	..	..	..	..	1	..	..	..
15	90	4	85	34	17	5	48	12	77	69	25	57	10	28
41	1350*	133	438	91	139	71	93	94	220	98	541	195	57	220
49	1298	112	403	92	130	65	93	66	195	105	543	199	63	207
4	18	13	19	8	..	..	..	..	..	14	..	..	..	6

*For voting purposes only, there should be added to Montreal Branch, an additional 309 members, 176 being resident in the United States, 99 in British possessions and 34 in foreign countries.

Moncton	Montreal	Niagara Peninsula	Ottawa	Peterborough	Quebec	Saguenay	Saint John	St. Maurice Valley	Saskatchewan	Sault Ste. Marie	Toronto	Vancouver	Victoria	Winnipeg
165.25	1,455.65	251.33	419.34	144.32	92.36	266.75	256.94	76.95	⑥	353.30	631.86	215.45	101.79	115.22
105.17	1,881.47	195.39	573.37	137.03	244.60	107.27	132.65	120.12	⑥	156.65	656.11	301.59	109.70	293.48
15.00	113.00	39.85	63.00	22.00	..	..	..	..	⑥	24.00	..	..	3.00	35.00
2.08	5.27	..	44.61	.91	.25	.97	..	..	⑥	.85	9.91	.78	..	22.50
..	709.43	42.05	365.75	4.05	288.75	..	1.25	35.00	⑥	109.00	290.68	..	..	45.52
122.25	2,709.17	277.29	1,046.73	163.99	533.60	108.74	133.90	155.12	⑥	290.50	956.70	302.37	112.70	396.50
7.53	773.26	..	127.33	46.27	61.00	22.03	49.23	24.42	⑥	23.57	213.55	95.52	43.67	96.28
26.56	217.52	69.04	606.55	32.00	32.91	71.07	6.90	67.81	⑥	144.92	..	119.95	.72	54.66
..	724.96	43.35	25.00	40.71	319.56	..	9.31	46.23	⑥	43.20	169.95	..	30.35	50.90
25.00	300.00	75.00	..	..	100.00	..	25.00	..	⑥	25.00	100.00	50.00	25.00	25.00
10.00	120.00	..	20.00	..	..	..	7.50	5.00	⑥	1.00	..	20.00	8.45	20.00
..	154.92	..	..	..	..	..	..	3.00	⑥	..	..	..	..	..
..	..	..	..	..	..	..	..	..	⑥	..	15.00	..	..	..
8.00	30.00	..	6.00	8.00	..	..	..	..	⑥	10.00	..	..	..	11.00
..	99.77	..	22.25	..	10.00	..	..	..	⑥	..	85.10	..	..	29.00
4.02	55.93	15.79	86.18	14.74	2.83	3.00	10.69	.98	⑥	4.00	42.11	39.42	..	10.06
81.11	2,476.36	203.28	893.31	141.72	526.30	96.10	108.63	147.44	⑥	251.69	625.71	324.89	108.19	296.90
41.14	232.81	74.01	153.42	22.27	7.30	12.64	25.27	7.63	⑥	38.81	330.99	*25.52*	9.51	99.60
206.39	1,688.27	325.34	572.76	166.59	99.66	279.39	282.31	84.63	⑥	574.11	959.85	192.93	106.30	214.82

⑥Because of recent changes in officers, due to enlistment, it was not possible to secure these figures at the time of going to press.

SASKATCHEWAN BRANCH

As in the past several years all meetings, except the annual meeting, were held jointly with the Association of Professional Engineers of Saskatchewan and the local section of the American Institute of Electrical Engineers. The programme for the year was as follows:

Jan. 22—**Nature Appreciation,** an illustrated address by S. G. Bard, Field Collector, Provincial Museum.

Feb. 16—Annual meeting held jointly with the Association of Professional Engineers.

Mar. 15—**The Development of the Combustion Chamber of the Internal Combustion Engine,** by Professor E. A. Hardy, University of Saskatchewan.

April 15—**The Middle East and the War,** by M. A. MacPherson, K.C.

Nov. 16—**Ceramics and Ceramic Engineering,** by Professor W. G. Worcester, University of Saskatchewan.

Dec. 20—**Airport Construction in Saskatchewan,** by G. T. Chillcott, District Airway Engineer, Department of Transport.

The average attendance at these meetings was fifty-seven.

SAULT STE. MARIE BRANCH

The Executive Committee met on January 9th, and appointed standing committees. The committees and the chairmen are as follows:—

Papers and Publicity	J. S. MacLeod
Entertainment	J. L. Lang
Membership	C. Stenbol
Legislation and Remuneration	F. Smallwood

The Executive Committee met eight times during the year to discuss and promote the activities of the Branch and Institute.

Eight dinner meetings were held during the year. The average attendance was 23 members and guests. The meetings were held at no set time during the month, but were arranged to suit the convenience of the speakers.

Programmes of the meetings held were as follows:—

Jan. 26—**Modern Aircraft Development,** by George Ponsford, Director of the Ontario Provincial Air Service.

Feb. 23—**The Technique of Fruit Growing,** by A. G. Clarkson.

Mar. 15—Illustrated address on the **History of the Development of the Telephone,** by G. L. Long, Historian of the Bell Telephone Company.

April 26—**Mining and Beneficiation of Siderite at the Helen Mine,** by G. W. MacLeod.

Sept. 27—**The Manufacture of High Explosive Shells,** by Carl Stenbol.

Nov. 1—**The Fauna and Flora of Algoma,** by Paul P. Martin, Chairman, Algoma Travel Bureau.

Nov. 22—**War Time Communications,** by G. L. Long, Historian of the Bell Telephone Company.

Dec. 20—**Annual meeting** for 1940.

The Executive Committee regrets the loss through change of address of a number of active members of the Branch. The following have moved from the Branch: H. J. Leitch, Chairman of the Branch, A. G. Clarkson, F. A. Masse, and C. W. Holman, also R. J. Merritt, S.E.I.C.

ST. MAURICE VALLEY

The Branch held the following meetings during the year, and the attendances are shown in brackets.

Feb. 16—Meeting at the Cascade Inn, Shawinigan Falls. **Chromium in Steel,** by C. K. Lockwood of the Shawinigan Chemicals Limited, Montreal (40).

Mar. 5—Annual meeting of the Branch at the Laurentide Club, Grand'Mère. Reception and dinner previous to the meeting. The guest speaker was the General Secretary, Mr. L. A. Wright, who spoke on Institute activities (22).

May 1—Dinner meeting at the Chateau de Blois, Three Rivers, to welcome the President of the Institute on his official visit. The President was accompanied by Councillor A. Larivière and Mr. H. Cimon from Quebec and the General Secretary, L. A. Wright.

TORONTO BRANCH

The annual meeting of the Branch was held at the Granite Club on Thursday, April 18th, 1940. This change of meeting place evidently met with the approval of the 110 who were present.

The meeting was preceded by a dinner at 7 p.m. Among those present were Dr. T. H. Hogg, president of the Institute; E. P. Muntz, vice-president, Zone B; J. A. Vance, councillor, London Branch; A. R. Hannaford, secretary-treasurer, Hamilton Branch; Alexander Love, chairman, Hamilton Branch; D. G. Geiger, representing the A.I.E.E.; Bruce H. Wright, representing the Ontario Association of Architects and E. L. Cousins, speaker of the evening.

During the past year the Executive Committee has held twelve meetings with an average attendance of nine.

Regular meetings during the year are listed below with attendance given in brackets.

Jan. 18—Annual Students' night. **Wind Bracing,** by S. J. Simons; **The Rehabilitation of Flooded Generators,** by D. R. B. McArthur; **Aerodrome Construction,** by D. E. Kennedy; **Some Aspects of Depreciation,** by E. E. Hart; **Salvage,** by J. P. Stirling; **Science and War,** by B. Etkin (50).

Feb. 1—**Intercommunication in the Army,** by Lieut. Col. E. G. Weeks (75).

Feb. 8-9—Annual General and Professional meeting.

Feb. 22—**The Limestone and Lime Industry of the Thames River Valley,** by S. R. Frost (25).

Mar. 7—**Modern Sanitation and Water Supply Practice,** by William Storrie, and Dr. A. E. Berry (55).

Mar. 21—**Insulating, Heating and Air Conditioning of Buildings,** by Professor E. A. Allcut (50).

April 4—**Activities of the National Research Council in Relation to the War,** by C. J. Mackenzie (55).

April 18—Annual Branch Meeting (110).

Oct. 17—**The Bright Path, Wiring the Wilderness, Dancing Conductors,** films shown by courtesy of the Hydro Electric Power Commission of Ontario.

Nov. 7—**Modern Boiler Equipment,** by W. A. Osbourne (85).

Nov. 21—**Modern Problems in Highway Construction,** by Charles M. Baskin (25).

Dec. 5—**Man Power,** by McNeely DuBose (60).

Previous to each regular meeting, dinners have been held in Hart House. These have been well attended and enjoyed by all who have availed themselves of the opportunity to attend.

The highlight of the year just passed was the Annual General and Professional Meeting which was held in the Royal York Hotel on February 8-9th. The General Chairman was Dr. A. E. Berry, and the Chairman of the Papers Committee was Prof. C. R. Young, who undertook a gigantic task and carried it through with the appreciation of all those who were fortunate enough to be present. There was a total registration of 489 members, 200 of these being from out of town.

It is with deep regret that we record the death of the following members of the Branch during the year: R. A. Baldwin, W. P. Chapman, Lieut. Col. Duncan MacPherson, H. T. Routly and E. M. Salter. Sincere sympathy is extended to their families in their loss.

VANCOUVER BRANCH

Activities were well maintained by the Vancouver Branch during the year just closed. During the year twelve well attended meetings were held—two luncheon and ten evening functions. A particularly interesting meeting was held on May 27 when addresses were given by Lt. Col. L. E. Atkins and Capt. Arthur Trudeau of the Seattle office of the United States Army Engineers.

In July the Branch was honoured with a visit from the General Secretary of the Institute, Mr. L. Austin Wright. During his stay Mr. Wright met many of the members of the Institute as well as the executives of branches of sister organizations in the province.

The members of the Vancouver Branch have answered loyally to the call for officers in the Canadian Active Service Force. Seventeen members are recorded as being on active service at the present time.

An itemized list of meetings held during the year is appended hereto. The total membership of the Branch is now 192.

Jan. 29—Luncheon meeting. **Activities of the War Supply Board,** by Major W. G. Swan, Director of Construction, War Supply Board, Ottawa.

Feb. 19—**Pressures in Earth Fills,** by H. N. Macpherson.

Mar. 11—**The Organization of the Royal Canadian Air Force,** Address by Squadron Leader L. E. Wray, R.C.A.F. Station, Vancouver.

Mar. 27—**The Development of Roller Chain Driving,** by Stanley Morton, A.M.I.MECH.E., B.C. Manager, Renold Coventry Co. Ltd.

April 12—**The Design and Construction of Modern Airport Runways,** an illustrated address by Norman W. McLeod, of the Department of Asphalt Technology, Imperial Oil Ltd., Sarnia.

May 27—**The White River Flood Control Project and the Mud Mountain Dam,** an illustrated address by Lieut. Col. Layson E. Atkins, District Engineer, U.S. Army (Seattle District), and Captain Arthur G. Trudeau, Chief of Construction Division.

Sept. 30—**Regulation of Public Utilities,** by W. A. Carrothers, Chairman, Public Utilities Commission for the Province of British Columbia.

Oct. 23—**The King George VI Highway,** an address by Ernest Smith, Assistant District Engineer, Provincial Department of Public Works, New Westminster, and W. P. Beavan, Surfacing Engineer, Provincial Department of Public Works, New Westminster.

Nov. 4—**The Growth and Structure of Wood,** illustrated lecture by J. B. Alexander, M,SC., Chief of the Division of Timber Mechanics, Forest Products Laboratory, Department of Mines and Resources, Vancouver.

Nov. 23—Annual dinner meeting. **The B.C. Lumber Industry Marches with the Troops,** by J. G. Robson.

Dec. 16—Dinner in honour of the Institute President. The meeting was addressed by Dr. Hogg, Dr. Lefebvre, Mr. Vance and Mr. L. Austin Wright.

VICTORIA BRANCH

During the year seven general meetings of the Branch were held, six of them being dinner meetings and one a luncheon meeting, with an average attendance of 25, which reflects considerable revival of interest among the membership.

The list of meetings together with addresses and the speakers during the year 1940 is as follows:—

Jan. 19—Dinner and Annual Meeting. **Brothers of the Bridge,** by A. L. Carruthers, Bridge Engineer, Provincial Department of Public Works.

April 12—Dinner meeting. **A Tour through Europe,** coloured motion pictures, by Norman Yarrow, Works Manager, Yarrows Ltd., Victoria, B.C.

April 18—Dinner meeting. **Design and Construction of Modern Airport Runways,** by Dr. Norman McLeod of the Asphalt Division of the Imperial Oil Co., Calgary, Alta.

July 15—Luncheon meeting. The General Secretary, Mr. L. Austin Wright, spoke to the Branch on the British Engineer's Children Evacuee situation.

Oct. 22—Dinner meeting. **Fuel and Our Use of It,** by Kenneth Moodie, Engineer, Provincial Architect's Office, Victoria.

Nov. 29—Dinner meeting. **Public Utilities Regulations,** by J. C. MacDonald, Engineer, and S. R. Weston, Chief Engineer, B.C. Public Utilities Commission.

Dec. 17—Dinner meeting. Visit of Past President Dr. O. O. Lefebvre, J. A. Vance, and the General Secretary, on the occasion of the President's tour of the western branches.

Three meetings of the executive committee were held to deal with business relating to the Branch and Institute headquarters.

Membership

As was the case in the previous year there were several transfers of branch members to and from other branches, and a number of members of our Branch have gone overseas. In all, ten transfers were made to the Branch and twelve transfers away.

WINNIPEG BRANCH

The Executive Committee held thirteen regular and three special meetings during the year. Nine general meetings were held under the joint auspices of the Winnipeg Branch and the Association of Professional Engineers of the Province of Manitoba, continuing an arrangement entered into in 1938, in which all general meetings except the annual meeting and any special meetings were to be held jointly. The annual meeting was held on February 1st.

In addition to the above the Branch was honoured by a visit by Dr. Hogg on December 11th, at which time the Branch held a special general meeting. Dr. Hogg was accompanied by Councillor J. Vance of Woodstock, Ontario, and L. Austin Wright, the General Secretary. The next day Mr. O. O. Lefebvre, a past president, also arrived, and the Executive and members of past executives gave a luncheon in honour of Dr. Hogg and the party from Headquarters.

The papers presented are listed below, the attendance for each meeting being shown in brackets.

Jan. 25—**Modern Weather Forecasting,** by Dr. Donald C. Archibald, of the Meteorological Division of the Department of Transport (102).

Feb. 22—**Unlocking Canada's Treasure Trove.** Sound pictures by courtesy of the Department of Mines and Natural Resources. Introduced by G. E. Cole (104).

Mar. 7—**Plastics,** by Prof. H. Saunderson, University of Manitoba. (87).

Mar. 21—**Teletypewriter Systems and some Applications,** by J. Granich, Printer Telegraph Supervision C.P.R. Communications (59).

April 4—**The Design and Construction of Modern Airport Runways,** by Dr. N. W. McLeod, Department of Asphalt Technology, Imperial Oil Company, Sarnia Ont. (145).

April 18—**Arc Welding, its Development and Progress,** by Professor W. F. Riddell, University of Manitoba (71).

Oct. 17—**Gas, Coke and Allied Subjects,** by A. H. Harris, Jr., Manager of Gas Utility, Winnipeg Electric Company (56).

Nov. 7—Visit to the Sugar Beet Plant of the Manitoba Sugar Company, under the auspices of Messrs. Fosness and Hrudka.

Nov. 21—**Broadcast Networks in Canada,** by V. C. Jones, District Engineer, Communications Department, C.P.R. (60).

Abstracts of Current Literature

Abstracts of articles appearing in the current technical periodicals

THE PERFORMANCE OF MODERN AIRCRAFT DIESELS

By Paul H. Wilkinson, *S.A.E. Journal*, November, 1940

Abstracted by L. M. Arkley, M.E.I.C.

In 1939, actuated by the conflicting reports in regard to the status of the Diesel engine in aircraft, Paul H. Wilkinson, consulting engineer of New York, set out to find something on the subject first-hand.

He visited Germany and investigated such plants as the Junkers and the B.M.W. engine factories and the Dornier works where Diesel-engined flying boats are built, the repair shops of Deutsche Lufthansa where the Diesels used in their airlines are serviced and he also talked with Dr. Schmidt in his laboratory. Besides Dr. Schmidt, he met (in Germany) such experts as Mr. Achterberg, Dr. Schwager and Mr. Lang.

In France he met Messrs. Clerget, Coatalen, Jalbert and others interested in this work.

In England he visited the Bristol and Napier engine factories and talked with many people interested in Diesels including the well known Dr. Fedden. Recently he spent some time at the N.A.C.A. engine laboratory at Langley field where a comprehensive Diesel development programme is under way.

The author describes and shows photographs of many engines such as—

(a) The Jumo 205, developing 880 hp., for take off and weighing only 1.43 lb. per hp.

(b) The Junkers Jumo 207 equipped with turbo-supercharger, developing 1,000 hp. for take-off and this output is maintained at altitudes of 20,0C0 ft., weight per hp. of 1.43 lb., including supercharger and a b.m.e.p. of 131 lb. per sq. in. The specific fuel consumption of these engines is 0.35 lb. per hp. hr. at cruising speed.

(c) The 16-cyl. water cooled Clerget, operating on the four stroke cycle (built in France) is equipped with four Rateau turbo-superchargers, and is designed to develop 2,000 hp. at 2,200 r.p.m., altitude 16,000 ft., specific weight 1.87 lb. per hp., with b.m.e.p. of 145 lb. per sq. in.

The above gives an idea of the kind of information appearing in the paper and there are tables such as the following giving interesting comparisons.

Make & Model	Junkers Jumo 207	Allison V 1710 C6	Rolls-Royce Merlin X	Hispano-Suiza 12Y
Type	Diesel	Gasoline	Gasoline	Gasoline
Cooling	Water	Ethylene Glycol	Ethylene Glycol	Water
Number of cylinders	12	12	12	12
Total displacement	1014 cu. in.	1710 cu. in.	1647 cu. in.	2197 cu. in.
Maximum horse power	1000	1000	1010	1200
R.p.m.	3000	2600	3000	2600
Output, hp. per cu. in.	0.99	0.58	0.61	0.55
Weight of engine, lb.	1430	1280	1394	1080
Specific wt., lb. per hp.	1.43	1.28	1.38	0.90
Fuel Consumption (ratio), lb. per hp-hr.	0.38	0.58	0.66	0 55
As above for cruising	0.35	0.46(E)	0.53(E)	0 44(E)
Bmep. lb. per sq. in.	1.31	1.77	1.61	1 67
Rated altitude	20,000	12,000(E)	17,500	11,500

(E)—Estimated figures.

Judging from the data compiled, the author believes that the Diesel, on the whole is better than the gasoline driven unit for airplane work.

He gives the advantages of the Diesel as follows (1) reduced fire hazard; (2) low fuel operating cost; (3) large pay load and flight range possibilities; (4) reliability; (5) efficiency.

Diesel Fuel

Commenting on the above he says that Diesel fuel is safer than gasoline because it does not give off inflammable vapours at atmospheric temperature and it has a higher flash point. There has yet to be recorded a fire on a Diesel-engined airplane where the fuel ignited and burned.

Low Operating Cost

According to the author combining the lower specific cost of the Diesel with the lower specific fuel consumption gives a final figure much in favour of the Diesel.

Reliability

Ninety long non-stop flights over the South Atlantic (1900 miles) and 48-2,400 mile trips over the North Atlantic completed by the Diesel-engined planes of the Deutsch Lufthansa are cited as an example of reliability. In another table, mileage and time of operation are given for each year from 1931 to 1938 as total mileage flown of 4,243,895 with 69,967 flying hours.

In the discussion following the presentation of the paper, which gives a rather rosy picture of the Diesel compared with the more commonly used gasoline engine, Mr. Robert Insley of the Pratt & Whitney Aircraft Corporation, and Mr. A. L. Beall and Mr. Nutt of the Wright Aeronautical Corporation all pay their respects to Mr. Wilkinson; the general trend of their remarks tend to discredit many statements appearing in the paper. A few important points brought out in the paper are first the limiting of the fire hazard because the Diesel needs no electric spark for ignition and uses a fuel which will not readily take fire and burn under atmospheric conditions but it must be remembered here that the ordinary Diesel fuel oil used is not suitable for airplane work; it must be refined which brings its cost to near the gasoline figure.

The second point noted is the comparatively low specific weight value for Diesels of about 1.43 lb., and along with this is the low specific fuel consumption of 0.38 lb. per hp. hr.

On the whole the paper is a painstaking effort and is well worth reading.

WAR-TIME FACTORIES

From *Trade & Engineering* (London), December, 1940

Valuable hints on the design of single-storey war-time factories, based on experience of the effects of bombing, are given in Bulletin No. C. 12, issued by the Research and Experiments Department of the Ministry of Home Security.

After pointing out that the object of air attack is to paralyze production, the Bulletin states that war-time designers can do much to make factories highly resistant to collapse and difficult to fire, while damage can be localized, and the steadiness of the workers reinforced by giving them cover at hand. The intelligent development of the design methods advocated is regarded as an important counter in maintaining production despite air attack.

So far more steelwork has been destroyed by fire than by high explosives. The simplest way of minimizing fire damage is to limit the combustible materials in the factory. In the roof timber purlins or any form of slates or tiles on boarding should not on any account be used.

The tendency towards very large buildings should be reversed. Even in a small building, the explosions will to some extent be confined by the walls and roof, and adjacent buildings will be relatively undamaged.

By far the most common type of factory for war-time production is the single-story building, and the first principle in its design is that all loads should be carried by a framework of steel or reinforced concrete. Load bearing walls are dangerous. Where reinforced concrete is used the most satisfactory way of minimizing damage is to divide the framework into as many discontinuous units as possible, thus localizing any collapse that may occur.

The second principle is that the steel frame should resist collapse notwithstanding the sudden removal of any one main member. This is not so rigorous as it sounds. Near the explosion, the load is generally relieved by the roof covering being blown away, and there have been a number of cases where direct hits have severed either the rafter or the main tie of a steel roof truss without even producing a measurable sag.

The chief risk to roof steelwork arises from the violent displacement of a stanchion foundation, and the consequent shearing of the stanchion cap connection, leading to collapse of roof trusses. This risk is eliminated if two simple precautions are taken. The cap connection of the stanchion to the roof member should be made stronger than is usual in order that it shall not be sheared off even if the stanchion base is shifted 4 or 5 inches by a near miss. This precaution is particularly necessary in the case of trusses or beams framing into external stanchions. In addition to the effects of ground movement such stanchions are liable to be subjected to a considerable horizontal blast pressure applied to them by whatever wall construction is adopted. Provided their cap connections are adequate, however, the worst effect of this blast will be to bow out the stanchions without causing any major damage or collapse. In addition, the roof girder or valley beam should be spliced so as to be continuous. This will ensure that, even if a stanchion is destroyed, the valley beam is adequate to carry the dead load only of the roof (without the sheeting) over two bays. These precautions will not serve if two adjacent stanchions are destroyed, and a stanchion spacing of at least 30 ft. each way is desirable to prevent this.

The external walls of a war-time factory should be regarded as simply protective screens against weather and bomb fragments. Panels and sheeting should be so designed that blast damage shall not be transmitted by them to the framing. To ensure that the sheeting shall blow in harmlessly it should be of asbestos-cement or other brittle material, with anti-scatter protection by means of wire or sisal netting, which may be of large mesh, securely fixed to the steel framing behind the sheeting. The use of corrugated steel sheeting is not recommended for walls, as although it will blow out harmlessly from a hit inside the building, it is liable to cause considerable buckling of the steelworks under the effects of a near miss outside the building.

The use of lightweight internal partitions to sub-divide a factory should be avoided. Such partitions are particularly liable to blast damage and if glazed or sheeted with a brittle material they are a serious source of danger to personnel. Substantial internal partitions, however, can be designed to afford a considerable measure of protection. If they are built the full height of the shop they will provide useful fire stops and may limit blast damage to the roof. They should be framed in steel or reinforced concrete independent of the main structure.

The little evidence so far available on the behaviour under the effects of direct hits and near misses of flat roofs incorporating monitor lights and giving overhead protection by a 4 in. reinforced concrete slab indicates that they should afford considerable protection to the factory from debris thrown up from bomb craters. They may even give some protection to plant against the effects of those light bombs which, being instantaneously fused, explode when they strike the roof. Such a bomb would merely blow a hole about 5 ft. square in the roof with relatively little damage to the interior of the factory.

The effect of a large bomb exploding inside a factory is however, likely to be much more serious. The reinforced concrete roof slabs will undoubtedly be lifted over a fairly wide area. It is possible that they may also be displaced slightly and fall back into the shop instead of upon the supporting steelwork. Should this occur the roof slabs would do even more damage than the bomb, and this eventuality must be guarded against at all costs. The best safeguard would be to anchor the slabs to the steel framework. Such anchorage need not be of any great strength, but it should be designed to withstand an upright pressure on the roof of at least 100 lb. per sq. ft. Alternatively the slabs may be linked together. A saving of steel could be effected if the slabs were designed to be continuous, such continuity being provided by additional top reinforcement placed in position and grouted in after the slabs are erected.

Roofs being less subject to external blast from a near miss than are walls, the objection to the use of corrugated steel for walls does not apply to sheeted roofs, for which it is the ideal covering. The area of sheeting likely to be destroyed by a direct hit is about fifteen times as great for asbestos cement as for corrugated iron. The resistance of asbestos cement sheeting to blast can be considerably increased by reinforcing it, preferably with light-gauge sheet steel. Such sheeting reinforced with fabric tape has a considerably greater resistance to impact loads than unreinforced sheeting.

Insulating board lining under sheeted roofs should on no account be used. Under a direct hit such a lining does not save the roof sheeting and causes extensive damage to the roof steelwork. Unlined roof sheeting fixed in the usual way is capable of being blown off without damage to the steelwork. The presence of the lining, however, results in an excessive uplift being applied to the steelwork and may cause very extensive damage to it.

PULLING UP TRACK AT TEN BLOCKS AN HOUR

From *Transit Journal* (Albany, N.Y.) December, 1940

Removal of rails from the abandoned tracks of the Lafayette Street Railway was greatly facilitated by a machine designed and built by R. L. Shambaugh of Lafayette. The work was accomplished without first taking up the paving, and the ties were not disturbed, so that the street surface could be restored with the least disturbance.

The machine used consists of an A-shaped frame made up of steel beams. The channels which form the uprights have holes drilled at regular intervals for adjusting the height of the boom of a truck-mounted crane. The base, which is of built-up members, is attached at one end to the crane truck. To start the removal of a rail the paving is removed adjacent to a joint and the crane pulley attached by means of the crane tongs. As soon as the rail end has been lifted high enough a nickel-steel roller is inserted below it across the frame. The entire structure is then pulled along the street by the crane truck, a second truck being hitched in front to give extra traction. Since the frame is pressed against the pavement by the rail itself the disturbance is limited to the area immediately adjacent to the rail.

The machine was used in Lafayette on streets paved with brick and with black-top asphalt. Some of the rails were set in concrete 2 by 4 in. thick. Rails and spikes were pulled out as the machine moved along, leaving a ribbon of twisted steel ready to be cut up and hauled away. On an asphalt paved street, nearly ten blocks were removed in an hour. Finally, concrete was poured into the trench formed and the paving completed with asphalt.

STEAM FOR AEROPLANE PROPULSION

From *Trade and Engineering* (London) December, 1940

A London engineer visualizes the day when British aircraft will be powered by a new type of steam generator which he has invented. He may or may not live to see that day dawn—for he is 75 years old—but at any rate he has produced a model which works quite efficiently and conjures up all sorts of possibilities for the future of British aviation.

Much remains to be done on the invention, for as yet it is not certain that the device can be adapted for use in aircraft, though the inventor, Mr. Ernest Clarkson, is convinced it can be. A steam-driven aero-engine would obviously contain a great number of advantages, perhaps the most important of which is its silence. A night bomber equipped with such an engine would be extremely difficult to find. All the sound locators in the world would fail to pick it up, and unless there are developments which end for all time the problem of night interception it would be all Lombard Street to a China orange that it would be able to locate and bomb its target and return home without being seen by an enemy fighter.

The new idea upon which Mr. Clarkson worked was one which required both an unusually small steam generator and a very small quantity of water. The plan was not to boil water in the mass in boiler tubes but to apply a combination of spraying water into the tubes and impregnating it with an absorbent material which was kept at such a heat that the moisture evaporated immediately. In his first simple model Mr. Clarkson derived the heat from a Bunsen burner. The engine worked most efficiently. Starting from cold, it was turning over in 20 seconds and continued to run with a good output of power until its small supply of water was finished. The energy developed by a "boiler" only three-quarters the capacity of the cylinder was surprising.

Encouraged by the results obtained from this tiny model Mr. Clarkson constructed a bigger model, worked on rather different lines, but with the same basic principle. At one end he fixed a blow-lamp working on paraffin oil. This directed heat towards six straight copper tubes about 8 in. in length. Inside these tubes were much smaller ones, with tiny holes bored at intervals along the length. Between the two tubes he placed a lining of his secret metal substance. Underneath, he placed a brass tank with a water capacity of one quart, the water being pumped into two chambers—one for steam and the other for water. As soon as the outer copper tubes became really hot the water was sprayed through the holes in the inner tube upon the hot metal and was immediately converted into steam. The outlet of steam from the generator to the engine he controlled by means of a stop-cock or regulator. With this model he had expected to get a pressure of 200 lb. He not only obtained it but actually broke one of the 200 lb. gauges.

Mr. Clarkson believes that if the idea were developed for use in aeroplanes the engine could be driven by crude oil. He claims that the generator will work in any position, and indeed, after seeing it, there seems no reason why it should not. If the generator was adopted for use in aircraft, the copper tubes could be reinforced on the outside by steel tubes, and the whole of the tube area could be encased in asbestos or other covering, thus both conserving the heat inside and preventing it from getting into the aircraft itself outside.

NATIONAL DEFENCE SURVEY

From *Journal of the Institution of Engineers*, (Australia), August, 1940

A survey of the engineering profession for purposes of national defence was conducted in 1939 and immediately after the receipt of the returns from individual members, a preliminary classification was carried out. This classification was on a broad basis, the returns being grouped under nine convenient major headings. Although this grouping had a specific usefulness, it did not afford a ready selection of, say, the members who had had experience in, or were engaged on any particular type of work, without examining a large number of returns under one or more of the major headings. For this reason a more detailed classification was considered to be necessary and this has been undertaken by a group of members of the Sydney Division.

The returns received as the result of the original survey, together with those filed subsequently, have been re-classified, every important particular given on each return being indicated by a code number. Each return has been coded and the particulars recorded on cards punched to correspond with the coding of each particular return. In the event of a member having experience in more than one branch of engineering, a separate card has been made for each branch. By the use of a sorting machine, which has been made available for the use of The Institution, members with any particular qualifications can be determined very rapidly. A selection of the most suitable man can then be made by reference to the original returns and as the numbers of returns necessary to be examined has been greatly reduced, the survey should prove of greater use to the authorities.

The system of classification provides for 14 main headings but each of these is sub-divided into a number of special classes, the whole scheme permitting of the most precise selection. Its extension to the records of other Divisions has been recommended.

The classification, however, will be complete only when returns have been received from 100 per cent. of the membership of The Institution. This cannot be achieved without the personal co-operation of those concerned. The necessary forms will be made available on application.

MODERNIZATION OF WATERLOO AND CITY RAILWAY

From *The Engineer* (London) November 15, 1940

The first stage of the modernization of the Southern Railway's line between Waterloo Station and the Bank—the Waterloo and City Railway—has now been completed. The new arrangements were brought into operation on October 28th.

The new rolling stock now running on the line has been designed to obtain the maximum amount of seating capacity consistent with comfort, and also allows for a very much greater standing space than in the old rolling stock. Twenty-eight new coaches are being supplied—twelve motor coaches and sixteen trailer coaches. They will seat 1,312 passengers and will be formed into five five-coach trains, each consisting of two motor coaches and three trailer coaches. The remaining two motor coaches and one trailer coach are spares for maintenance, etc. During the busy hours five-coach trains will be run with accommodation for 600 passengers, and during the slack hours the service will be maintained by motor coaches detached from the five-coach trains. The control equipment is of the most modern design and is similar to and largely interchangeable with the equipments used on the latest suburban and express units of the Southern Railway. The coaches are provided with electrically controlled, air-operated doors, so that the guard is able to control all the doors on a train from one position. A tunnel telephone hand set is carried in each driving cab for use in emergency, and can be clipped to bare wires run the length of each tunnel. The clipping of the telephone to the wires automatically cuts off the current in the tunnel concerned and places the motorman in communication with the electric supply sub-station.

It has not been possible to introduce the new stock gradually as part of the improvement of this railway has been the moving of the conductor rail from its original position centrally between the running rails to the standard position laid down by the Ministry of Transport, i.e., 16 in. outside the running rail. As many as 6,445 yards of new conductor rail have been laid. The standard arrangement of conductor rails incidentally enabled the Waterloo and City trains to be tested on the surface lines of the Southern Railway.

In order to reduce noise to a minimum, the running rails have been welded into 315 ft. lengths, involving 544 welded joints. Noise absorbing shields will also be experimented with after the new rolling stock has been brought into use. These shields will be fitted between the lower portion of the coaches and the tunnel walls. New lighting in the tunnels has been installed on a semi-automatic principle, and colour-light signalling has been introduced. Tickets are no longer issued on the trains, as four automatic ticket-issuing machines have been provided at each station, as well as three booking offices at Waterloo and one at the Bank station.

Powers have been obtained for the construction of escalators at Bank Station, and a low-level subway giving direct access to the London Passenger Transport Board Central London Line; but, owing to the war, this section of the work has been deferred.

The Waterloo and City Railway is only 1 mile 46 chains long. The line was opened in August, 1898, and it carries an average of 30,000 passengers daily, most of them, of course, during the business rush hours.

DISPATCHER ON THE AIR

From *Transit Journal* (Albany, N.Y.) December, 1940

Realizing that time is becoming increasingly important in all aspects of transit operation, the Brooklyn & Queens Transit division of the New York City Transit System has streamlined its dispatching system through the establishment of two-way radio communication.

The Brooklyn & Queens surface system serves an area approximately 8 by 16 miles, using about 1,235 street cars and 300 buses. In addition to a headway recorder system for checking the passage of cars at various control points, about 175 street supervisors are used, some being assigned to twenty Chevrolet radio patrol cars.

Each car is handled by one man and carries fuses, cable, a 10-ton jack and other equipment, enabling the patrol inspector to handle almost any emergency from equipment repair to the removal of heavy traffic obstructions. Patrol districts include both street car and bus routes, and are divided on a basis of amount of work involved. Inspectors are men of long experience; they work on nine-hour shifts.

Ten of the patrol cars are equipped with 15-watt transmitters and receiving sets, both similar to those used on police patrol vehicles; the other ten cars have receivers only. In addition, receiving sets are installed on four heavy emergency trucks, on two lines department automobiles and on two autos of the surface track department. Two-way installation on only half of the cruisers was intended to provide a test of the real need for two-way talk. Four months' operation indicates that the need for two-way equipment is vital, because when the dispatcher calls a one-way car he either "sits on a hot seat" until he gets a clearance over the telephone, or makes an additional call to a nearby two-way cruiser to get an immediate answer, with the result that two-way cruisers get two to three times more work to do.

The dispatching radio equipment, furnished by Westinghouse Electric & Manufacturing Company, consists of a 50-watt central transmitter, remote control equipment in the dispatcher's office and four remote receivers spaced to pick up talk from the 15-watt transmitters on the patrol cars. The central transmitter is located at emergency headquarters approximately in the heart of the system. Its antenna is mounted on top of the building and rises 240 ft. above street level. Although low in power, the transmitter has given adequate coverage of the entire area, and system officials are quite satisfied with the results, though they had been warned it might not be sufficient to do the job. Experience indicates a minimum of "shadowed" area (where reception is difficult) and that most of these could not be materially reduced even with a considerably more powerful transmitter.

BOMBER VS. BATTLESHIP

From *Trade & Engineering* (London) December, 1940

The Attack at Taranto

The great success last month of the torpedo and bomb attack by aircarft of the Fleet Air Arm against units of the Italian Navy as they lay at anchor in Taranto harbour has revived once more the old controversy of the bomber versus battleship. This controversy raged for years before the war, and no satisfactory decision was ever arrived at. Those whose life had been spent in the Navy were firmly convinced that the battleship would always be able to hold its own; those who knew how devastating a bomb, delivered accurately from an aircraft, could be, were equally convinced that the ship would suffer severe damage if it did not sink altogether.

The first year of war would appear to have shown that each side was right to a certain extent. There have been cases of capital ships being hit and suffering little damage; there have been others of a bomb sending the ship to the bottom. It is certainly clear that smaller warships, such as destroyers, cannot hope to be any match for a bomber. About the effect of a torpedo delivered from an aeroplane there has never been much controversy. It was obvious that if only the torpedo-carrier could get into position the torpedo would destroy its target. The only doubt was whether the attacking aricraft would be able to live through the hail of fire which would be sent up by the ships.

Torpedoes dropped from the air are of the usual naval type, but slightly modified to enable them to be carried by a bomber. But the technique of a torpedo attack is entirely different from that of bombing. Bombs can be discharged against a ship either in a dive or in the orthodox manner, and from any height, although a ship is notoriously a most difficult target to hit if it is on the move. In this case the ships at Taranto were in harbour, and constituted an ideal objective.

To attack an objective with a torpedo is a hazardous task, for, carrying this weighty and cumbersome cargo, an aircraft cannot adopt evasive tactics, but must fly in a straight line. It must also come down to a height considerably less than 100 ft. and is consequently exposed to the fire of the light anti-aircraft guns with which all warships are equipped. Once it has been "fired" from the aircraft the torpedo moves forward under its own power, as it does after being fired from a submarine or destroyer.

The success of the Fleet Air Arm in this action has demonstrated the necessity of having ship-borne aircraft with every unit of the Fleet. Italy does not possess a single aircraft-carrier, and, before the war in the Mediterranean is over, she will no doubt have good cause to regret it. Had she possessed Fleet fighters, the Italians would no doubt have been able to minimize the effects of the raid. As it was, she had to rely entirely on the light guns on the ships, and they were able to bring down only two of the attackers. Aircraft-carriers are admittedly very vulnerable to attack from the air, but the Fleet Air Arm is now equipped with such splendid fighters that they would be able to give adequate protection against any force which Italy could muster.

It is doubtful whether any naval air service possesses such a first-rate aircraft as the new Fairey Fulmar. It has been described in many quarters as a "large Hurricane," but it would be much more accurate to describe it as a "baby Battle"—the younger brother of the bomber made by the same firm. In performance the Fulmar stands high above the older aircraft in use with the Fleet Air Arm. Not only has it a useful speed in the air but it also possesses another necessary attribute for a ship-borne aeroplane in having a low landing speed.

The success of the Fleet Air Arm in the Mediterranean may go a long way towards minimizing the advantage which the Italians enjoy in operating so near home, and may have far-reaching effects on the result of the war in the Middle East.

TEST ROAD COMPARES BASES OF VARYING THICKNESS

From *Engineering News Record* (New York, N.Y.), January, 1941

Highway bases of eight types, some stabilized with cement, some with asphalt and some untreated, are being tried out on a test road near Sacramento, Calif., under supervision of the California Division of Highways. The purpose is to make comparative tests of the different low-cost road designs and materials with a view to selecting the most economical base, under light traffic, both with regard to first cost and subsequent maintenance costs. A feature of this project is the placing of the road bases to be tested in strips 100 ft. long, varying in thickness from the minimum that could be considered practicable, to a thickness that should withstand all ordinary wear, thus giving an indication of how the failure progresses and at which thickness the several types are adequate to render service under the test loads that are used.

The test road is of oval shape with two 200-ft. tangents whose ends are connected by semicircular arcs. Each of the two tangents, which are 15 ft. wide, contains four 7½ by 100-ft. test panels, thus putting a different base under each of the two wheel tracks. Subgrade for the entire test section was prepared by excavating a trench in underlying hardpan and placing therein a 6-in. layer of clean, porous sand and screenings with pipes for admitting water. Over the sand is a 12-in. cover of soil with very low bearing value (saturated bearing value 5 per cent or less).

On this foundation the base materials were placed, increasing the thickness uniformly from a 3-in. base (plus a 2-in. surface) to an 18-in. thickness, also with a 2-in. surface. The point at which failure of maximum thickness occurs is expected to indicate the comparative strength and serviceability of the different types of construction, and direct observation should show how much benefit derives from the various forms of stabilization.

The eight bases comprise:

(1) Crusher-run base (untreated) with a minimum bearing value of 100 per cent.

(2) Cemented gravel mixture (untreated) with a 50 per cent bearing value.

(3) Same as (2) stabilized with 5 per cent emulsified asphalt.

(4) Same as (2) stabilized with 6 per cent portland cement.

(5) Sand-clay mixture (untreated) with a 15 per cent bearing value.

(6) Same as (5) stabilized with 5 per cent emulsified asphalt.

(7) Same as (5) stabilized with 6 per cent Portland cement.

(8) Same as (5) stabilized with 5 per cent of a special cut-back asphalt.

Over the entire test area a plant-mixed asphalt surfacing 2-in. thick was laid to protect the surface and to insure uniformity of load application. Subgrade base and bituminous wearing surface were compacted to the same extent as under favourable construction conditions.

Before the test was begun, water was put into the sand layer until water level rose to the underside of the layer of low-bearing-value soil. Thereafter the water inflow was continued at a rate just sufficient to maintain the water at this level until complete saturation of the 12-in. layer of soil had occurred as the result of capillary attraction.

When the subgrade saturated in this way, a loaded truck was started around the track, using first the legal load limit (17,000 lb. on the rear axle). Under this load failures in the thinner sections occurred too rapidly for satisfactory observation and the rear axle loading was reduced to 12,000 lb. The test load is operated around the track at 15 m.p.h.

Each failure of the road surface is repaired as it develops, after noting position and character of the failed area. Thus the surface is maintained constantly in good condition in order that no sound area may be prejudiced by pounding resultant from adjacent broken areas.

Tests were begun in the fall and were continued for 15,000 passes of the truck before closing down for the winter. During the rainy season it is expected that all bases and subgrades will take up a comparatively high percentage of moisture (the California Division of Highways has found this to be the case even in arid climates like Imperial Valley) and thus in the spring after all materials have had an opportunity to absorb moisture from winter rains as well as by capillarity, the test will be continued to obtain data for final conclusions. Officials of the Division of Highways have stated that until the tests have been completed, results will not be considered conclusive.

THE INSTITUTION AND AUSTRALIA'S WAR EFFORT

From *Journal of the Institution of Engineers*, (Australia), July, 1940

Considerable progress has been made in connection with the R.A.A.F. Preliminary Training Scheme developed within The Institution to provide facilities for the preliminary training in educational subjects, of recruits for the Royal Australian Air Force.

This scheme originated in a suggestion made by Mr. H. R. Halliday, B.E., A.M.I.E. Aust., to the Minister for Air that, to enable the period between enlistment and entrance to a training camp to be employed usefully, facilities should be provided Air Force recruits for "brushing up" those subjects of which an intimate knowledge is imperative if the recruit is to thoroughly absorb the specialized instruction he is later to receive.

In the provision of these facilities the Sydney Division of The Institution offered its full co-operation. The offer was accepted and, in consultation with the Educational Officer of the R.A.A.F., representatives of the Great Public Schools of Sydney and members of the Institution are devoting their time to the conduct of classes which all persons, accepted for service as air crews, are invited to attend.

No less than 477 members of the Sydney Division have offered their services in this connection, and at the present time 45 groups each comprising from 10 to 12 recruits, have been organized and are attending the classes arranged.

Both day and evening classes are held, and these are located throughout the various suburbs of Sydney, so that recruits who are still continuing their civil employment pending their call-up, may attend a class most conveniently situated to their place of residence.

The day classes occupy four half days each week, these being conducted at the headquarters of various engineering establishments, both governmental and private. The staffs of the organizations concerned have been freed to give necessary instruction.

The evening classes are conducted on three evenings in each week, each class occupying two hours, and these are held in the Great Public and State schools, church halls, various public halls, gas and electric light companies' showrooms and even the apprentices' room at one of the Sydney race-courses. Classes are being now organized in many towns throughout the State.

The subjects covered in the classes held include arithmetic algebra, logarithms and trigonometry, mechanics and physics. Each subject, or section, is subdivided into 16 lessons with five revision lessons, and the whole course is designed to be covered, either by correspondence or in class work, in 21 weeks. The four sections of the work are studied concurrently.

The scheme has been extended recently to include the educational training of artisans and mechanics required for the ground engineering staffs or in the production shops. In this extension the Sydney Technical College is directly co-operating, and is engaged in the training of ground staffs, i.e., fitters, air craft hands, etc.

NEW WORKS LIGHTING INTENSITIES RECOMMENDED IN REPORT

From *Industrial Power and Fuel Economist* (LONDON) OCTOBER 1940

The Departmental Committee on lighting in factories has recommended a new standard of intensities, and many installations have automatically become out of date.

The recommended minimum of lighting intensity is raised from 1 foot-candle at floor level to 6 foot-candles at 3 ft. above the floor. In some situations a lower intensity is permissible, but for most working areas this figure is the minimum.

Such an increase cannot be achieved by any haphazard decision as indiscriminately to fit higher power lamps. Existing lighting points and mounting heights should be used to fullest advantage, so ensuring a minimum dislocation of production and careful use of available materials, but a planned lighting scheme should be advised.

For general lighting, this can usually be mostly carried out by an arrangement of dispersive fittings. Each installation, however, has its peculiarities, and scientific application of principles by knowledgeable engineers is necessary.

For instance, where bays are relatively narrow in relation to their height, the fitting of dispersive reflectors at full height in accordance with too general a rule would result in undue wastage of light on walls, particularly if they have a low reflection factor. The simple solution is to mount dispersive reflectors at a convenient height something less than the maximum possible.

Combining Overhead and Side Lighting

In large bays where fittings need to be mounted above the cranes, it is advisable to fit concentrating type reflectors. The light distribution will then be such that illumination on horizontal surfaces is likely to be very much greater than that on a vertical plane, and so it is usually desirable to combine the overhead lighting with side lighting by suitable mounted angle reflectors. See Fig. 1.

Besides arrangement of fittings, another major problem of lighting planning is the choice of a light source. High pressure mercury vapour electric discharge lamps, such as Osira lamps, suit most industrial purposes, their efficiency being 38-45 lumens per watt, according to the wattage. Their higher visual acuity compared with tungsten lamps is a great asset, and the almost complete absence of red rays is a definite advantage in many production fields such as steel machine work.

Fluorescent electric discharge lamps have practically the same efficiency and they, or a combination of discharge lamps and tungsten lamps, will avoid an unpleasant facial appearance—sometimes a merit where female labour is employed.

Local Lighting

The need for high intensities in carrying out fine detail work with high accuracy has made local lighting increasingly popular. It cannot be emphasised too strongly, however, that this should always be supplementary to general lighting, and in no way supersede it. Brightness at the working level must not exceed ten times that of the surroundings or a tendency to eyestrain due to the need for ocular adjustment will be created. A further point to remember in maintenance is that the type of fitting necessary for local lighting requires very frequent cleaning, as it is nearly always installed near moving machinery.

A new lamp known as the Osira 5 ft. mains voltage fluorescent tubular lamp has many characteristics, especially in colour values, which make it worth consideration under this heading. The light colour is so near to day light that operatives find it extremely pleasant. Colour discrimination is very good, and fine detail easily distinguishable. The surface brightness is low, making it possible to utilise low mounting heights for high intensity local lighting. Their linear construction ensures heat dissipation over a wider area than is possible with a discharge lamp—a valuable factor in local lighting, because it minimises discomfort of the operative.

The result of applying knowledge involving such elements as have been described is well summarized in the following table.

Productive Value of Better Lighting

Process	Foot-candles Old system	Foot-candles New system	Increase of Production Per cent.
Typesetting by hand....	1.3	20	24
Foundry..............	2.5	7	7.5
Tile Pressing..........	1	3	6
Silk Weaving..........	50	100	21
Lathe Work...........	12	20	12
Post Office (Sorting)....	3	6	20
Wire Drawing.........	3	9	17
Roller Bearing Manufacture................	5	20	12.5

These figures are taken mainly from investigations carried out by the Government and show clearly how beneficial can be any efforts to assist the frequently overtaxed worker's eye.

Mixing Day and Artificial Light

An interesting aspect of sicentific lighting which arises from Black-out conditions is the manner of mixing day and artificial light. No matter how effective artificial lighting may be, there is an adverse subconscious effect upon workers who operate entirely under its influence during daylight hours. It is not feasible to exclude the psychological value of daylight per se, but prime requirements for welfare are bright or cheerful surroundings.

The admission of daylight is naturally ideal, since it is distributed from the sky with equal intensity in all directions, and provides a large upward component overhead in the form of reflected light off the ground. The proportion of daylight is not important, as the amount does not need to contribute measurably to actual working light. Where removable shutters were substituted for blackened windows after complaints by workpeople, the operatives troubled only to remove some of the shutters saying "just a little daylight makes all the difference." In this instance, artificial light was provided for workers during the day as well as at night.

It is suggested, therefore, that where daylight can be introduced by the installation of sliding doorways, adjustable blinds, roof ventilators, etc., this should be done. Should this be impossible, a cheerful lighting effect as well as one of high intensity should be achieved, because fatigue of the worker in a permanently blacked-out building is probably largely induced by the knowledge that daylight is present outside, and this induction will be the greater wherever lighting is notably "artificial."

When blending artificial light with daylight, electric discharge lamps are better than tungsten lamps. Also, for a given amount of light the heat developed is about a third of that of the necessary tungsten lamp installation, and the temperature is less liable to be raised to uncomfortable levels.

From Month to Month

News of the Institute and other Societies, Comments and Correspondence, Elections and Transfers

THE PRESIDENT SUFFERS AN ACCIDENT

The injury to Dr. Hogg, which occurred three days ago at Toronto on January twentieth, has turned out to be less serious than was at first feared. Just as the *Journal* goes to press a telegram from Toronto conveys the encouraging statement: "Appears to be no real anxiety as to ultimate recovery."

Although full details are lacking, it seems that the President was hit by a motor truck while crossing the street at the Royal York Hotel, where he had attended the Empire Club luncheon to the Governor General. He suffered severe head injuries, but X-ray examinations showed there was no concussion.

It is too early to foretell the length of incapacitation that will follow, but it is certain that he cannot be at the Annual Meeting. This will be a great disappointment to him and to all members.

Frequently, an accident such as this gives startling proof of the esteem in which a person is held. No sooner was the news of the accident made public than inquiries began to pour into Headquarters. Beyond any doubt, our president occupies a position of unusual importance and prominence, both in the affairs of the country and in the hearts of those who know him. On behalf of the entire membership, the *Journal* extends to him sympathy and good wishes.

PRIZES AND AWARDS

Elsewhere in this issue are the reports of various prize committees announcing the awards for 1940. In addition to these, Council announces the award of the Sir John Kennedy Medal to Lieut.-General A. G. L. McNaughton, and the inaugural awards of the Julian C. Smith Medal to eight members of the Institute.

The Sir John Kennedy Medal is awarded "as a recognition of outstanding merit in the profession." It is apparent that a more deserving selection could not be made than Lieut.-General A. G. L. McNaughton. It is expected that arrangements for the presentation will be made through the senior engineering institutions in England.

The establishing of the Julian C. Smith medal was announced in the October *Journal*. It is appropriate that the memory of such a staunch supporter of the Institute should be perpetuated within the Institute by this excellent endowed medal. It is further appropriate that the initial awards should include members who were associated with Mr. Smith in many of his interests.

The medal is given for "achievement in the development of Canada," an objective which was always close to the heart of Mr. Smith. The inaugural announcement contains the names of several persons, although it is intended that for the future the honour shall be restricted to one award a year. Herewith is the list, and a brief account of the attainments which prompted the committee and Council in making the selection.

W. D. Black, of Hamilton, Ont., B.A.Sc., Toronto, 1909, President of the Otis-Fensom Elevator Co. Ltd. President of the Canadian Manufacturers' Association in 1938. Member of the Executive Committee, Bank of Canada. Patron of the Toronto Symphony Orchestra. Trustee, Leonard Foundation. Vice-President of the Allied War Supplies Corporation.

R. J. Durley, of Montreal, Que., B.Sc. University College of London, 1887; Ma.E., McGill University, 1898. Secretary-Emeritus of the Engineering Institute of Canada. Author of "Kinematics of Machines." Professor of Mechanical Engineering at McGill University (1901-12); Secretary, Canadian Engineering Standards Association (1919-25); Secretary of Engineering Institute of Canada (1925-1938). Member of Council and Chairman of the Canadian Advisory Committee, Institution of Civil Engineers (1940).

Augustin Frigon, of Montreal, Que., I.C., Ecole Polytechnique, Montreal, 1909; M.I.T. Boston, 1909-10; Ecole Supérieure d'Electricité, Université de Paris, E.E. 1921 and D.Sc. 1922. Assistant Manager of the Canadian Broadcasting Corporation. Author of many engineering reports. Member of Royal Commission on Radio Broadcasting (better known as Aird Commission), 1928-1929. Member of Electricity Commission, Province of Quebec (known as Lapointe Commission) 1934-35. President, Quebec Electricity Commission, 1935-36. President of Corporation de l'Ecole Polytechnique de Montréal.

F. W. Gray, of Sydney, N.S. St. George Technical School, graduated in coal mining '98. Hon.LL.D., Dalhousie, 1937. Assistant General Manager, Dominion Steel & Coal Corporation. Author of "Coal Fields and Coal Industry in Eastern Canada," and "Undersea Coal Mining." A staunch supporter of professional engineering bodies. President of Canadian Institute of Mining and Metallurgy, 1932.

Sir Herbert Holt, of Montreal, Quebec. D.C.L., Bishop's College, and LL.D. McGill. Chairman of the Board Royal Bank of Canada, and Montreal Light Heat & Power Cons. Director in a large number of corporations. Governor of McGill University, and the Montreal General Hospital. President of the Royal Victoria Hospital, Montreal. Established Herbert S. Holt Foundation in 1934.

R. S. Lea, of Montreal, Que. B.Sc. 1890, Ma.E. 1893, McGill. Consulting engineer. Author of many important engineering reports. Assistant Professor, Civil Engineering, McGill University (1893-1902). Adviser to Ontario Hydro-Electric Power Commission and certain federal and provincial governmental departments in connection with river problems.

Beaudry Leman, of Montreal, Quebec. B.Sc. University of Lille, France, and McGill University. Dr.c.sc. University of Montreal, 1934. President and managing director of Banque Canadienne Nationale, and director of several important companies. Past president of the Canadian Bankers' Association. Member, Canadian Advisory Committee on St. Lawrence Waterway. Member, Allied War Supplies Corporation.

C. A. Magrath, of Victoria, B.C. LL.D., Toronto, 1926. Retired. For many years, practised as irrigation engineer and land surveyor in western Canada and North-West Territories. Member of Legislature of N.W.T., 1891-1902. Member of House of Commons of Canada, for Medicine Hat, 1908-1911. Identified in advisory and executive positions on many governmental commissions and boards. Chairman of Canadian Section, International Joint Commission 1914-1935. Chairman, Hydro-Electric Power Commission of Ontario, 1925-1931.

It is hoped that all prize winners can attend at Hamilton and receive their honours before their fellow members.

MEETING OF COUNCIL

Minutes of a meeting of the Council of the Institute, held at Headquarters on Saturday, January 18th, 1941, at ten-thirty a.m.

The secretary read a letter from General McNaughton expressing his sincere appreciation of the great honour which the Institute had conferred upon him in the award of the Sir John Kennedy Medal. The secretary was directed to communicate with the secretaries of the Institutions in London to see if arrangements could be made for the presentation to take place at some joint function in London.

It was noted with appreciation that Lieut.-Col. C. G. DuCane, O.B.E., a prominent member of the Institute in London, had consented to represent the Institute on the occasion of the presentation of the James Watt Medal of the Institution of Mechanical Engineers to Professor Stodola on January twenty-fourth.

Mr. Newell, as chairman of the Finance Committee, reviewed briefly the financial statement for the year 1940 as prepared by the auditors. The figures were very similar to those of last year, and showed an operating surplus of a little over $3,000.00, which was substantially more than had been anticipated in the budget. Arrears of fees and current fees had kept up very well; *Journal* advertising and subscriptions were practically the same as last year; general expenses were down about $700.00, and rebates to the branches were a little less than last year, due to the co-operative agreements with the Professional Associations. It was decided to appropriate an additional $1,000.00 to the building reserve fund.

The satisfactory condition of the finances of the Institute was noted with appreciation, and on the motion of Mr. Wardle, seconded by Colonel Grant, it was unanimously resolved that the report of the Finance Committee and the financial statement be accepted.

The report of Council for the year 1940, the treasurer's report, and the reports of the various Institute committees, were taken as read and accepted for presentation to the Annual Meeting.

The general secretary presented a letter from Mr. Gaherty, chairman of the Institute's Committee on Western Water Problems, which accompanied the report of that committee. In view of the international significance of the report, and of the definite recommendations which are made, it was decided it should be printed and copies sent to all councillors so that a complete discussion could be held at the annual Council meeting in Hamilton.

The report of the Past-Presidents' Prize Committee recommended that the prize be not awarded this year. This report was accepted.

The committee had also considered at some length the question of how best to stimulate interest in this prize, which up to now had been unsatisfactory. Following discussion, it was finally decided that Past-President Challies be asked to discuss the matter with the other past-presidents and see if the rules governing this award could not be revised so as to create a greater interest.

On the recommendation of the Duggan Medal and Prize Committee, it was unanimously RESOLVED that the Duggan Medal and Prize for the year 1940 be awarded to M. S. Layton, Jr.E.I.C., for his paper "Coated Electrodes in Electric Arc Welding."

On the recommendation of the Gzowski Medal Committee, it was unanimously RESOLVED that the Gzowski Medal for the year 1940 be awarded to Elizabeth M. G. MacGill, M.E.I.C., for her paper, "Factors Affecting the Mass Production of Aeroplanes."

On the recommendation of the Plummer Medal Committee, it was unanimously RESOLVED that the Plummer Medal for the year 1940 be awarded to O. W. Ellis for his paper, "Some Developments in Alloys during the last Twenty Years."

On the recommendation of the Leonard Medal Committee, it was unanimously RESOLVED that the Leonard Medal for the year 1940 be awarded to R. G. K. Morrison, M.C.I.M.M., for his paper, "Points of View on the Rock Burst Problem."

The reports of the examiners regarding Students' and Juniors' Prizes were received and approved as follows:

John Galbraith Prize to W. C. Moull, S.E.I.C., for his paper "The Electrification of a Modern Strip Mill."

Ernest Marceau Prize to Marc Trudeau, S.E.I.C., for his paper "Points Fixes et Lignes d'Influence."

Phelps Johnson Prize to Léo Brossard, S.E.I.C., for his paper "Geology of the Beaufor Mine."

H. N. Ruttan Prize: no papers received.

Martin Murphy Prize: no papers received.

The membership of the Nominating Committee of the Institute for the year 1941, as submitted by the various branches, was noted and approved. It was unanimously RESOLVED that Professor R. A. Spencer, M.E.I.C., of Regina, be asked to accept the chairmanship of this committee.

The annual reports of the various branches were received for presentation to the annual meeting.

A Striking Committee was appointed to make recommendations regarding the chairmen of the various Institute committees for the year 1941.

Dr. Challies reported that he had recently attended a meeting of the executive committee of the Engineers' Council for Professional Development at New York. He explained that at that meeting it was announced that E.C.P.D. had been asked to continue the work of the Committee on Professional Ethics which had been inaugurated by the American Engineering Council. The executive asked the Institute to name a representative to this committee, and after consulting Dr. Surveyer, who was also in New York, Dr. Challies had tentatively proposed Professor C. R. Young. He now asked Council's approval of that recommendation, which was unanimously given.

Mr. Perry, chairman of the House Committee, reported that the contract for underpinning the Headquarters building had been awarded to A. F. Byers & Company Limited, the lowest tenderer. He gave a detailed description of the work, which was now well under way.

Considerable time was spent discussing the proposal which had been made to the Department of Labour by the joint committee of three secretaries representing the Engineering Institute of Canada, the Canadian Institute of Mining and Metallurgy and the Canadian Institute of Chemistry, a copy of which had been mailed to every councillor. It was decided unanimously that Council approved of the principle involved and was agreeable to offering any constructive assistance within its power. The secretary was instructed to inform the Deputy Minister to that effect. Council also asked the general secretary to continue to represent the Institute in this matter.

The general secretary reported that during his recent visit to the Victoria Branch a suggestion had been made by the councillor and others that the branch hold a professional meeting at Victoria. Council was quite interested in this proposal, but decided that it should be left to the consideration of the incoming Council and Finance Committee.

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

Admissions	
Members	6
Juniors	3
Affiliates	1
Students	18

Transfers	
Junior to Member	3
Student to Member	1
Student to Junior	11
Affiliate to Member after passing examination under Schedule "C"	1

It was noted that the next meeting of Council would be held in Hamilton on Tuesday, February 5th, 1941, at ten-thirty a.m.

The Council rose at one-fifteen p.m.

DOMINION COUNCIL

The Annual Meeting of the Dominion Council of Professional Engineers was held at the Royal York Hotel, Toronto, on January 20th and 21st. The president of the Council, D. A. R. McCannel, M.E.I.C., of Regina (representing the Saskatchewan Association), occupied the chair. Others present included: Professor R. E. Jamieson, M.E.I.C., (Quebec); F. W. W. Doane, M.E.I.C., (Nova Scotia); C. C. Kirby, M.E.I.C., Honorary President, (New Brunswick); W. P. Dobson, M.E.I.C., (Ontario); P. Burke-Gaffney (Manitoba); Professor H. R. Webb, M.E.I.C., (Alberta); F. W. MacNeill (British Columbia); and Major M. Barry Watson, M.E.I.C., Secretary-Treasurer of the Council.

Mr. S. R. Frost, M.E.I.C., President of the Ontario Association of Professional Engineers, welcomed the representatives of the various provinces and offered them the assistance and facilities of the Association.

Among the reports presented to the Council were the reports of the Committees on the Admission of Foreign Engineers; Licensing of Engineers; the Construction Industry in Canada; National Defence and the Profession; and the Training of Young Engineers.

The Council reports that there is a definite shortage already of engineers in Canada and it is now necessary to allocate such engineering talents that we have. It expressed its willingness to assist in undertaking such distribution. According to the Council, insufficient guidance is being given to young men entering the engineering profession and it was resolved that the various Associations should offer guidance to high school students in regard to the duties and the necessary qualifications of an engineer, in order to cut down on the high percentage of failures in the various engineering colleges of the country. The Committee on the Training of the Young Engineers is co-ordinating its work with that of other engineering organizations.

D. A. R. McCannel of Regina was re-elected president of the Council for the year 1941. The other members of the Executive are the vice-president, the member from Quebec (not yet named); and W. P. Dobson of Toronto. Major M. Barry Watson was re-elected as secretary-treasurer.

The next meeting of the Council is to be held in St. John, New Brunswick, in 1942.

ELECTIONS AND TRANSFERS

At the meeting of Council held on January 18th, 1941, the following elections and transfers were effected:

Members

LeBel, Paul, B.A.Sc., (C.E.) (Ecole Polytechnique), consltg. engr., technical services, Imperial Oil Ltd., Montreal, Que.

Lloyd, Warren G., B.A.Sc. (Univ. of Toronto), divn. plant engr., western divn., Bell Telephone Company of Canada, Toronto, Ont.

Metcalfe, Neil, B.Sc. (Univ. of Wales), chief metallurgist, Burlington Steel Co. Ltd., Hamilton, Ont.

McCavour, Samuel Thomas, B.Sc. (C.E.), (Univ. of N.B.), chief engr. and joint mgr., The Great Lakes Paper Co. Ltd., Fort William, Ont.

Packard, Royal Day, S.B. (Mass. Inst. Tech.), chief engr., Brown Corporation, La Tuque, Que.

Saunders, Melville Sydney, B.A.Sc. (Univ. of Toronto), topographic engr., Tropical Oil Company, Colombia, S.A.

Juniors

Ain, Joseph, B.Eng (Civil), (McGill Univ.), instr'man., Dept. of Transport, Montreal, Que.

Crandall, Seymour Arnold, B.S. in Mining (Mich. Coll. of Mining), Creighton Mine, International Nickel Co. of Canada, Copper Cliff, Ont.

Rahilly, Thomas Francis Jr., B.Sc. (Mech.), (Queen's Univ.), master mechanic, blast furnace dept., Algoma Steel Corporation Ltd., Sault Ste. Marie, Ont.

Affiliate

Milligan, Gordon Herald, commercial representative, Calgary Power Company, Edmonton, Alta.

Transferred from the class of Junior to that of Member

Lamoureux, Marcel, B.Eng. (McGill Univ.), asst. engr., Dept. Public Works Canada, Ottawa, Ont.

Piché, Joseph Alphonse Arthur, B.A.Sc., (C.E.) (Ecole Polytechnique), asst. engr., Dept Public Works Canada, Quebec, Que

Pooler, Gilbert Douglas, B.Sc. (Queen's Univ.), asst. inspr., arms inspection br., Dept. of National Defence, Ottawa, Ont.

Transferred from the class of Student to that of Member

Ansley, Fred G., B.Sc. (Queen's Univ.), field engrg., Ford Motor Co. of Canada, Windsor, Ont.

Transferred from the class of Student to that of Junior

Baird, Malcolm Francis, B.Sc. (Elec.), (Univ. of N.B.), asst. lamp engr., Canadian Westinghouse Company, Hamilton, Ont.

Boone, Harold Percival, B.Sc. (Univ. of N.B.), apparatus correspondent, Canadian Westinghouse Company, Hamilton, Ont.

Brown, Ernest F., B.Eng. (Mech.), (McGill Univ.), junior mech. engr., Royal Canadian Mint, Dept. of Finance, Ottawa, Ont.

Chambers, Robert. B.Sc. (Elec.), (Univ. of Alta.), field engr., Shawinigan Engineering Company Ltd., Shawinigan Falls, Que.

Clarke, Bruce Porteous, B.Eng. (McGill Univ.), asst. hoist engr., Canadian Ingersoll Rand Co., Lennoxville, Que.

Dufour, Gaston, B.A.Sc., (C.E.) (Ecole Polytechnique), engr., Aluminum Co. of Canada, Arvida, Que.

Foster, Ian McLeod, B.Eng. (McGill Univ.), mech. engr., Brown Corporation, La Tuque, Que.

Guénette, Joseph Antoine Paul, B.A.Sc. (C.E.), (Ecole Polytechnique) asst. res. engr., Dept. of Roads, Montreal, Que.

Meagher, Robert Douglas, B.Eng. (Chem.), (McGill Univ.), gas plant operator, British American Oil Co. Ltd., Montreal East, Que.

Miller, Alex. Matthew, B.Sc. (Civil), B.Eng. (Mech.), (N.S. Tech. Coll.), refractory engr., Dominion Steel & Coal Corporation, Sydney, N.S.

Shatford, Ralph Grant, B.Eng. (N.S. Tech. Coll.), cracking coil inspr., Imperial Oil Limited, Dartmouth, N.S.

Students Admitted

Anderson, James Douglas (McGill Univ.), 3525 University Street, Montreal, Que.

Batanoff, George Boris, (Univ. of Sask.), 202 Clarence Ave. South, Saskatoon, Sask.

Bogle, Roy Thomas, B.A.Sc. (Mech.), (Univ. of B.C.), 426 Park St., Peterborough, Ont.

Borrowman, Ralph Willson, B.Sc. (Civil), (Univ. of Man.), 1192 Wolseley Ave., Winnipeg, Man.

Carty, Desmond Geoffrey, (McGill Univ.), 160 Waverley St., Ottawa, Ont.

Covo y Stramba, Peter Victor, (McGill Univ.), 3653 University St., Montreal, Que.

Eddy, Robert Cheyne, (Queen's Univ.), 406 Johnson St., Kingston, Ont.

Fleming, John Patten, (Univ. of Toronto), 61 Foxbar Road, Toronto, Ont.

Gareau, Leo Eugene Arthur, (McGill Univ.), 5509 Durocher Ave., Outremont, Que.

Gordon, Abraham Isaac, (McGill Univ.), 1343 Lajoie Ave., Outremont, Que.

Gordon, John A., (McGill Univ.), 534 Prince Arthur St. W., Montreal, Que.

Johnston, John Smyth, (Queen's Univ.), 15 Daniel St., Smiths Falls, Ont.

Leduc, René, B.A.Sc. (C.E.), (Ecole Polytechnique), Dept. of Roads, Montreal, Que.

Miller, Justin Ormond, (McGill Univ.), 3506 University St., Montreal, Que.

Simpkins, Arthur C., (McGill Univ.), First St., Sunny Brae, N.B.

Tremblay, Gérald René, (Ecole Polytechnique), 6880 De Laroche St., Montreal, Que.

Wein, Harry Garrick, (McGill Univ.), 1621 Ducharme Ave., Outremont, Que.

Yosipovitch, Joseph, (McGill Univ.), 661 Querbes Ave., Outremont, Que.

NATIONAL DEFENCE AND U.S.A.

To assist the national defence programme and industry in general in providing urgently needed engineers, Cornell University launched a nation-wide quest for fifty of America's best qualified secondary school seniors to be trained as engineers. They will be awarded John McMullen Regional Scholarships in Engineering this spring. The scholarships carry variable stipends up to $400, a year throughout a four or five-year course in the College of Engineering.

Dean S. C. Hollister announced recently that application blanks and instructions were mailed to more than 3,000 principals and headmasters throughout the United States.

Personals

News of the Personal Activities of members of the Institute, and visitors to Headquarters

C. D. Harrington, M.E.I.C., vice-president and general manager of Anglin-Norcross Corporation, has recently been elected president of the Montreal Board of Trade. Since his graduation from McGill University in 1907 he has always been engaged in construction work, first with the firm of Byers and Anglin and later with Anglin Limited.

Wing Commander T. R. Loudon, M.E.I.C., professor of applied mechanics at the University of Toronto has recently been promoted from Squadron Leader to this rank and appointed chief technical officer of the Flight Research Establishment at Ottawa. He was previously in command of the School of Aeronautical Engineering established last year at Montreal under the British Commonwealth Air Training Plan.

Douglas S. Ellis, M.E.I.C., professor of civil engineering at Queen's University, Kingston, Ont., was recently appointed head of the department of civil engineering succeeding the late Professor W. P. Wilgar.

Colonel N. C. Sherman, M.E.I.C., chief ordnance mechanical engineer, Department of National Defence, Ottawa, has been appointed commandant of the R.C.O.C. Training Centre, Kingston, Ont.

C. D. Harrington, M.E.I.C.

R. E. Heartz, M.E.I.C.

Past Presidents J. B. Challies, M.E.I.C., and **Arthur Surveyer,** M.E.I.C., attended the Executive Meeting of the Engineers' Council for Professional Development held in New York City on January 4th, 1941.

Major M. Barry Watson, M.E.I.C., has been appointed second in command of the University of Toronto contingent of the Canadian Officers' Training Corps. He will also continue as chief instructor of the unit.

T. A. McGinnis, M.E.I.C., was recently elected chairman of the Kingston Branch of the Institute. Born at Belleville, Ont., he was educated at Queen's University, Kingston, where he received his degree in 1909. After graduation he engaged for a few years in railway surveys and construction. In 1907, he became resident engineer at the Canada Cement Company plant near Belleville, Ont., later becoming operating superintendent. From 1911 to 1914, he was construction engineer for the same company at various plants. From 1914 to 1918, he was managing director of Missisquoi Marbles Limited, Philipsburg, Que. In 1918, he became senior member of the firm McGinnis and O'Connor, engineers and contractors. Mr. McGinnis is now the owner of the firm.

R. E. Heartz, M.E.I.C., is the newly elected chairman of the Montreal Branch of the Institute. Born at Marshfield, P.E.I., he graduated from McGill in 1917 with the degree of B.Sc., and immediately after graduation was employed by the St. Maurice Construction Company at La Loutre, on the construction of the Gouin dam. Later in the same year he enlisted with the Royal Air Force, received his commission early in 1918, and was appointed flying instructor, being demobilized in 1919. In that year he joined the Fraser-Brace Engineering Company, Ltd., and was employed on the construction of the Big Eddy dam on the Spanish river. Mr. Heartz became resident engineer at La Gabelle development on the St. Maurice river in 1922, having joined the staff of the Shawinigan Engineering Company in 1920. He was resident engineer on the St. Narcisse development on the Batiscan river in 1924-1925, and in 1926 was transferred to Montreal for investigating preliminary design of hydro-electric developments. In 1927, Mr. Heartz was appointed resident engineer of the Paugan Falls development on the Gatineau river, and since the completion of that undertaking has been connected with the design and construction of different hydro-electric projects. He is at present assistant chief engineer of the Shawinigan Engineering Company.

R. B. Herbison, M.E.I.C., who was with the firm of Glenfield and Kennedy Limited, Kilmarnock, Scotland, is now a member of the Observer Corps and a lecturer in anti-gas measures, high explosive and incendiary bombs with the defence services in Scotland. Mr. Herbison was at one time mechanical designer and field engineer in the mechanical department of the Dominion Bridge Company, Lachine, Que.

Victor Meek, M.E.I.C., has recently been appointed controller of the Dominion Water and Power Bureau in the Department of Mines and Resources at Ottawa. Mr. Meek had been assistant controller since 1924.

Norman Marr, M.E.I.C., chief hydraulic engineer of the Dominion Water and Power Bureau in the Department of Mines and Resources at Ottawa, has been appointed assistant controller, succeeding Mr. Meek.

John Morse, M.E.I.C.

J. B. Challies, M.E.I.C.

P. S. Gregory, M.E.I.C.

Past-President J. B. Challies, M.E.I.C., has been appointed, last month, vice-president and executive engineer of The Shawinigan Water & Power Company, Montreal. Dr. Challies has been with the company since 1924, when he resigned the position of Director of the Dominion Water and Power Bureau at Ottawa to accept a professional appointment with Shawinigan.

P. S. Gregory, M.E.I.C., has been appointed vice-president in charge of sales and promotion with the Shawinigan Water & Power Company, Montreal. He joined the firm in 1918, having been previously connected with the Electrical Commission of Montreal and the Montreal Tramways Company.

John Morse, M.E.I.C., is one of the new vice-presidents of Shawinigan Water & Power Company of Montreal, and is in charge of operation. Mr. Morse has been with the company since 1907, having successively occupied the positions of superintendent of operation, general superintendent and assistant general manager.

C. H. McL. Burns, M.E.I.C., chairman of the Niagara Peninsula Branch of the Institute, who has been works manager and manager of the two Welland forging plants of the Canada Foundries and Forgings Ltd., for the last six and a half years, is at present associated with the Federal Foundries and Steel Company Ltd., in rehabilitating and bringing into production the old London Rolling Mills plant at London and the Sandwich Foundry at Windsor, recently acquired by this newly organized company. The Federal company expects to be in production within a few weeks and will produce S.A.E. rolled sections at London and grey iron and steel castings on a production basis at Windsor. Mr. Burns is associated in this work with the Brant Company of Detroit, specialists in industrial engineering and management.

Leslie Mackay, M.E.I.C., was appointed, last August, general superintendent and acting general manager of the Manitoba Power Commission, Winnipeg. He was graduated from the University of Manitoba in 1927. From 1929 to 1931 he was assistant resident engineer on the construction of Slave Falls power house for the Winnipeg Hydro-Electric System. He joined the Manitoba Power Commission in 1932 as secretary and assistant to the manager.

R. F. McAlpine, M.E.I.C., has returned to the Halifax office of Wm. Stairs Son & Morrow Limited, after having spent a few years as manager of the Cape Breton branch of the company. Mr. McAlpine joined the firm as a sales engineer upon his graduation from the Nova Scotia Technical College in 1928.

John Pringle, M.E.I.C., left last month for Trinidad, B.W.I., where he expects to stay for about a year in charge of work of a special nature. He was graduated from the University of Toronto in 1916 and, after serving in the last war with the Royal Engineers, he engaged in construction work in this country and in the United States. In this connection he supervised the erection of large apartment houses in New York City. In 1930, he became president of his own general contracting and real estate business in New York City. Mr. Pringle returned to Canada last year.

S. Stephenson, M.E.I.C., is now overseas with the 1st Canadian Pioneer Battalion, Royal Canadian Engineers. Previous to his joining up he had been for the last few years connected with the Whiting Corporation in Toronto.

P. J. Colgan, Jr.E.I.C., has joined the Royal Canadian Air Force and is, at present, stationed at Toronto. Previous to enlisting he was with the Cosmos Imperial Mills at Yarmouth, N.S.

J. B. Bryce, Jr.E.I.C., has left the National Research Council to accept a position in the hydraulic department of the Hydro-Electric Power Commission of Ontario at Toronto.

J. M. A. Crowe, Jr.E.I.C., who was a demonstrator in hydraulics in the department of mechanical engineering in the University of Toronto, is now located in Colombia, S.A., with the Tropical Oil Company.

John W. Wright, S.E.I.C., who was recently connected with Defence Industries Limited at Parry Sound, Ont., is now working in the aircraft division of the National Steel Car Corporation at Malton, Ont.

R. E. Jess, S.E.I.C., is now training as a pilot with the Fleet Air Arm in England. Previous to enlisting he was a student in engineering at McGill University.

E. R. Davis, S.E.I.C., is now production manager of the Control Apparatus Division of Railway and Power Engineering Corporation Ltd., at Toronto. He was previously electrical engineer with the Dominion Engineering Works, Montreal.

S. D. Levine, S.E.I.C., is on the inspection staff of the British Purchasing Commission and is stationed at the Republic Steel Corporation in Buffalo, New York. He was graduated from the University of Toronto in 1939.

Guy Savard, S.E.I.C., has joined the Royal Canadian Dragoons at St. Johns, Que., as a lieutenant. He was graduated from Royal Military College, Kingston, in 1937 and after a period of post-graduate work in Paris returned to Canada with the Canadian Liquid Air Company at Montreal.

VISITORS TO HEADQUARTERS

Captain V. R. Davies, M.E.I.C., Royal Military College, Kingston, Ont., on December 28th.

G. F. St-Jacques, M.E.I.C., Engineer, Provincial Public Utilities Board, Quebec, on December 28th.

Jean Morency, Jr.E.I.C., Inspector, Quebec Bureau of Mines, from Quebec on December 31st.

Marcel Papineau, S.E.I.C., from Noranda, on December 28th.

Professor H. E. T. Haultain, M.E.I.C., University of Toronto, from Toronto on January 3rd.

Paul Vincent, M.E.I.C., Secretary-Treasurer of the Quebec Branch, from Quebec on January 6th.

Georges Gravel, S.E.I.C., and **Rosaire Saintonge,** S.E.I.C., from Sherbrooke, Que., on January 9th.

David Hutchison, M.E.I.C., Manager, Mackenzie River Transport, Hudson Bay Company, from Edmonton, Alta., on January 16th.

Paul E. Buss, M.E.I.C., President, Spun Rock Wools Limited, from Thorold, Ont., on January 24th.

John C. Oliver, M.E.I.C., Registrar, Association of Professional Engineers of British Columbia, from Vancouver, B.C., on January 24th.

R. J. Chambers, M.E.I.C., Mechanical Engineer, Gaspesia Sulfite Company, Ltd., from Chandler, Que., on January 27th.

Obituaries

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

David Williams Burpee, M.E.I.C., died at Fredericton, N.B., on November 3rd, 1939. He was born at Sheffield, N.B., on July 31st, 1875. His preliminary education was obtained in the grammar schools and his technical education through correspondence courses. He joined the Canadian Society of Civil Engineers as an associate member in 1904 and became a full member in 1910. He was a member of the American Engineering Association from 1906 to 1919. The greater part of his career was spent in railroading which he started in 1896, becoming chief engineer of the E.M.M.R. in 1914. Following this, he spent two years as a mining engineer in Newfoundland, returning to Canada in 1917 to join the staff of the New Brunswick Highway Department as a district engineer. In 1920 he resigned to become chief engineer of the Bangor and Aroostook Railway but later returned to the N.B. Highway Department, where he remained until 1926. From that time until 1928 he was with the Canada Steamships Ltd., retiring, on account of ill health, to his home in Fredericton, N.B., where he was able to do a limited amount of work at his avocation, cabinet making and repair, until his death.

Ernest Milton Salter, M.E.I.C., died suddenly at his home at Toronto on December 12th, 1940. He was born at Auburn, N.Y., on November 17th, 1889, and he was educated at the University of Toronto where he was graduated in 1911 in civil engineering. Upon graduation he became engaged in railway construction with the Canadian Northern Ontario Railway at Nipigon. In 1914 he joined the Greater Winnipeg Water District as a draughtsman and after a few months became resident engineer on railway construction. In 1915 he was assistant engineer on aqueduct construction for the Greater Winnipeg Water District. In 1919 he joined the Imperial Oil Company as a mechanical engineer at Sarnia, Ont., and later went to British Columbia where, for some years, he was general superintendent of the Imperial Oil Refinery at Ioco. He resigned this post because of ill health in 1930 and returned to Toronto, joining the manufacturing department. Two years later he was appointed safety engineer at the Sarnia refinery, leaving that post in 1938. Mr. Salter was supervising engineer at Malton airport near Toronto from February to July, 1940, at which time he was made supervising engineer at St. Catharines airport which position he occupied at the time of his death.

Mr. Salter joined the Institute as a Student in 1911 and was transferred to Junior in 1912. He became an Associate Member in 1916.

Athol Choate Wright, M.E.I.C., died at his home at Ottawa on January 5th, 1941. He was born at Hull, Que., on September 2nd, 1879, and was educated at Ottawa Collegiate Institute. For a period of five years from 1899 he was engaged in mining and surveying in western Ontario and British Columbia. In 1903 he became connected with the construction of the National Transcontinental Railway, first as an instrument man. He became resident engineer in 1908 and later occupied the same position with the Canadian Pacific Railway until 1914. From 1916 to 1919, he was overseas with the Royal Canadian Engineers and returned with the rank of captain. He then entered the Department of the Interior at Ottawa as an assistant hydraulic engineer. In 1933 he became connected with the National Parks of Canada, in the same department, and in 1935 he was made superintendent of Jasper National Park. He returned to Ottawa in 1938 and became attached to the Parks Branch of the Department of Mines and Resources. He had retired from this position last June.

Mr. Wright joined the Institute as a Student in 1908 and was transferred to an Associate Member in 1919. He became a Member in 1922.

COMING MEETINGS

The Engineering Institute of Canada—Fifty-fifth Annual General and Professional Meeting to be held at Hamilton, Ont., on February 6th and 7th. Secretary, L. Austin Wright, 2050 Mansfield St., Montreal, Quebec.

American Institute of Mechanical Engineers—Annual Meeting, New York, Engineering Societies Building and Commodore Hotel, February 17th to 20th. Secretary, C. E. Davies, 29W., 39th St., New York.

Ontario Good Roads Association—Annual Convention, Royal York Hotel, Toronto, February 26th to 27th. Secretary, T. J. Mahony, Court House, Hamilton, Ont.

Canadian Institute of Mining and Metallurgy—Annual Meeting, Montreal, March 10th to 12th. Secretary, E. J. Carlyle, Drummond Bldg., Montreal.

Corporation of Professional Engineers of the Province of Quebec—Annual Meeting, Montreal, March 29th. Registrar, C. L. Dufort, 354 Ste-Catherine St. East, Montreal.

The American Ceramic Society—43rd Annual Meeting, Lord Baltimore Hotel, Baltimore, Md., March 30th to April 5th.

Electrochemical Society—The 79th Annual Meeting to be held at the Hotel Cleveland, Cleveland, Ohio, April 16th to 19th.

American Water Works Association—Annual Convention, Royal York Hotel, Toronto. June 22nd to 26th. Secretary, Harry E. Jordan, 22 E 40th St., New York.

Canadian Electrical Association—51st Annual Convention, Seigniory Club, Quebec, June 25th to 26th, Secretary, B. C. Fairchild, 804 Tramways Building, Montreal.

News of the Branches

Activities of the Twenty-five Branches of the Institute and abstracts of papers presented

BORDER CITIES BRANCH

H. L. Johnston, m.e.i.c. - *Secretary-Treasurer*
A. H. Pask, Jr.e.i.c. - - *Branch News Editor*

The Annual Meeting of the Border Cities Branch was held on December 6th in the Prince Edward Hotel at Windsor, and began with a dinner at 6.30 p.m. Following this was a business meeting and the election of officers for 1941.

The chairman, Mr. J. F. Bridge, then gave the chair to Mr. T. H. Jenkins who proposed a toast to Mr. J. Clark Keith. Mr. Bridge presented Mr. Keith with a gold e.i.c. pin. Mr. Keith gave a short speech of thanks and presented the branch with a bronze plaque of the e.i.c. crest. This was received by Mr. Bridge who replied for the branch.

Mr. Jenkins with a few words on the history behind the branch reminded those present that this was the 21st anniversary of the organization of the Border Cities Branch. He then introduced as historian Mr. O. Rolfson, a charter member, to outline the history of the branch.

J. B. Keith presents the Border Cities Branch with a replica of the Institute's crest.

Mr. Rolfson told of the first meetings of organization beginning with an informal meeting held in the office of Mr. A. J. Stevens on January 17th, 1919. Mr. Stevens was elected chairman. On January 23rd formal application for the establishment of a branch was voted and signed by 20 Members and Associate Members. This was approved on February 25th and the group authorized to form a branch. Final elections were held on March 28th.

Mr. Rolfson recounted the names of many prominent and widely known members. He gave biographical sketches of several of these, many of whom have passed on.

Following the talk Mr. Bridge was again given the chair. The meeting adjourned on the motion of Mr. Jenkins seconded by Mr. F. J. Pollock.

EDMONTON BRANCH

B. W. Pitfield, Jr.e.i.c. - *Secretary-Treasurer*
J. F. McDougall, m.e.i.c. *Branch News Editor*

Mr. R. E. Allen, chairman of the Petroleum and Natural Gas Conservation Board of Alberta, addressed the December meeting of the Edmonton Branch on the evening of December 10th. He was introduced to the meeting by Dr. J. A. Allan of the Department of Geology of the University of Alberta. His topic was **Some Aspects of Oil Conservation in Alberta.**

He defined conservation as efficient production to prevent waste. As examples of conservation practised by modern men he mentioned forest and soil conservation. Forests are essentially a crop that can be replaced and soil can be remade and fertility returned. However, when dealing with petroleum we are dealing with a material that cannot be replaced or at the present time substituted. Every oil field is a liquidating asset as soon as it is found.

He mentioned how in 1923 many new fields were discovered in California and because of limited pipe lines capacity the old pumping fields were shut down. The new fields were depleted with horrible waste. By 1925 it was necessary to once again produce oil from the pumping fields. It was found that these old wells were in much better condition after their long rest.

In 1929, more California fields were discovered, and in the light of previous experience were operated more efficiently and oil conservation was started on a pro-rata basis. It was not until 1931 that sufficient data was available to show that conservation meant a longer life for a field, as well as a longer and greater income.

One of the principal savings due to conservation is a longer flowing well which in turn means cheaper overall production. He pointed out how it is necessary for oil wells to have sufficient energy in the form of gas pressure to bring the oil out of the producing sand and to the surface. Many wells have sufficient natural energy, if conservation is practised, to bring to the surface from 93 to 94 per cent of the entire quantity of oil contained in the sand, Improper production could easily reduce this to 50 or 55 percent.

Mr. Allen then dealt with a five-point programme for efficient production. He outlined these points as follows:

1. Adoption and use of the optimum rate principle by which a field is operated at a rate which will permit the greatest production in its entire life.

2. Reservoir pressure regulation. This is necessary for the conservation of the underground energy.

3. Development of an economical drilling programme.

4. Let a field produce only what the market can absorb and prevent dumping.

5. Prevent disturbing pressures in the industry such as an unreasonable profit motive.

In speaking of the Alberta situation he stated that at present the greatest need is for the development of more fields because conservation is easier to apply when the supply is ample.

He also pointed out how Alberta oils are limited in their competition with other oils because of high transportation costs. The eastern limit of the Alberta market is Portage-la-Prairie. A reserve of 200,000,000 barrels would be necessary to build a pipe line to Winnipeg, and the present Turner Valley reserve of 85,000,000 barrels is far from sufficient.

He stated that Alberta oils are also limited in competition with foreign oils because of high production costs. Most of the drilling equipment comes from the United States and high duties and unfavourable exchange at the outset mean a 60 per cent differential handicap.

At the close of the paper Mr. C. E. Garnett moved a hearty vote of thanks to Mr. Allen. Twenty-five members were present at the meeting. Chairman E. Nelson presided.

HALIFAX BRANCH

L. C. Young, M.E.I.C. - *Secretary-Treasurer*
A. G. Mahon, M.E.I.C. - *Branch News Editor*

The Annual Meeting of the Halifax Branch of the Institute was held at the Nova Scotian Hotel, Friday evening, December 20.

Branch Secretary L. C. Young read retiring Chairman Charles Scrymgeour's report of the past year's activity, which included the signing of the co-operative agreement between the Institute and the Association of Professional Engineers of Nova Scotia. Three meetings were held during the year, at which guest speakers addressed the members of the branch.

The secretary reported on the financial standing at the end of the fiscal year, and Scrutineers, H. W. Mahon and G. V. Ross, advised the chairman on the result of election of new officers for the coming year. S. L. Fultz was elected chairman, with J. A. MacKay, Dr. A. E. Cameron, Professor A. E. Flynn, D. G. Dunbar and J. F. MacKenzie replacing the retiring members of the executive. At this point in the meeting, retiring Chairman Charles Scrymgeour turned the chair over to S. L. Fultz.

There was considerable discussion as to the advisability of holding the joint meeting of the A.P.E.N.S. and the Halifax Branch of the E.I.C. this year. It was decided, however, that this function would take place as in the past, with some curtailment of entertainment.

The main feature of the evening was an address by Mr. Charles Scrymgeour, followed by moving pictures on the subject of **Fire Control in the Oil Refining Industry.** The address was exceptionally interesting and outlined the methods by which fire was avoided and fought in modern oil refining plants. The picture was provided by the Imperial Oil Company, and it well illustrated the speaker's remarks, showing actual conflagrations and the operation of oil fire fighting equipment.

HAMILTON BRANCH

A. R. Hannaford, M.E.I.C. - *Secretary-Treasurer*
W. E. Brown, Jr.E.I.C. - *Branch News Editor*

The annual business meeting was held at the Rock Garden Lodge on the evening of Monday, January 6th, 1941, when 63 members and guests were present. C. E. Sisson brought best wishes from the Toronto branch, for a successful Annual General Meeting in Hamilton in February and promised every support from Toronto.

The meeting was presided over by Alex. Love, the retiring chairman. After a very enjoyable dinner, the guest speaker, a gentleman travelling under the name of Colonel Beauchemin, who had arrived too late to take dinner with us owing to a presumed motor accident, gave a very interesting talk on British relations with the French, but towards the end of the talk it became evident that the disguise was hiding none other than T. S. Glover, M.E.I.C.

The business of the branch was now carried on. W. A. T. Gilmour was elected chairman, S. Shupe, vice-chairman, A. R. Hannaford, secretary-treasurer. Executive Committee: H. A. Cooch and A. C. McNab for two years and T. S. Glover and C. H. Hutton remain for one year. W. E. Brown is re-elected as assistant secretary and branch news editor.

After the business was completed Alex. Love handed the chair over to the new chairman, W. A. T. Gilmour.

A very hearty vote of thanks was given to the retiring chairman for the excellent work carried out during his term of office, and in his reply he thanked the executive and all members for the support so willingly given to him on all occasions.

In the interval between some very good musical numbers, door and other prizes were given out including a useless old electric stove and a broken down radio. However, behind this nonsense was a keen knowledge that our country is at war and with this in mind five partially filled in War Savings Certificates were given as other prizes.

Dr. Burke of McMaster University, replying to a special vote of thanks from Mr. Love, said the University authorities were pleased to give the Branch facilities for its meetings, which are of such great advantage to the membership.

KINGSTON BRANCH

J. B. Baty, M.E.I.C. - *Secretary-Treasurer*

On October 31st, 1940, the Kingston Branch held its annual dinner and business meeting at the Queen's Students Union. Eighteen members and three guests were present. The chairman, Major G. G. M. Carr-Harris presided. The report of the secretary-treasurer was presented and accepted.

The following officers were elected: chairman, T. A. McGinnis; vice-chairman, P. Roy; secretary-treasurer, J. B. Baty; executive: V. R. Davies, K. H. McKibbin, K. M. Winslow, A. H. Munro; ex-officio: G. G. M. Carr-Harris.

The general business and policy of the branch was discussed.

Major H. H. Lawson paid fitting tribute to the memory of the late Professor W. P. Wilgar, pointing out the important role he had filled in the activities of Queen's University and of the Institute, and recalling that he had served as the first secretary of the Kingston Branch of the Institute.

Mr. Louis Trudel, assistant to the general secretary, from Headquarters, reported upon the war activity of the Institute, and described the work of the employment bureau and its close contact with both industry and the departments of the government. He called special attention to the affiliation of The Engineering Institute of Canada with the Engineers' Council for Professional Development, and reported upon the good health and increased membership of the Institute.

Major G. G. M. Carr-Harris, mechanical engineer, Royal Canadian Ordnance Corps, delivered an interesting address on **Some Fundamental Engineering Principles as Applied to Mechanization.** This was published in the December, 1940, issue of the *Journal.*

LAKEHEAD BRANCH

H. M. Olsson, M.E.I.C. - *Secretary-Treasurer*
W. C. Byers, Jr.E.I.C. - *Branch News Editor*

The executive of the Lakehead Branch welcomed Mr. L. Austin Wright, general secretary, and Mr. J. A. Vance, a councillor of the Institute, on December 10th, at a luncheon held at the Royal Edward Hotel in Fort William. They were later escorted through the Canadian Car & Foundry Company plant and shown several points of interest at the Lakehead in company of the chairman, Mr. H. J. O'Leary.

A general dinner meeting was held at 6.30 p.m., at the Shuniah Club, in Port Arthur, and 35 members and guests were present.

The chairman called on Mr. J. A. Vance, who described the work of the Papers Committee and urged more exchange of speakers between the various branches, thus creating more interest at the meetings.

Mr. Wright was then called on to speak, and told of the contribution being made by engineers throughout Canada toward the prosecution of the war and expressed the desire of the Institute members to extend their knowledge and skill in the present conflict. He stated that there are now over 5,100 members in Canada and abroad, and that the Institute can boast of a credit balance in the bank. Mr. Wright also told of the large number of important war posts that are held by members of the Institute. He told of the work being done to improve the status of the engineers.

Mr. R. B. Chandler tendered a vote of thanks to the speakers and Mr. P. E. Doncaster and Mr. J. Antonisen expressed their appreciation.

LETHBRIDGE BRANCH

E. A. Lawrence, s.e.i.c. - *Secretary-Treasurer*
A. J. Branch, m.e.i.c. - - *Branch News Editor*

The Lethbridge Branch of the Engineering Institute of Canada held its regular meeting on Wednesday evening, Nov. 6th, 1940, at the Marquis Hotel with W. Meldrum presiding. Routine business was first attended to, then members and visitors assembled to listen to the address of the evening. Among the visitors were A. D. McLean, Superintendent of Air-Ways, Civil Aviation Div., Dept. of Transport and Flight-Lieut. J. F. Grant, Assistant to Air Commodore Cowley.

Mr. Knutson introduced the speaker, Ewan D. Boyd, Officer in charge of the Air Traffic Control Tower at Kenyon Field, who spoke on **Air Traffic Control.**

At the close of his address Mr. Boyd, assisted by Mr. Paul Doyle of the Air Traffic Control Staff, showed on a screen a large number of pictures of various airports of the North American Continent: New York, Toronto, Winnipeg, Chicago, Detroit and Lethbridge.

The number of questions asked of the speaker, after the address, was a good indication of the widespread interest in flying and all things connected therewith.

G. S. Brown had the support of the entire meeting in moving that a vote of thanks be accorded Mr. Boyd.

The meeting closed with the singing of the national anthem, after which refreshments were served by the staff of the Marquis Hotel.

On Wednesday evening, December 18th, 1940, the Lethbridge Branch of the Institute held its regular meeting in the Marquis Hotel.

In conformity with custom this was Ladies' Night and a suitable programme had been arranged.

In the unavoidable absence through sickness of the chairman of the branch, W. Meldrum, the meeting was presided over by J. M. Campbell. Following the singing of "O Canada," about 40 members and guests sat down to an excellent dinner, which was further enhanced by the music of Mr. Geo. Brown and his orchestra. Following the dinner the meeting was entertained by Mrs. Cull's group of young ladies in a delightful rendering of Christmas carols and popular songs. Lethbridge may well be proud of Mrs. Cull and her young ladies, who have done such splendid work in a good cause over a period of years. The Chairman conveyed to them the thanks and appreciation of the Lethbridge Branch as they prepared to leave.

After a short period of Community Singing led by Mr. R. S. Lawrence, and in which all joined, Mr. Chas. Daniel obliged with three songs which were much enjoyed.

The Chairman tendered the thanks of the Lethbridge Branch to Mr. Geo. Brown and his orchestra, and to Mr. Daniel for their contribution to the entertainment of the meeting. He then proceeded to give the meeting a resume of the proceedings of the joint meeting of members of the Association of Professional Engineers of Alberta and members of the Engineering Institute of Canada, held in Calgary on Saturday, Dec. 14th, 1940, for the signing of the co-operative agreement.

The chairman then called on J. T. Watson to introduce the speaker for the evening, J. G. Maxwell, traffic representative, Trans-Canada Air Lines. In introducing the speaker Mr. Watson paid tribute to Geo. Wakeman, general traffic manager, Trans-Canada Air Lines, Winnipeg, who had so kindly provided the films and equipment, and had arranged for a representative to come from Calgary to display them.

Mr. Maxwell stated that Lethbridge, one of the first stations on the T.C.A. system, was a good business point for the T.C.A. To give an idea of the volume of business handled by T.C.A. he stated that it carries an average of 90,000 lb. of mail per month, and has a load average of 70 per cent. Growth has been phenomenal and extensions of the service only await delivery of new planes which are expected in the next few months.

In a brief explanation of the motion pictures to be shown the speaker said that one entitled "African Skyways" was released by British Overseas Airways, which despite the war was still maintaining its service to and across Africa; and that the other entitled "The Swift Family Robinson" was released by Trans-Canada Air Lines and was being shown for the first time in western Canada, both pictures being complete with 'sound.'

"African Skyways" began with scenes of jungle life—elephants, giraffes, alligators, wart-hogs, hippopotami, and others, while from the 'sound' equipment came the chanting of natives, then followed scenes showing giant aircarft at various stages of flight across Africa from Alexandria to Cape Town; threshing with oxen, lifting water by hand for irrigation along the Nile, gold and diamond mines and native dances at Kimberley, how mail is delivered and collected at the "far flung outposts of Empire"; places which formerly could only be reached after arduous travel for several weeks by sea and land, now being reached by air travel in a few hours. The whole picture was filled with interesting glimpses of Africa and air travel across its vast distances.

"The Swift Family Robinson" was a motion picture in colour depicting the flight by air of the Robinson family from Montreal to Vancouver. It showed many of the interesting features of such a trip as it followed the progress of the Robinsons across Canada, and gave those present a better conception of Canada's great accomplishment, "Trans-Canada Air Lines."

Mr. Maxwell then expressed his willingness to answer questions, and the general interest in airways and flying was evident in the number of questions asked, all of which were ably dealt with by Mr. Maxwell.

A vote of thanks to Mr. Maxwell and Trans-Canada Air Lines was moved by C. S. Clendening, and heartily endorsed by all present.

LONDON BRANCH

Harry G. Stead, Jr.e.i.c. - - *Secretary-Treasurer*
John R. Rostron, m.e.i.c. - *Branch News Editor*

The regular meeting of the London Branch was held in the Board Room of the Public Utilities Commission, on Thursday evening, December 12th. The special speaker was Professor Robt. F. Legget, assistant professor of civil engineering at the University of Toronto, who chose as his subject, **Engineering in the MacKenzie River Basin.**

The speaker first described the geography of the area, which indicated that the MacKenzie River is one of the eight major river systems of the world, second only in size, in North America, to the Mississippi. Its catchment area is about 682,000 sq. mi., as compared with the St. Lawrence basin of 498,000 sq. mi. From its source to its several mouths in the Arctic Ocean, the MacKenzie River is 2,525 mi. long. Great Slave Lake, which is the largest fresh water area in the region, has a surface of 12,000 sq. mi. It is the fourth largest great lake of the North American continent.

Since the coming of the aeroplane in 1921, this region has opened up to the prospector, where formerly its activities were confined to the trapper and the Hudson Bay posts. To-day, industry has developed a salt well with processing plant, two water-power plants, five gold mines, an oil refinery, and the mine on Great Bear Lake, now not operating, from which radium was obtained.

Professor Legget described the engineering features of these several activities, and especially referred to the difficulties in transportation from the commercial centre at Edmonton to the operations of these several industries.

His address was illustrated with lantern slides, and the speaker was thanked by Chairman H. F. Bennett for his kindness in coming to London, and for the very excellent and informative address which he had given.

Many of the 23 members and guests present took part in the discussion, and Professor Legget added much to his address by his informative answers.

OTTAWA BRANCH

R. K. Odell, m.e.i.c. - *Secretary-Treasurer*

An illustrated address on the **Development of Mechanical Transport** was presented at the noon luncheon of the branch on December 19, 1940. Major M. M. Evans, Technical Staff Officer, Directorate of Ordnance Services, Department of National Defence, Ottawa, was the speaker.

The automotive industry has been of tremendous help in solving the problems of design and production of mechanized units for the Canadian forces and for shipment overseas, stated Major Evans. Among other things they have made available their personnel for this service almost to the point of crippling themselves. From this personnel has been drawn many of the present technical staff of the Department of National Defence that has to deal with mechanization.

The work for the staff has been very heavy, particularly at first, with twelve-hour days the rule and Sunday also being utilized. However, within a year after war was declared, many thousands of vehicles manufactured in Canadian plants have been shipped overseas and many more used in Canada for training and other purposes.

In the first Great War, stated the speaker, there were no specialized vehicles for military purposes, and the commercial trucks used were not entirely satisfactory. So great was the need felt for special and more rugged types of vehicles that the British War Office, in common with other countries, started in to develop specialized military units, using the experiences of the war as a guide. In the meantime, however, commercial vehicles themselves rapidly improved to such an extent that the War Office felt they could forgo their own investigations and use trucks and other vehicles right out of the factory. Then in the early 30's they adopted the practice of specially designing the vehicles again but employing as many commercial parts as possible.

The speaker, by the use of slides, illustrated the various types of vehicle equipment required, including equipment for the carrying of personnel, headquarters staff officers, wireless apparatus, machine gun units, anti-tank guns, and for hauling heavy artillery. In general much of the equipment has to have front wheel drive to obtain added traction, a short wheel base, large tires to give flotation over soft ground, high clearance for rough ground, and every facility for easy manoeuverability. They should be able to operate in any climate and maintenance problems should be reduced to a minimum.

In the manufacture of vehicles for the present war, special attention has been paid to the matter of standardization. The importance of this feature was stressed by the speaker, the idea being that the easy interchangeability of parts makes for rapid replacements or repairs whether in this country or overseas.

Although many hurdles have had to be surmounted in carrying out the programme set down, stated Major Evans, progress has been good and, incidentally, costs have been kept below what would have been required for purely commercial vehicles had they been used for the purpose. Production is now going on in full swing with many orders being turned out for the British Government as well.

W. H. Munro, chairman of the Ottawa Branch of the Institute, presided.

PETERBOROUGH BRANCH

A. L. Malby, Jr.E.I.C. - *Secretary-Treasurer*
E. Whiteley, s.e.i.c. - *Branch News Editor*

For twenty years, the Annual Dinner has marked an anniversary of the founding of Peterborough Branch of the E.I.C. Each year has added to the tradition of the event until, like most birthday celebrations, it is now something to look forward to, and to remember.

This year was no exception. Some 85 members and guests met at the Kawartha Golf and Country Club for the dinner on November 20th.

Dr. Thomas H. Hogg, president of the Institute, was introduced to the meeting by Mr. G. R. Langley. Peterborough Branch has been consistently fortunate in having the president at their annual dinner. Dr. Hogg outlined some of the present activities of the E.I.C. as a national organization. He mentioned the recent election of the E.I.C. to membership in the Engineer's Council for Professional Development, an important event in the life of the Institute. Progress was reported in the work of associating the E.I.C. and various provincial Associations of Professional Engineers, particularly in Nova Scotia, New Brunswick and Manitoba.

Annual Dinner of the Peterborough Branch.

These talks by the president are very helpful in bringing to each member a realization that the Institute is a national organization with activities beyond those of the local branches.

Mr. De Gaspé Beaubien, treasurer of the Institute, and joint chairman of the National War Savings Committee then addressed the gathering, in the latter capacity, on the economic aspects of the present war savings scheme. A brief summary follows.

There are very good reasons why the government issued War Savings Certificates as well as War Loan Bonds. The one appeals to classes that cannot be reached by the other. Also, the certificate appeals to savings in progress, the bond appeals to existing savings. They supplement each other.

And there are broader economic reasons for the War Savings Certificate. In normal times the financial and economic equilibrium of the country is regulated by supply and demand; e.g., over production leads to lower prices and a slackening of production or increase in consumption which restores the balance. The war introduces abnormal factors. Quantities of new products are required and new industries spring up. The country's wages are increased by some $900,000,000 per year. At the same time old industries have part of their productive capacity diverted to war work; there are no more goods than normal to be bought, in some cases less. If people with enhanced purchasing power compete to buy these goods an increase in prices would be inevitable and the vicious spiral of rising wages and rising prices means inflation. This could easily paralyze industry, disrupt our capital structure, and lead to labour trouble, all of which must be avoided at a time when our factories must supply equipment that is as vital for victory as fighting men.

The War Savings Certificate was designed to curtail inflation by diverting present excess purchasing power. This can be done by taxation to a limited extent, but in a free country such as this one, the restraint in handling excess purchasing power is preferably voluntary.

The National Committee supplies leadership, but actual selling and boosting of sales is done by local committees. Some 1,500 of these have been set up and are doing splendid work. All of this work, with the exception of a few full time workers at the Bank of Canada, is voluntary.

Peterborough Branch is indebted to Mr. Beaubien for an inspiring insight into this phase of our national war effort. Economics can be dry, but Mr. Beaubien made this issue a living one for his hearers, very interesting and stimulating.

There have been many annual dinners, all similar, yet each different. We will remember this 20th dinner for its association with Dr. Hogg and Mr. Beaubien, and for its minor but no less pleasant features—the stirring songs of Mr. Frank Oldfield, the reminiscing of Mr. C. E. Sisson, the stories of Mr. A. L. Killaly, and the notable introduction of Mr. Beaubien in both English and French by Mr. J. M. Mercier.

"There be of them that have left a name behind them..."

Those of us who live in city or district where street and place names are those of persons must have wondered about the people who are thus remembered. We wonder, but not often can we learn much about them.

Just such an unusual opportunity was given to the members of Peterborough Branch at their meeting, December 5, 1940. One of our members, Mr. J. W. Pierce, O.L.S., D.L.S., M.L.S., has spent many years as Land Surveyor in Peterborough and the surrounding districts. In the course of his work he has fallen heir to notes and papers of the early surveyors of these parts and has made an interesting hobby of collecting them. With some of these old notes, letters, and maps as illustrations, Mr. Pierce addressed the branch on **Early Surveys and Land Surveyors in Peterborough.** It was a colourful story that everyone enjoyed a great deal. Though it cannot be reproduced as told, and it loses much if a reader is not familiar with the local background in it, a brief summary follows for the benefit of the historically minded among readers of the Journal.

Surveys were begun in Ontario in 1783.

The townships of Monaghan and Smith were surveyed in 1817 and 1818 by S. S. Wilmot.

The town plot of Peterborough was laid out by Richard Birdsall in 1825. As happened in many Canadian cities, some streets followed the Indian portage trail, the rest were oriented to township lines.

John Houston came next, a colourful figure, born in Ireland, 1790, and commissioned a land surveyor in 1820. He served as local supervisor in the settlement of Peterborough district by Irish immigrants from 1825 on. He was a natural leader and besides being a surveyor was also justice of the peace, coroner, and later a major in the local militia. He surveyed the townships of Verulon and Methuen, and completed the survey of Peterborough in 1833-34.

John Reid, born 1807 in Ireland, came to Canada in 1822 and became a surveyor in 1837. He and his friend, Hon. T. A. Stewart, gave us our Reid street and Stewart street. As a surveyor, John Reid is remembered for his location of the north boundary of Peterborough in 1845 and the Burleigh road 1855.

G. A. Stewart and Sandford Fleming were apprenticed to John Reid in his survey practice. The former moved to Port Hope and finally became first superintendent of Banff National Park.

Sandford Fleming is well known as the engineer who gave us Standard Time. Mr. Pierce showed the meeting a reproduction of a map of Peterborough which Sandford Fleming engraved and printed during one of his winters as an apprentice. It was a remarkable piece of draughtsmanship.

Theodore and Mutius Clementi (whose father, Muzie Clementi, invented the pianoforte) were also among the apprentices with John Reid. They built the first of the now numerous summer cottages on beautiful Stony Lake.

J. W. Fitzgerald (born 1828) became a land surveyor in 1857 and came to Peterborough then. He did considerable work on the subdivision of townships around the city.

The records show among these early surveyors also J. W. Junior, T. Hewson (born 1846, P.L.S. 1866, died 1898) and A. J. Cameron (born 1864, P.L.S. 1889, died 1912).

No history of Peterborough would be complete without a mention of its famous lift lock. This was first suggested by a local man, Richard Birdsall Rogers (born 1857, P.L.S. 1879), also one of the early surveyors of the district.

During the discussion which followed Mr. Pierce's talk, our dependence on the landmarks left by these early surveyors was brought out, and incidentally, a project first sponsored by Mr. Pierce was mentioned—that of locating as far as possible the original marks of these early surveys and replacing the fast disappearing stones and trees on which these marks were made by more permanent concrete posts. The Ontario government had undertaken this worthwhile task, but lately had allowed it to lapse.

SAINT JOHN BRANCH

V. S. Chesnut - *Secretary-Treasurer*

G. L. Dickson, from Moncton, was elected president of the Association of Professional Engineers of the Province of New Brunswick at the annual meeting, held January 14th at the Admiral Beatty Hotel, preceding the annual joint dinner of the association and the Saint John Branch of The Engineering Institute of Canada. Mr. Dickson succeeds G. A. Vandervoort of Saint John as president.

Also elected to office were A. A. Turnbull, Saint John, as vice-president, and C. C. Kirby, Saint John, secretary-treasurer, while the following new councillors were elected: W. L. Lawson, Fredericton; A. R. Bennett, Moncton. Four councillors who still have another year to serve are V. C. Blackett, Moncton; R. K. Wills, Chatham; James T. Turnbull, Saint John, and Mr. Kirby.

J. P. Mooney, chairman of the Saint John branch of the Institute, presided over the dinner. The guest speaker was J. A. McCrory, vice-president and chief engineer of the Shawinigan Engineering Company, whose subject was **The La Tuque Development in Quebec.**

Mr. McCrory gave an illustrated address on the hydro development project carried out on the St. Maurice river, a scheme which has taken on huge proportions in the last two years. A four-unit plant is now in operation each at 50,000 hp. he said. Three had been in service continually since the plant was opened January 1st.

The fourth unit was operating at capacity much of the time, as well. By the use of slides he traced the construction work from its start in 1938. The dam is 1,337 ft. long and 100 ft. high. With completion of the construction contracts the entire facilities are now in the hands of the operators.

About 40 years ago, said Mr. McCrory, the first development in this area was carried out with a delivery of about 2,000 hp. to Montreal. With a view to bringing about the latest development a study was made of its possibilities in 1927.

The speaker dealt extensively with the entire project and outlined the progress being made in La Tuque's contribution to wartime industrial needs as a result of the last two years' construction programme.

SASKATCHEWAN BRANCH

Stewart Young, m.e.i.c. - *Acting Secretary-Treasurer*

A joint meeting of the Saskatchewan Branch of the Institute and the Saskatchewan Association of Professional Engineers was held in the Kitchener Hotel, Regina, on Friday, December 20, 1940, with 44 members and guests in attendance. The speaker of the evening, G. T. Chillcott, District Airways Engineer, Department of Transport, gave a comprehensive picture of the advance made during the past year in **Airport Construction in Saskatchewan.** A hearty vote of thanks was tendered the speaker on motion of H. R. MacKenzie. P. C. Perry, Branch Chairman, was in charge of the meeting.

SAULT STE. MARIE BRANCH

O. A. Evans, Jr.e.i.c. - *Secretary-Treasurer*
N. C. Cowie, Jr.e.i.c. - *Branch News Editor*

The Sault Ste. Marie Branch of the Institute held its annual meeting on Friday, December 20th, in the Grill room of the Windsor Hotel. Twenty members and guests sat down to an appetizing turkey dinner at 7.30 p.m.

The business portion of the meeting began at 8.15 p.m. The minutes of the previous meeting were read and adopted on motion of A. M. Wilson and A. E. Pickering.

The secretary's report was then read and adopted on motion of L. R. Brown and A. E. Pickering. W. M. Reynolds then brought in the report of the Nominating and Scrutineers Committee on the results of the election. The following were elected to office: E. M. MacQuarrie, chairman; L. R. Brown, vice-chairman; O. A. Evans, secretary-treasurer; N. C. Cowie, resident executive; C. R. Murdock, of Kapuskasing, non-resident executive. The chairmen of the various committees then brought in their reports. L. R. Brown and A. M. Wilson moved that W. M. Reynolds and N. C. Cowie be appointed auditors for the year 1941. F. Smallwood and N. C. Cowie moved that the secretary's honorarium be paid.

The society was then favoured by a short address by Judge MacDonald who left a few thoughts with members.

The chairman then thanked the members for their co-operation during the year. C. Stenbol moved that the meeting be adjourned.

VANCOUVER BRANCH

T. V. Berry, m.e.i.c. - - *Secretary-Treasurer*
Archie Peebles, m.e.i.c.- *Branch News Editor*

On the occasion of the visit to Vancouver of Dr. Thomas H. Hogg, president of the Institute, the branch held a dinner meeting at the Georgia Hotel on Monday, December 16th. Forty-two members and guests attended, and bid welcome to Dr. Hogg and his party. Dean J. N. Finlayson, branch chairman, presided, and others at the head table included Dr. O. O. Lefebvre, Institute past president; J. A. Vance, chairman of Papers Committee; C. K. McLeod, councillor of the Institute and past chairman of the Montreal branch; L. Austin Wright, general secretary; Dr. E. A. Cleveland and Major G. A. Walkem, past presidents of the Institute.

In a brief address, Dr. Hogg outlined the progress of negotiations towards the affiliation of the Engineering Institute of Canada with the various provincial Associations of Professional Engineers. An agreement has recently been concluded with the Alberta Association, which is the third province now having common membership arrangements with the Institute.

In the opinion of the speaker, Canada will probably receive a large influx of population from those countries of Europe which are now being subjected to the destructive agencies of war, and which will not be able to support their own people after the war is finished. People from countries which, through no desire of their own, have been over-run in the course of the war, will be anxious to get away from the scene of such destruction and the hardships which it will bring, and many of them will look towards Canada as a country offering them the opportunity to build a new home and enjoy it in peace. These people will bring with them industrial and agricultural skill, and perhaps capital, and will take part in a period of expansion in Canada, such as always takes place with an increase of population. While the future cannot be predicted beyond a certain period, if this post-war growth is based on sound principles, there is no reason why it should not continue for a long time.

The engineering profession will share in this rehabilitation, and will also have to do its part in the reconstruction of those countries which are in the actual theatre of conflict.

Other members of the visiting party also spoke briefly.

Dr. Lefebvre recalled his previous visits to Vancouver with obvious pleasure, and pointed out that since his term of office as president of the Institute it had become a custom for that officer to visit the western branches. He also gave further information on the relations between the Institute and the provincial associations. He did not see any pertinent difficulties in the way of an agreement for common membership in British Columbia. In New Brunswick, those problems which had arisen have been satisfactorily solved, and the path is clear for such an agreement. A similar situation is progressing favourably in Manitoba. In Quebec and Ontario there is not yet sufficient demand for affiliation, although there is a large existing common membership.

Mr. McLeod brought the greetings of the Montreal Branch, and hoped that a closer association of the branches might be brought about through the visits of members to other branches.

Mr. Vance spoke of the difficulty of arranging a central clearing house for papers to be published in the Journal. He suggested that each branch should take the initiative in submitting worth-while papers and addresses given at its own regular meetings, for publication. He also stressed the value of communicating with headquarters and other branches when a member was travelling across the country. Engineers do a considerable amount of travelling as a group, and often overlook the value to be found in visiting members of other branches at such times.

Mr. Wright spoke on the activities of the Council, and gave many examples of the problems which face it in the course of furthering the interests of the profession. Some of these difficulties are not widely known, as they are not discussed outside of council, but they exist, and require a great deal of time and effort in dealing with them. At the present time most of such problems have to do with the placing of technically trained men in the new industries arising out of war production. The necessity for a proper control of trained personnel is becoming greater every day, in order that war production shall not lag on account of inefficient placing of trained persons. Various government departments have control over such matters, so that it is necessary to secure co-operation between the government and the engineering profession. A great deal of work has already been done by the engineering societies, and it is felt that full and complete advantage of this has not yet been taken in the placing of engineers in their proper fields in the war effort.

At the close of the meeting a motion was made by Mr. I. C. Barltrop to send the best wishes of the Vancouver Branch to Mr. R. J. Durley, secretary-emeritus of the Institute. This was unanimously carried.

VICTORIA BRANCH

Kenneth Reid, m.e.i.c. - *Secretary-Treasurer*

The presence of Dr. T. H. Hogg, president of the Institute, and the general secretary, Mr. L. Austin Wright, at the ceremony of the signing of the agreement between the Alberta section of the Engineering Institute and the Association of Professional Engineers of Alberta in Calgary on December 14th presented the opportunity of an invitation being extended to the president and his party to pay a visit to the British Columbia branches as well, while in western Canada. Subsequently, arrangements were made for a general meeting of the Victoria Branch to be held in honour of President Hogg on the evening of December 17th at the Pacific Club, Victoria.

The meeting was preceded by a dinner at which twenty-six members and a few friends were present. The unfortunate circumstances necessitating the immediate return of Dr. Hogg to the East after visiting the Vancouver Branch was a very great disappointment to the Victoria members, however the presence of Past President Dr. O. O. Lefebvre and Mr. J. A. Vance somewhat alleviated this keen regret. Mr. E. W. Izard, chairman of the Branch, presided at the dinner and meeting to which Dr. W. A. Carrothers, chairman of the B.C. Public Utilities Commission, and Mr. H. D. Parizeau, Dominion hydrographer, were among the guests present.

Following a few short business transactions, the chairman called upon Dr. O. O. Lefebvre to address the meeting. Dr. Lefebvre spoke of his previous delightful experiences in his visits to the Coast, and the pleasure of escaping, if even for a short time, the cold and snow now being experienced on the Prairies and eastern Canada. He told of the meeting in Calgary and the signing of the agreement for the Alberta engineers, expressing the hope for an early movement of a similar nature in British Columbia and in certain other provinces of Canada. He mentioned the necessity for a proper classification of engineers, citing a number of abuses of the term which had recently come to his notice. The field of operations for the Institute and the Associations were outlined, the latter to regulate the practice of engineering and the Institute to promote engineering interests.

The general secretary, Mr. L. Austin Wright, being asked to speak, told of the affairs of the Institute at Headquarters, stating that the membership had now exceeded the five thousand mark for the first time in fifteen years and that the finances were in very good condition. He expressed the regrets of Dr. Hogg at not being able to be present explaining the necessity of his sudden and hurried return to Ontario. Mr. Wright spoke of the great co-operation and assistance that the Institute was rendering to the Dominion government at Ottawa and of the many placements of highly qualified technical engineers in war services through this co-operation. He also mentioned a number of details in connection with the very successful meeting recently held in Calgary.

The chairman next called upon Mr. J. A. Vance, who is at present chairman of the Institute's Papers Committee, to say a few words. Mr. Vance spoke of the work of his committee during the past year and particularly stressed the importance of branch visits and the exchange of speakers between adjacent or near branches. The value of keeping other branches informed of meetings and of the movements of engineers in their territory who might give addresses was stressed as an excellent means of stimulating the interest in the Institute and the branches.

Brief addresses of welcome and expressions of thanks to the visiting speakers were accorded by Mr. F. C. Green, Mr. A. L. Carruthers, Mr. Kenneth Moodie, and Mr. H. D. Parizeau and thus terminated another very successful and interesting Victoria Branch meeting.

Library Notes

Book notes, Additions to the Library of the Engineering Institute, Reviews of New Books and Publications

LIST OF NEW AND REVISED BRITISH STANDARDS

(Issued during October, 1940)

B.S. No.

436-1940—Machine Cut Gears, A. Helical and Straight Spur. (Revision).
This revision includes several important additions, and many improvements have been made in the charts in order to save time in calculations.

693-1940—Oxy-Acetylene Welding in Mild Steel. (Revision).
This specification is now in line with the code issued by the London County Council with regard to the use of oxy-acetylene welding in London, and also includes some simplified tests which will be sufficient to ensure sound welding.

789A-1940—Steel Tubes and Tubulars, Light-Weight and Heavy Weight Qualities. (Revision).
To meet the urgent need for the utmost economy in steel consumption, this War Emergency British Standard has been prepared at the request of the Ministry of Supply to supersede the B.S. 789-1938.
It provides for the replacement of the former three qualities (gas, water and steam), by two qualities designated respectively "light weight" and "heavy weight."

909-1940—Vitamins A and D in Oil for Animal Feeding Purposes.

910-1940—Controlled Cod Liver Oil Mixture for Animal Feeding Purposes.
The above two War Emergency Standards have been issued at the request of the Ministry of Food.
Following the outbreak of war an announcement had been made by the Ministry of Food in regard to war time veterinary cod liver oil. In order to ensure an adequate supply of veterinary cod liver oil the Ministry, together with the Ministry of Agriculture and Fisheries, had approved a scheme involving the dilution of stocks of cod liver oil of a high vitamin potency with a suitable marine oil to be supplied by the Ministry.

920-1940—Naval Brass Die Castings.
Provides for naval brass castings and specifies both the chemical composition of the ingots and the mechanical properties of the castings.

921-1940—Rubber Mats for Electrical Purposes
The mats referred to are rubber insulating mats for use as a floor covering near electrical apparatus in circumstances involving the possibility of direct contact with equipment of which the voltage does not exceed 3300 volts to earth.

922-1940—Domestic Electrical Refrigerators
This Specification prescribes the general constructional requirements, the performance and the methods of computing the capacity and food-storage area of domestic electrical refrigerators.

923-1940—Impulse-voltage Testing
Deals with the general principles of impulse-voltage tests with the object of determining the effect of voltage surges of short duration (such as are caused by lightning discharges) on electrical installations and on their individual parts.

924-1940—Rubber Hose with Woven Fabric Reinforcement
Provides for mandrel-built, wrap-cured rubber hoses internally reinforced by plies of woven fabric for air, low and high pressure water, chemical and brewers' maximum length 60 feet.

Prices—No. 436 7/6d Net. Post free 7/10d.
Remainder 2/– each Net. Post free 2/3d each.

Copies of the new specifications may be obtained from Canadian Engineering Standards Association 79, Sussex Street, Ottawa, Ontario.

CANADIAN ENGINEERING STANDARDS ASSOCIATION

NEW AND REVISED STANDARDS

C.E.S.A. No.

C22.2. No. 1A 1940—Second Edition. Power-Operated Radio Devices. Section (A) Inductively-coupled (Transformer) Type.

The Canadian Engineering Standards Association announces the revision of Specification C22.2 No. 1—Power operated Radio Devices—which was originally issued in March, 1932, and is now issued in two sections, namely "Section (A)—Inductively-coupled (Transformer) type" and "Section (B)—Conductively-coupled (Transformerless) Type." Both sections are Approvals Specifications issued under Part 11 of the Canadian Electrical Code, the requirements of which must be met in order to obtain C.E.S.A. approval of the electrical equipment concerned. Section (A), now published, becomes effective for new production on the date of publication, November 30th, 1940, and Section (B), which is still in committee stage, will be published shortly.

C22.2 No. 35 1940—Second Edition. Extra-Low Potential Control Circuit Wires and Cables.

The Canadian Engineering Standards Association announces the publication of a revised edition of Specification C22.2 No. 35—Extra-low Potential Control-circuit Wires and Cables which was originally issued in December, 1936, and is now issued as an Approvals Specification under Part 11 of the Canadian Electrical Code, the requirements of which must be met in order to obtain C.E.S.A. approval of the electrical equipment concerned. This specification is effective as of February 15th, 1941, for new production. The requirements of the specification have been modernized, particularly the section dealing with insulation which has been revised and extended to include rubber insulation. This rubber insulation is to be protected by a closely woven cotton braid covered with a flame-proofing compound to enable the insulation to withstand the flame test. The requirement relative to the size of conductor has been broadened so that either No. 18 or No. 16 B. & S. gauge copper wire can now be used.

C22.2 No. 69 1940—Porcelain Cleats, Knots and Tubes

The Canadian Engineering Standards Association announces the publication of a new Approvals Specification, C22.2 No. 69-1940—Porcelain Cleats, Knobs and Tubes—under Part 11 of the Canadian Electrical Code, the requirements of which must be met in order to obtain C.E.S.A. approval of the electrical equipment concerned. This specification is effective as of March 15th, 1941, for new production.

The standard was prepared in collaboration with interested manufacturers and industrial associations, and is based on laboratory tests and record in service. Its requirements apply to the construction and test of porcelain cleats, knobs and tubes intended for the support of wires and cables in open-wiring and in knob-and-tube work. Knobs intended for over-surface wiring are not within the scope of this specification.

Copies of these Standards may be obtained from the Canadian Engineering Standards Association, National Research Building, Ottawa, price 50 cents each.

ADDITIONS TO THE LIBRARY

TECHNICAL BOOKS

Cofferdams

By Lazarus White and Edmund Astley Prentis, New York, Columbia University Press, 1940. 273 pp., 9½ x 6¼ in., $7.50.

Minerals Yearbook, 1940

Published by the United States Department of the Interior, Bureau of Mines. Washington, 1940. 1511 pp., 6 by 9¼ in.

The Canadian Almanac, 1941

Edited by Horace C. Corner, Toronto, Copp Clark Company, Limited, 6 x 9 in., $7.00.

TRANSACTIONS, PROCEEDINGS

American Society of Civil Engineers

Proceedings, Part 2, October 1940, V. 66.

Institution of Naval Architects

Transactions of the Institution of Naval Architects, 1940.

REPORTS

Canadian Broadcasting Corporation

Annual Report for the fiscal year ended March 31, 1940. Ottawa, King's Printer, 1940.

Canadian Engineering Standards Association

Canadian Electrical Code Part 2, Essential Requirements and Minimum Standards Covering Electrical Equipment, specification No. 35 Construction and test of extra low potential control-circuit wires and cables.

Canadian Electrical Code Part 2, Essential Requirements and Minimum Standards Covering Electric Equipment, specification No. 1 Construction and test of power-operated radio devices. Section (A) Inductively coupled (Transformer) type.

Cornell University—Engineering Experiment Station

Ultrasonics and Elasticity by H. F. Ludloff, July, 1940.

The Engineering Foundation

Annual Report for 1939-1940.

Institute of The Aeronautical Sciences

Bibliography of Aeronautics; part 1, Transportation; part 2, Meteorology; part 3, Insurance; part 5, Seaplanes; part 6, Flying Boats; part 7, Amphibians; part 8, Autogiros; part 9, Helicopters; part 10, Cyroplanes; part 11, Medicine.

Ohio State University—Engineering Experiment Station

America's Sources of Power and National Defence, by C. E. MacQuigg, November, 1940. Circular No. 38.

Portland Cement Association

Concrete Grandstands. Chicago, Portland Cement Association.

U.S. Department of Commerce—Building Materials and Structures

Structural Properties of a Precast Joist Concrete Floor Construction Sponsored by the Portland Cement Association, BMS62; Plumbing Manual, report of subcomittee on Plumbing, Central Housing committee on research, design and construction, BMS 66; Effects of wetting and drying on the permeability of masonry walls, BMS 55; A survey of Humidities in residences, BMS 56; Roofing in the United States—Results of a questionnaire, BMS 57; Properties of adhesives for floor coverings BMS 59.

University of California Publications

Phylogeny of North American Equidae, by R. A. Stirton, Berkley University of California Press, 1940.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet the books are not in the Institute Library, but inquiries will be welcomed at headquarters, or may be sent direct to the publishers.

(THE) AIRCRAFT PROPELLER, Principles, Maintenance and Servicing.

By R. Markey. Pitman Publishing Corp., New York, 1940. 155 pp., illus., diagrs., charts, tables, 8½ x 5 in., cloth, $1.50.

This text has been written to explain the workings of the aircraft propeller to student pilots, mechanics and laymen. Elementary aerodynamics and the construction and maintenance of propellers are dealt with, and separate chapters are devoted to description of certain types of constant-speed and varia able-pitch propellers. There is a list of definitions.

(THE) AIRPLANE and ITS ENGINE

By C. H. Chatfield, C. F. Taylor and S. Ober. 4 ed. McGraw-Hill Book Co., New York, 1940. 414 pp., illus., diagrs., charts, tables, 8½ x 5½ in., cloth $3.00.

This book is intended "for the reader who desires a sound knowledge of the basic principles and a broad view of the present development of the airplane and its power plant, without giving to the subject the intensive study which is essential for the designing engineer or the expert mechanic." The new edition has been carefully revised to cover recent developments in all lines.

ANNUAL REVIEWS of PETROLEUM TECHNOLOGY, Vol. 5, 1939.

By F. H. Garner. Institute of Petroleum, c/o The University of Birmingham, Edgbaston, Birmingham 15, England, 1940. 457 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, 11s.

Reviews by experts of developments during 1939 are contained in this annual compilation covering the whole range of petroleum technology; geology, geophysics, drilling and production, transportation and storage, refining operations, gasoline and oil engines, lubrication, analysis and testing, etc. A new chapter on addition agents is included in this volume. In addition to chapter references there is a general review of petroleum literature in 1939, and the last chapter furnishes production and commercial statistics.

CATALYSIS, Inorganic and Organic

By S. Berkman, J. C. Morrell and G. Egloff. Reinhold Publishing Corp., New York, 1940. 1130 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $18.00.

This extremely comprehensive work discusses the phenomenon of catalysis, describes the various catalysts and the reasons for and extent of their activity and, in general, gives a systematic presentation of the subject with some consideration of its historical evolution. Inhibitors, promoters, poisons, carriers and characteristic catalytic reactions in inorganic and organic chemistry are discussed. There is a 350 page classification of catalysts with respect to type of reaction, and a final chapter dealing with catalysis in the petroleum industry. The work is thoroughly documented.

(THE) DEVELOPMENT of MATHEMATICS

By E. T. Bell. McGraw-Hill Book Co., New York and London, 1940. 583 pp., 9½ x 6 in., cloth, $4.50.

The author presents a broad account of the part played by mathematics in the evolution of civilization, describing clearly the main principles, methods and theories of mathematics that have survived, from about 4000 B.C. to 1940. Besides outlining the development of the leading ideas, the book gives the student a well-rounded understanding of the story by explaining the mathematics involved. Details of antiquarian interest are subordinated to a fuller exposition of things still alive in mathematics than is customary in histories.

DISPLACEMENT, VELOCITY and ACCELERATION FACTORS for RECIPROCATING MOTION

By L. B. Smith. P.O. Box 317, Hampton, Va., 1940. 17 pp., diagrs., tables, 9 x 6 in., paper, $.40 (3 copies, $1.00)

The tables presented in this pamphlet are intended for the use by engineers and others who need to compute displacement, velocity and acceleration factors for a reciprocating motion controlled by a uniform angular motion. A worked-out example of the procedure in using the tables is given, and the derivation of the exact formulas from which the tables were computed is shown in the appendix.

FESSENDEN, Builder of Tomorrows.

By H. M. Fessenden. Coward-McCann, Inc., New York, 1940. 362 pp., illus., tables, 9 x 6 in., cloth, $3.00.

The life and work of one of the well-known American pioneers in radio communication are described by his wife. His technical achievements, in addition to his contributions to this important field, include submarine signalling and detection, the generation and storage of power, and many articles on mathematical, physical and electrical subjects. There is also mention of his researches on the pre-deluge civilizations. A bibliography is appended.

FIRE ASSAYING

By O. C. Sheperd and W. F. Dietrich. McGraw-Hill Book Co., New York and London, 1940. 277 pp., illus., diagrs., charts., tables, 9½ x 6 in., cloth, $3.00.

Designed for the practicing assayer as well as for the technical student, this manual covers the fire assaying of gold, silver, the platinum metals, and certain base metals in ores, metallurgical products, bullions and solutions. The book also contains material on sampling methods, descriptions and lists of assay equipment and supplies and a geographical list of assay supply houses.

GRAPHS, How to Make and Use Them

By A. Arkin and R. R. Colton. rev. ed. Harper & Brothers, New York and London, 1940. 236 pp., illus., diagrs., charts., tables, 9½ x 6 in., cloth, $3.00.

All the usual methods of graphic representation are clearly and simply explained in this introductory work on the subject. The opening chapters present general principles and proper equipment for graph construction, and a wide variety of uses in business, economics, engineering and other fields is illustrated in the succeeding chapters.

MACHINE DESIGN

By L. J. Bradford and P. B. Eaton. 4th ed. John Wiley & Sons, New York, 1940. 275 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $3.00.

The object of this text is to supply a brief course which can be covered in about twenty-five lessons, and which will provide a good groundwork of the fundamental facts and processes of machine design. The new edition has been revised to conform with recent developments, especially in bell and roller bearings, gears and spring design.

MAGNETISM and VERY LOW TEMPERATURES

By H. B. G. Casimir. University Press, Cambridge, England; Macmillan Co., New York, 1940. 93 pp., charts, tables, 8½ x 5½ in., paper, $1.40.

The material contained in this booklet, presented originally in a series of lectures, is a systematic account of the field of research dealing with the relation between magnetism and very low temperature states. Special attention is given to paramagnetism and adiabatic demagnetization. There is a list of references.

MATERIALS HANDBOOK

By G. S. Brady. 4th ed. McGraw-Hill Book Co., New York and London, 1940. 591 pp., charts, tables, 9½ x 6 in., lea. cloth, $5.00.

The many materials used in industry are identified and described in this concise encyclopedic reference book. Information is given on physical and chemical properties, constitution and uses. The materials vary from such basic raw materials as mineral ores and woods to such products as alloy steels and synthetic resins. Intended primarily for purchasing agents and industrial executives, its field is much wider for reference use. Useful tables are appended.

MECHANICAL VIBRATIONS

By J. P. Den Hartog. 2 ed. McGraw-Hill Book Co., New York and London, 1940. 448 pp., diagrs., charts, tables, 9½ x 6 in., cloth, $5.00.

In addition to the theoretical presentation of the subject, this textbook presents practical applications to water wheels, steam turbines, automobiles, airplanes, Diesel engines and electrical machinery. The text has been revised in accordance with recent developments, many new problems have been added and a comprehensive list of useful formulas has been appended. There is a bibliography.

PORT DICTIONARY of TECHNICAL TERMS

Compiled by Committee on Standardization and Special Research. American Association of Port Authorities, 2223 Short St., New Orleans, La., 1940. 208 pp., 9½ x 6 in., cloth, $1.50.

An enlargement of an earlier glossary, this technical dictionary defines words and phrases pertinent to all phases of port and harbor work. Many of the several hundred definitions are of considerable length, where special explanation was thought necessary.

PUBLIC UTILITIES and the NATIONAL POWER POLICIES

By J. C. Bombright. Columbia University Press, New York, 1940. 82 pp., 9 x 5½ in., cloth, $1.25.

This sketch of the New Deal power policies discusses the control of public utilities, rate regulation, holding companies, etc., and their relation to the question of public ownership. The electric light and power industry is used as an example, and the criticisms of present government policy are discussed. Suggestions are given for further reading.

RADIO AMATEUR'S HANDBOOK, 18th ed., 1941

American Radio Relay League, West Hartford, Conn. 552 pp., illus., diagrs., charts, tables, 10 x 6½ in., paper, $1.00, buckram, $2.50.

This well-known manual covers comprehensively the amateur short-wave field. The fundamental principles and the design, construction and operation of transmitting and receiving apparatus are described in detail, including ultra-high frequency, emergency, and portable equipment. Many new illustrations and descriptions of new equipment have been added, and the catalog and manufacturers data section has been expanded.

(THE) RING INDEX, a List of Ring Systems Used in Organic Chemistry. (American Chemical Society Monograph No. 84).

By A. M. Patterson and L. T. Capell. Reinhold Publishing Corp., New York, 1940. 661 pp., diagrs., 9½ x 6 in., cloth, $8.00.

The Ring Index is a collection of known parent ring systems, arranged in order from the simplest to the most complex. It is a compilation of structures, not of compounds, although corresponding compounds exist in nearly every case. Each entry presents the ring structure, commonly used names, even though not formed according to the system, references to original literature and to "Boilstein's Handbuch," and a serial number for future reference. There is an alphabetical index of names, and an appendix containing the proposed international rules for numbering ring systems.

SALES ENGINEERING

By B. Lester. John Wiley & Sons, New York, 1940. 200 pp., diagrs., 9 x 5½ in., cloth, $2.00.

Sales engineering is defined as the art of selling equipment and services which require engineering skill in their selection, application and use. The author discusses the field of sales engineering, describes the work of the sales engineer under current conditions, and indicates the training and development of the sales engineer.

STATISTICAL PROCEDURES and THEIR MATHEMATICAL BASES

By C. C. Peters and W. R. Van Voorhis. McGraw-Hill Book Co., New York, 1940. 516 pp., diagrs., charts, tables, 9½ x 6 in., cloth, $4.50.

This book is designed to bridge the gap between elementary courses in which the formulas are given from a purely authoritative viewpoint, and the original monographic contributions which are often so highly mathematical. The authors bring together and synthesize the classical statistics and certain new developments, explaining mathematical derivations and their use from the viewpoint of students with little mathematical training. Exercises and references accompany each chapter.

STEAM-TURBINE PRINCIPLES and PRACTICE

By T. Croft, revised by S. A. Tucker, 2 ed. McGraw-Hill Book Co., New York, 1940. 298 pp., illus., diagrs., charts, tables, 8½ x 6 in., cloth, $3.00.

This book gives the operating engineer, the plant superintendent and the manager the information necessary for the successful and economical selection and operation of steam turbines. It covers installation, lubrication, testing and maintenance with special attention given to the economics of steam-turbine operation. The new edition has been generally revised to conform to current practice and has a new chapter describing the engineering principles involved in turbine selection and heat balance.

(THE) Story of SUPERFINISH

By A. M. Swigert, Jr. Lynn Publishing Co., Detroit, Mich., 1940. 672 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $5.00.

The equipment, technique and advantages of the metal finishing process called "superfinish" are discussed at length. Other methods for producing machined surfaces are described in detail, all methods for measuring machined surfaces are fully treated, bearing materials and design are considered, and the metallurgy and lubrication of metal surfaces are given considerable attention. The book is illustrated by a profusion of graphs, diagrams, photographs and photomicrographs.

PRELIMINARY NOTICE

of Applications for Admission and for Transfer

January 22nd, 1941

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, 1941.

L. Austin Wright, General Secretary.

*The professional requirements are as follows:—

A 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 attainment 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

DE BONDY—JOSEPH AGAPIT, of Selkirk, Man., Born at Sorel, Que., May 1st, 1895; Educ.: 1905-13, Mount St. Bernard College, incl. chemistry and physics. Personal study and travel; 1915-16, lab. asst., Beauchemin & Fils Ltee., Sorel, Que.; 1916-17, lab. chemist and asst. metallurgist, and 1917-19, asst. furnace operator, Canadian Steel Foundries Ltd., Montreal. 1919-21, in charge Bessemer & Electric Steel Furnaces; 1921-41, metallurgist, in full charge of iron and steel production, Manitoba Steel Foundries, Ltd., Selkirk, Man. (In charge production of steels, synthetic irons, alloy steels and irons of all types. Laboratory, microscopy, heat-treating, production and quality of product). Member—Amer. Soc. for Metals, Amer. Soc. for Testing Materials. Has delivered papers before E.I.C., C.I.M.M. and other societies, and written articles for industrial and technical publications.

References: J. W. Craig, H. L. Briggs, J. F. Cunningham.

HOLE—WILLIAM GEORGE, of 5270 Queen Mary Road, Montreal, Que. Born at Edmonton, Alta., Dec. 20th, 1910; Educ.: B.Sc. (Civil), Univ. of Alta., 1933. Post-graduate study, Univ. of London, England; 1925-33, Lockerbie & Hole, plumbing and heating contractors; 1934, Darling Bros. Ltd., Montreal; 1935, Warren Webster & Co., Camden, N.J.; 1936-40, managing director, Warren Webster & Co. Ltd., London, England; At present, heating engr., T. Pringle & Sons, Montreal, Que.

References: H. R. Webb, R. S. L. Wilson.

HOLLAND—ALWIN, of Fort St. John, B.C. Born at Park Head, Ont., Jan. 21st., 1882; Educ.: 1911-14, articled ap'ticeship to B.C. land surveyor. Final exam. in math. B.C.L.S., 1919; 1914-18, overseas, C.E.F.; Followed occupation other than engrg. for several years; 1935-39, res. engr. in charge of constrn., B.C. Dept. of Public Works; 1939, surveyor and map maker for aerodrome sites, Northern B.C. and Southern Yukon; 1940-41, instr'man., airport constrn., Civil Aviation Divn., Dept. of Transport.

References: G. T. Chillcott, F. Young, F. H. Smail, H. L. Hayne.

LEIPOLDT—EWALD VAN NIEKERK, of Saraguay, Que. Born at Cape of Good Hope, South Africa, March 9th, 1890; Educ.: 1912-13, Charlottenburg Tech. High School, Germany; 1908-11, 4 year ap'ticeship course, English Electric Co. Ltd., Stafford, England; 1911-12, design of D.C. generators and motors, Siemens Sch., Nuremberg; 1913-14, preparation tenders and technical data, power and mining dept., Siemens, Berlin; 1914-15, asst. to consltg. power engr., Chile Copper Co., N.Y.; 1915-16, dftsman., Shawinigan Water & Power Company, Montreal; 1916-20, same work as 1914-15, incl. work for Braden Copper, American Smelters, and Guggenheim Bros.; 1920 to date, electrical engr., Shawinigan Engineering Company, Montreal. Supervision of electrical design of power stations, substations, and other electrical works for Shaw. Water & Power Co., also Gatineau Power Co. plants at Chelsea, Farmers and Paugan; preparation of specifications and recommendations for purchase of electrical equipment for above plants.

References: J. B. Challies, J. A. McCrory, McNeely DuBose, J. Morse, H. Massue, C. K. McLeod, C. E. Sissons, C. V. Christie.

MacKIMMIE—ROBERT DUNSTONE, of 507 King St., Peterborough, Ont. Born at Montreal, Que.; Nov. 21st, 1915; Educ.: B.Eng. (Elec.), McGill Univ., 1938; 1938-40, test course, and at present asst. engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

References: A. L. Dickieson, G. R. Langley, V. S. Foster, D. V. Canning, W. T. Fanjoy.

MacQUARRIE—ARCHIBALD HENRY, of Windsor, Ont. Born at Tansley, Ont., March 9th, 1893; Educ.: B.A.Sc., Univ. of Toronto, 1914; R.P.E. Ont.; 1921-22, lab. engr., Ford Motor Co. of Canada; With the Canadian Bridge Co. Ltd., as follows: 1919-21 and 1922-23, dftsman., 1923-27, squad foreman i/c tower dept. dfting., 1927 to date, sales engr., designing, estimating and contracting, specializing in transmission towers and substation structures.

References: F. H. Kester, P. E. Adams, J. C. Keith, A. E. Davison, H. E. Brandon, H. J. A. Chambers, J. E. Sproule, L. L. O'Sullivan.

MICHAUD—JOSEPH SYLVIO ANDRE, of 110 Concord St., Ottawa, Ont. Born at Sorel, Que., March 22nd, 1913; Educ.: B.A.Sc., (C.E.), (Ecole Polytechnique), Montreal, 1934; one year training course at B. F. Sturtevant main plant and offices, Boston; 1934-35, sales engrg., Humidaire Company; 1935-36, training course, 1936-39, sales engrg., supervision of installations (incl. Royal York Hotel air conditioning), dfting. specifications and plans, etc., for heating ventilating and air conditioning; B. F. Sturtevant of Canada Ltd.; 1939-40, mining roads divn., Mine and Geology Branch, Ottawa, inspection of tenders, specifications, contracts, statements of claims, etc.; at present asst. engr., heating divn., Directorate of Works and Bldgs., R.C.A.F., Dept. of National Defence, Ottawa.

References: W. H. Norrish, C. F. Johns, H. S. Grove, A. Circe, A. Frigon, O. O. Lefebvre.

PARKER—WILLIAM ERNEST BAIN, of 216 Deloraine Ave., Toronto, Ont. Born at Parkersville, Ont., Oct. 6th, 1912; Educ.: B.A.Sc., 1935, M.A.Sc., 1936, Univ. of Toronto; 1937-38 (intermittent), Brobst Forestry Co., Toronto; 1937 (3½ mos.), asst. engr., Ont. Dept. of Health; 1938-39-40 (winters), demonstrator, Univ. of Toronto; 1939 (7 mos.), engrg. dept., Township of Scarborough; May, 1940, to date, asst. research engr., H.E.P.C. of Ontario.

References: C. R. Young, R. W. Angus, A. E. Berry, R. B. Young, W. P. Dobson.

RICHARDS—GEORGE HENRY, of Brantford, Ont. Born at Willington, Derbyshire, England, May 25th, 1898; Educ.: I.C.S. Mech. Engr.; O.L.S. 1923. R.P.E., Ont., 1924; 1917-19, overseas, R.N.C.V.R.; 1919-24, articled ap'tice with Lee and Nash, Civil Engrs. and Land Surveyors, Brantford, Ont.; 1924, instr'man. on township surveys, plans, descriptions and surveys of mining claims, supervising constrn. of walks, walls, drives, etc., for landscape architect; 1921-31, first asst. and chief dftsman., Warner & Warner, Regd. Engrs., Detroit, Mich.; 1932-33, asst. county engr. of Brant; June, 1933 to date, manager, Lee & Nash, Brantford, Ont. Professional Engrs. and Ontario Land Surveyors.

References: F. P. Adams, H. A. Lumsden, F. H. Midgley, S. Shupe, E. G. MacKay, C. C. Cariss.

ROBINSON—CLESSON THOMAS MILLER, of Corner Brook, Nfld. Born at Knowlton, Que., Aug. 21st, 1910; Educ.: B.Sc. (Elec.), Queen's Univ., 1937; summer work, tracer dftsman., electrician's helper, control man. 1937-40, asst. elec'l. engr., hydro-electric power station at Deer Lake, Nfld.; 1940 to date, elec., civil, and mech. engr. in paper mill, Nfld. Pulp & Paper Mills Ltd., Corner Brook, Nfld.

References: C. M. Bang, D. M. Jemmett, L. T. Rutledge.

SMITH—CLEVE A., of 125 Evelyn Ave., Toronto, Ont. Born at Cairo, Ont., Sept. 1st, 1888; Educ.: B.A.Sc., Univ. of Toronto, 1916; 1916-17, dfting., Ontario Wind Engine & Pump Co.; 1917-18, dfting., H.E.P.C. of Ontario; 1918-19, dfting., and acting chief dftsman., Hollinger Cons. Gold Mines; 1919-23, engr. and estimator, Ontario Wind Engine & Pump Co.; 1923-28, struct'l. designer, and inspr. on constrn., 1928-39, chief dftsman. (transmission section, elec. engrg. dept.), and July 1939 to date, asst. engr. (same dept.), H.E.P.C. of Ontario.

References: T. H. Hogg, H. E. Brandon, W. P. Dobson, J. W. Falkner, D. Forgan.

FOR TRANSFER FROM THE CLASS OF JUNIOR

NESBITT—MICHAEL CULLUM, of 3701 Quadra St., Victoria, B.C. Born at Regina, Sask., Oct. 21st, 1908; Educ.: B.A.Sc., Univ. of B.C., 1931; R.P.E. of B.C.,

(*Continued on page 106*)

Employment Service Bureau

SITUATIONS VACANT

ENGINEER with pulp and paper experience to become Assistant Chief Engineer in a large mill. Either a man who can fit into the position immediately, or a younger man who has the training and ability to work into it gradually. The initial salary to be paid will depend upon the qualifications of the applicant. This position holds an interesting future for the right man. Send applications with full particulars to Box No. 2209-V.

ENGINEER for fabricating plant, must be experienced in the detail and design of structural steel. This is a permanent position for the man with the necessary qualifications. Apply to Box No. 2234-V.

RECENT ENGINEERING GRADUATE, preferably mechanical, with some drafting experience. Work will consist of machinery and piping layouts and other general engineering work in a paper mill near Ottawa. Permanent position and excellent prospects for suitable man. Men now employed in war industry will not be considered. Apply Box No. 2245-V.

MECHANICAL DRAUGHTSMAN, for layout of power plant equipment, piping systems, etc., preferably university graduate with three or four years' experience. State age, experience, salary desired. Location Toronto. Apply to Box No. 2247-V.

REQUIRED for large gold mining organization in West Africa, several mill shiftmen, mill men and electricians. Salaries up to £40, £32 and £40 respectively per month, free living quarters. Ocean passage paid and three months' leave granted per year at half pay. Yearly renewable contracts. Defence regulations do not permit wives to accompany husbands at this time. Apply Box No. 2258-V.

YOUNG CIVIL ENGINEER not more than two years out of college, with field and office experience, involving computation and engineering analysis. Apply giving full particulars to Box No. 2259-V.

SENIOR ELECTRICAL ENGINEER with from five to eight years experience required by large industrial concern. Apply with full details to Box No. 2261-V.

MECHANICAL DRAUGHTSMAN with some experience immediately required by a large industrial firm. Apply giving full particulars to Box No. 2262-V.

SITUATIONS WANTED

CONSTRUCTION ENGINEER, University graduate experienced in Power Plants, Transmission lines, gunite construction, etc. Available on short notice. Apply to Box No. 1527-W.

CIVIL ENGINEER AND SURVEYOR—Experienced in general building and war plant construction. Also installation of mechanical equipment. Immediately available. Apply to Box No. 2153-W.

ELECTRICAL ENGINEER, graduate, Age 47, married. Experience covers draughting, construction, maintenance, and operation. For the last ten years employed as electrical superintendent in a large industrial plant. Apply to Box No. 1718-W.

ENGINEER—M.E.I.C. Age 49. Desires change. Experience covers all types structural steel and plate work, rivetted and welded construction, as estimator. Designing, shop drawings. Available two weeks notice. Apply Box No. 2208-W.

MECHANICAL ENGINEER, Draughtsman, Specification Writer, Supervisor, specializing in Heating, Ventilating, Power Plants and Plumbing, available immediately. Will go anywhere. Apply Box No. 2285-W.

PRELIMINARY NOTICE (*Continued from page 105*)

1936; 1927-28, B.C. topographical work; 1932, placer mining; 1933, bridge and crib constrn.; 1934, hydraulic mining, drift placer mining; 1935-36, supt., Columbia Development Co. Ltd., placer mining; 1937, supt., Langly Prairie Airport; 1937, shifter, Wingdam Mine; 1938, supt., highway constrn. for Baynes & Horie Ltd.; 1938, foreman, paving and highway constrn.; 1939, supt., highway constrn., H. R. Wade, contractor; 1939, i/c grading, Patricia Bay Airport; 1940 to date, supt. engr., Dawson Wade & Co., Contractors. (St. 1928, Jr. 1936).

References: H. N. Macpherson, W. H. Powell, J. C. Oliver, C. W. Gamble, K. Reid.

BONNELL—ALEXANDER ROBERTSON, of Pointe-a-Pierre, Trinidad, B.W.I. Born at Sussex, N.B., April 13th, 1913; Educ.: B.Sc., Univ. of N.B., 1935; 1935-36 (summers), paving inspr., Milton Hersey Co., Geol. Survey of Canada; 1937, instr'man., 1937-39, asst. res. engr., N.B. Highway Divn.; 1939, surveyor, Port-of-Spain, Trinidad; 1939 to date, roads engr., Trinidad Leaseholds Ltd., i/c of layout, design, estimates and constrn. of roads of permanent and temporary nature. (St. 1935, Jr. 1938).

References: E. O. Turner, J. R. Scanlan, E. B. Allen, W. E. Weatherbie, R. W. Emery.

FOR TRANSFER FROM THE CLASS OF STUDENT

CAMPBELL—DUNCAN CHESTER, of 210 Einston St., West Saint John, N.B. Born at Saint John, April 20th, 1913; summers, 1932, asst. District Highway Engr's office, Saint John. Student asst., Geol. Survey of Can.; 1935, transitman, N.B. Highway Dept.; 1935-36, piling and concrete inspr., Foundation Co. of Canada; 1936-37, asst. engr., instr'man., and engr., N.B. Highway Dept.; 1939-40, engr., Dept. of Transport, Civil Aviation Br., Airport surveys; 1940 to date, asst. engr. or instr'man., Dept. of Transport, Civil Aviation Br., Airport constrn. and surveys. (St. 1935).

References: J. T. Turnbull, D. R. Smith, W. Griesbach, J. N. Flood, W. D. G. Stratton, W. J. Lawson, E. O. Turner, J. Stephens.

FORSYTHE—MARSHALL ANTHONY, of 3514 Hutchison St., Montreal, Que. Born at Bankhead, Alta., July 10th, 1912; Educ.: B.Sc. (Elec.), Univ. of Alta., 1937; summer work, 1934-35. Marcus Coal Mine, 1937, survey work; 1937 to date, elect'l. dftsman., Shawinigan Water & Power Co. Ltd., Montreal, Que. (St. 1937).

References: R. E. Heartz, A. B. Rogers, J. Charnley, W. E. Cornish, R. S. L. Wilson, C. A. Robb, E. W. Knapp.

SPENCE—GRAYDON DILL, of St. Croix, N.S. Born at St. Croix, April 1st 1910; Educ.: B.Sc. (Elec.), N.S. Tech. Coll., 1932; 1928-31 (summers), rodman recorder, instr'man.; 1932-35, High School teacher; 1936-37, i/c of hydro-electric project for the Annapolis Basin Pulp & Power Co. Ltd., incl. layout of pipe line, power house site and tailrace; 1937, land surveying for the Minas Basin Pulp & Power Co. Ltd.; 1937-38, res. engr. during constrn. of Ambursen Dam for the Minas Basin Pulp & Paper Co. Ltd.; 1938-39, special courses in forestry at Univ. of N.B.; 1939, land surveying; August, 1939, to date, res. engr. in the field on a water diversion development for the N.S. Power Commission. (St. 1931).

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"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public."

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THE ENGINEERING JOURNAL

VOLUME 24 MONTREAL, MARCH 1941 NUMBER 3

A MESSAGE FROM THE PRESIDENT

To serve as president of the Engineering Institute is one of the greatest honours that can come to a Canadian engineer. It gives him the responsibility of maintaining traditions established and strengthened throughout the years by men whose lives were devoted to the improvement of engineering and to building up the engineering profession. Their high standard of service constitutes a challenge to each successive incumbent, a challenge which it is now my privilege to accept. It will be my earnest endeavour to fulfil worthily the obligation thus imposed.

It has been customary in the past for an incoming president to speak of Institute policy for the ensuing year. This year there must be only one objective: to weld together all our resources, spiritual as well as material, into an unbreakable instrument for winning the war. To this task the entire membership of the Institute is dedicated.

In the past years we have been justly proud of the service given by the engineering profession in times of national peril. To-day, at this most critical moment in history, the engineers' war-time role is of even greater importance than in former crises. Engineers are now serving in numberless ways in all the fields of battle—on land, in the air, or upon the high seas—and are also rendering indispensable service in non-combatant duties—many of which are extremely hazardous. They are busy in industry, in the designing office and the workshops, in scientific laboratories, in educational institutions and training centres, and in public affairs.

But in addition to the work accomplished individually, by members, they can do much collectively as constituting a reputable and influential body. For example, the Institute, like a number of kindred organizations is actually in itself a reservoir of technically-trained man-power. Many of its members have special qualifications for particular positions; thus it is gratifying to learn that progress is now being made in utilizing the data regarding available men which exist in the professional records of the Institute and also in those obtained by other leading Canadian technical associations.

In this colossal struggle no one group in Canada would claim to be of greater importance than another, but possibly we engineers, as a body, realize more clearly than others how much this war is one of machines, of mechanics, of industrial production, of scientific development, of engineering technique and organization. We are proud that engineers are playing so vital a part in the conflict—proud, for instance, that the commander of the Canadian Army Corps, Lieutenant-General McNaughton, is an eminent and active member of our Institute, that the industrial organization of Canada is in the capable hands of another distinguished member, the Hon. C. D. Howe, and that scores of other members are holding positions of great responsibility.

Individual members of the Institute can render important service, not only in their daily war-work—whatever that may be—but also in promoting cool courage, quiet confidence, and unbroken morale in those with whom they come in contact. We, who have had an engineer's training and experience, should realize, better than laymen, the harm done by unguarded talk, idle gossip, and futile speculation based on imperfect or incorrect information. We can do much to impress upon those inclined to be careless in these respects the necessity of silence on all matters which may conceivably give comfort, information or assistance to the enemy.

We should realize that although in a physical sense this is a war of machines, no conflict in our history has been fought so entirely for the survival of human values. Our strength to-day lies not merely in our capacity to produce and man planes and tanks, but also in our recognition that our way of life is very precious, worth fighting for, worth dying for, if need be.

Just as we have huge arsenals for munitions, so also do we have, in a very real though intangible way, vast reserves of moral courage, capable of being constantly replenished by the inspirations of such deeds as the boarding of the *Altmark*, the battle for control of the "daylight air," Dunkerque, and the battle of Britain. When Captain Fogarty Fegen of the *Jervis Bay*, without a moment's hesitation, signalled that he was closing with the enemy, his contribution to our cause could not be measured in terms of ships and cargoes saved; his ebbing life and those of his men became the strength of millions—strength given to them as if by some gigantic blood-transfusion.

As engineers we can and will help materially in winning the war—but we must also dedicate our lives to maintaining that high morale without which no victory is possible.

The shadow of the swastika has fallen over nearly all the lands of Europe, blotting out in them all hope of personal liberty, free speech, and equal justice. Without these things we feel, as Britain does, that civilized life is impossible, and barbarism reigns.

What nobler task can there be than to fight this monstrous doctrine, to defend the last stronghold of freedom in Europe, and to make it impossible for Nazi methods to dominate the civilized world ?

C. J. Mackenzie

President

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WILLIAM E. WICKENDEN
President, Case School of Applied Science, Cleveland, Ohio, U.S.A.

Address delivered at the Annual Banquet of The Engineering Institute of Canada, Hamilton, Ont., February 7th, 1941.

Dr W. E. Wickenden

"Whosoever shall compel thee to go one mile—go with him twain." I am not sure that I should dare to choose this counsel of perfection from the Sermon on the Mount as a text for a talk to engineers south of the border, such is the present state of our biblical illiteracy. The professor of a past generation who withered a classroom disturbance at Yale by urbanely remarking "Young gentlemen, I beg you to restrain yourselves until I cast one more pearl," would be met to-day by uncomprehending stares. Some one has said that the trouble with us in the States is that we have lost three pasts; first we lost the classical past, next we lost the biblical past, and now we are losing the historical past. In Canada where, I believe, you are much more deeply rooted in piety and sound learning, you will catch the meaning of my text. Every calling has its mile of compulsion, its daily round of tasks and duties, its standard of honest craftsmanship, its code of man-to-man relations, which one must cover if he is to survive. Beyond that lies the mile of voluntary effort, where men strive for excellence, give unrequited service to the common good, and seek to invest their work with a wide and enduring significance. It is only in this second mile that a calling may attain to the dignity and the distinction of a profession.

A preacher who was once reproached for straying rather widely from his text replied "A text is like a gate, it has two uses; you can either swing on it, or you can open it and pass through." Let us pass on through. There is a school of thought that seems to hold that all of the problems of the engineering profession may be solved by giving it a legal status. If only we compel all who would bear the name of *engineer* to go the mile of examination and licensure, we shall have protection, prestige and emoluments to our heart's desire. They forget, perhaps, that there are many useful callings which have traversed this mile without finding the higher professional dignities at its end. We license embalmers, chiropodists, barbers and cosmetologists, but we do it for the protection of the public, and not to erect them into castes of special dignity and privilege.

There is an illusion abroad that any calling may win recognition as a profession by the mere willing it so and by serving notice to that effect on the rest of the world. It helps a lot, too, if you can invent an esoteric-sounding name derived from the Greek. One reads, for example, of a group of barbers who elect to be known as "chirotonsors" in order to raise the prestige of their "profession." The truth seems to be that as soon as any word acquires a eulogistic character, we promptly proceed to destroy it by indiscriminate usage. When one scientist observed what the advertising fraternity has done to the word *research*, he remarked dryly that we now use that word to mean so many things we shall soon have to invent another word to mean *research*. The ambition to dignify honorable work is laudable, but there is much seizing after the form and letting the substance escape which would be ludicrous, if it were not pathetic.

A prominent English churchman once remarked facetiously that there were three sorts of Anglicans—the low and lazy, the broad and hazy, and the high and crazy. It seems to be much the same among engineers in our thinking about our profession. We have a low church party which holds that status and titles are of little consequence; so long as the public allows us to claim them not much else matters if the engineer does an honest day's work. The broad church party is all for inclusiveness; if business men and industrialists wish to call themselves engineers, let us take them in and do them good, not forgetting the more expensive grades of membership. The high church party is all out for exclusive definitions and a strictly regulated legal status; in their eyes, what makes a man a "professional" engineer is not his learning, his skill, his ideals, his public leadership—it is his license certificate.

In view of these divided counsels, it may not be amiss to consider briefly what a profession is, how it came to be, why it exists, how its status and privileges are maintained and what obligations it entails; and finally to discuss a few of our current issues in the light of these backgrounds.

Of professions there are many kinds; open professions like music, to which any man may aspire within the bounds of his talents, and closed professions like medicine which may be entered only through a legally prescribed process; individual professions like painting and group professions like law, whose members constitute "the bar," a special class in society; private professions like authorship and public professions like journalism; artistic professions like sculpture and technical professions like surgery; ameliorative professions like the ministry and social work and professions which achieve their ends by systematic destruction like the army and navy. Despite all these differences of pattern, there are characteristic threads which run like a common warp beneath the varying woof of every type of professional life and endeavor.

If one seeks definitions from various authorities, he finds three characteristic viewpoints. One authority will hold that it is all an *attitude of mind*, that any man in any honorable calling can make his work professional through an altruistic motive. A second may hold that what matters is a certain *kind of work*, the individual practice of some science or art on an elevated intellectual plane which has come to be regarded conventionally as professional. A third may say that it is a special *order in society*, a group of persons set apart and specially charged with a distinctive social function involving a confidential relation between an agent and a client, as the bar, the bench and the clergy. Another source of confusion arises from the fact that some define a profession solely in terms of ideals professed, others solely in terms of practices observed, and still others in terms of police powers exercised. All authorities recognize that some of the distinguishing attributes of a profession pertain to individuals, while others pertain to groups, but there is considerable variation in the emphasis given. Let us glance briefly at these two sorts of distinguishing attributes.

What marks off the life of an individual as professional? First, I think we may say that it is a *type of activity* which is marked by high individual responsibility and which deals with problems on a distinctly intellectual plane. Second, we may say that it is a *motive of service*, as distinct from profit. Third, is the *motive of self-expression*, which implies a joy and pride in one's work and a self-imposed standard of workmanship—one's best. And fourth, is a *conscious recognition of social duty* to be accomplished, among other means, by guarding the standards and ideals of one's profession and advancing it in public understanding and esteem, by sharing advances in professional knowledge and by rendering gratuitous public service, in addition to that for ordinary compensation, as a return to society for special advantages of education and status.

Next, what are the attributes of a group of persons which mark off their corporate life as professional in character? I think we may place first a *body of knowledge* (science) *and of art* (skill), held as a common possession and to be extended by united effort. Next we may place *an educational process* of distinctive aims and standards, in ordering which the professional group has a recognized responsibility. Third in order is a *standard of qualifications*, based on character, training and competency, for admission to the professional group. Next follows a *standard of conduct* based on courtesy, honor and ethics, to guide the practitioner in his relations with clients, colleagues and the public. Fifth, I should place a more or less formal *recognition of status* by one's colleagues or by the state, as a basis of good standing. And finally *an organization* of the professional group based on common interest and social duty, rather than economic monopoly.

The traditional professions of law, medicine, and divinity had a common fountain head in the priestcraft of antiquity. What is professional in engineering and in certain other modern callings can be traced back only so far as the mediaeval merchant and craft guilds. These arose in the period when feudal society was breaking down and the beginnings of the modern commercial and industrial era were appearing. In this period of disintegration and remaking of the social order, before cities had grown strong and central governments powerful, police powers had not been largely developed or protective services created by the state. Men who wished to engage in far-flung commerce or in trade on any extensive scale found it necessary to organize for mutual protection, and this in turn led to monopolistic control. In the various crafts it was the guilds which regulated by ordinance the hours of labor, the observance of holidays, the length and character of apprenticeship and the quality of workmanship; and it was the guild which tested the progress of novices, apprentices and journeymen and finally admitted them to the ranks of the masters. When the cities and the states waxed powerful, they usually confirmed the monopolies which the guilds had gathered to themselves and even incorporated them into the structure of the municipality, as in the City and Guilds of London. The church too lent its blessing, since the religious philosophy of the middle ages regarded society as a commonwealth divided into divinely ordained functions, and not as a mere aggregation of individuals—an idea which recent Papal encyclicals have sought to reanimate under the name of a corporative society. In the spirit of the times, the guilds required members to contribute periodically to a common fund for the relief of distress, to participate in certain religious observances and to honor certain festivities and pageants.

Many of these features are perpetuated in the modern professional body. The public grants it more or less tangible monopolies and self-governing privileges, in consideration of which it engages to admit to its ranks only men who have proved their competency, to scrutinize the quality of their work, to insist on the observance of ethical relations, and to protect the public against extortion and bungling. The occasion which calls for professional service is often a human emergency in which the legal doctrine of *caveat emptor*—let the buyer beware—breaks down. When a baby is about to be born or an appendix must be removed, you want some guarantee that the job is in competent hands. The layman often finds professional knowledge and skill a little too esoteric for his judgment. If you have a problem of mental hygiene in your family you want some guarantee that you are dealing with a qualified psychiatrist and not with a quack. The public wisely puts the burden of guaranteeing at least minimum standards of competency on the profession itself. It may implement this obligation through public examinations and licensure, or it may entrust it to a system of certification within the profession itself, but in the end it comes down to the same thing—a profession must guarantee to the public the competency of its practitioners. In return, the public protects the profession from the incompetent judgment of the layman by a privileged status before the law.

Professional status is therefore an implied contract to serve society, over and beyond all duty to client or employer, in consideration of the privileges and protection society extends to the profession. The possession and practice of a high order of skill do not in themselves make an individual a professional man. Technical training pure and simple, I think we can agree, is vocational rather than professional in its character. The difference between the two is not merely a matter of length or one of intellectual levels—it is rather a matter of spirit and ideals and partly an educational overplus beyond the minimum required to master the daily job. This overplus must be sought largely through foundation studies which give a deeper insight into underlying principles and relations than the mere mastery of technique requires. For the lawyer this means the study of philosophy, history and social institutions; for the physician a grounding that is both deep and broad in biology and psychology; and for the engineer philosophic insights into the mathematical and physical sciences. This overplus, again, is partly a matter of knowledge of social forces and institutions which enables the professional man to view his work and its consequences not only as a service to a client, but also in terms of its implications for society. An engineer, for example, recommends the introduction of a labor-saving process; does he see in this only a saving in the immediate cost of production, merely assuming that this is a desirable end in itself, or can he perceive the sequence of effects which will be felt in the lives of individuals, the organization which employs them, the community in which it functions and the wider sector of society which it serves? In the answer to this question there is wrapped up much of the difference between a high-grade technician and a man of true professional stature.

Through all professional relations there runs a three-fold thread of accountability—to clients, to colleagues, and to the public. Is business a profession or can it be made so? We sometimes hear it referred to as the oldest of trades and the newest of professions. It seems clear that business is moving away from the dog-eat-dog area to one nearer the fringe of professional life. This occurs when the direct management passes from the hands of proprietors to a distinct administrative caste with little immediate stake in the profits of trade. Business may still be far from a true profession, but management is well within the pale. Business has lived traditionally from balance-sheet to balance-sheet; the time-span of its thinking has often been about three months; the profit-and-loss statement has been its only yard-stick. Professional managers, if assured of reasonable security of tenure, are better able to think and plan in terms of long-range prosperity and to act as responsible middle-men between investors, workers, customers and the public. At one time I worked for the Bell Telephone System, of which no individual owns as much as one per cent. It is the best example of manager-operated, as distinct from owner-operated, business that I know of and the one that comes nearest to fulfilling professional standards.

All of us can take pride in this example, because it is so largely an engineer-managed enterprise. If we were to narrow our professional fellowship so as to include only men who render technical service on an individual agent-and-client basis and exclude all whose work is primarily administrative, I feel that we should do an irreparable injury both to ourselves and to society. The engineer has been the pioneer in the professionalizing of industry, and his task is only begun. Organized labor, it seems, is intent upon gaining a larger voice in the councils of industry; it wants to sit in when policies are made and to share in planning the schedules of production. This may be its major strategy for the defense period; witness the Knudsen-Hillman partnership in Washington and the Reuther plan for aircraft production by the automobile industry. If any such day is ahead, the middle-man of management who can reconcile the stake of the investor, the worker, the customer and the public is going to be the key man on the team. For that responsibility, the finger of destiny points to the engineer. This makes it all the more urgent that the young engineer, while seeking in every way to gain a discriminating and not unsympathetic knowledge of the labor movement, should avoid being sucked into it by the lure of a quick gain in income and in bargaining power.

The ethical obligations of a profession are usually embodied in codes and enforced by police powers. The physician and lawyer are bound by explicit obligations and woe betide the man who oversteps them. As engineers, our codes are more intangible, as our duties are less definable. In any case, the obligations of a profession are so largely matters of attitude that codes alone do not suffice 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 ideal which puts service above gain, excellence above quantity, self-expression above pecuniary incentives and loyalty above individual advantage. No professional man can evade the duty 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 service. His knowledge, however, is to be regarded as part of a common fund built up over the generations, an inheritance which he freely shares and to which he is obligated to add; hence the duty to publish the fruits of research and to share the advances in professional practice. If the individual lacks the ability to make such contributions personally, the least he can do to pay his debt is to join with others in creating common agencies to increase, disseminate and preserve professional knowledge and to contribute regularly to their support.

There are too many engineers with a narrow and petty attitude on these matters; mature men who complain that the immediate, bread-and-butter value of the researches and publications of a professional society are not worth the membership fee, and young men who complain because it does not serve them as an agency of collective bargaining. Shame on us! Do we look with envy on the high prestige of medicine and of surgery? Then let us not forget that this prestige has been won not merely through personal skill and service, but through magnificent contributions to human knowledge without profit to the seekers and with incalculable benefits for all mankind. Do we covet public leadership on a par with the legal profession? Then we do well to remember that the overplus which differentiates a profession from a technical vocation calls for personal development and for powers of expression sufficient to fit a man for a place of influence in his community.

Measured by the standards I have been seeking to outline, many men who call themselves engineers and who are competent in accepted technical practices can scarcely be said to have attained a real professional stature. These are the men who have let their scientific training slip away, who do not see beyond the immediate results of their work, who look on their jobs as an ordinary business relationship, who contribute nothing to advancement by individual or group effort and who have little or no influence in society. They have been unable to surmount routine in the early stages of experience and have gradually grown content with mediocrity. There is much in the daily work of a physician, a lawyer and a minister of religion which compels him to be a life-long student. In peace times the army officer is likely to spend one year in six going to school. The student habit is less often a mark of the engineer, which is natural perhaps in a man of action rather than one of reflection, but far too many seem to leave all growth after their college days to the assimilation of ordinary experience, without deliberate intellectual discipline of any kind.

There is a certain school of thought which has two quick and ready remedies for all ills and shortcomings of the profession. One is to keep the boys longer in college and to compel them to cover both the arts and the engineering course; the second is to compel every engineer to take out a public license. One need not quarrel with either the aims or the means; so far as they go both are good, but they cover only the first mile. Registration, I believe, will always be a qualifying standard rather than a par standard for the engineering profession. It will go far toward keeping the wrong men out, but will serve only indirectly to get the right men in. Beyond it lies a second mile of growth and advancement for which effective stimuli, incentives and rewards can be provided only within the profession itself. The riper experience of the medical profession seems a safe guide. For the protection of the public, the law determines who may practice general medicine; but if a registered physician wishes to qualify as an orthopaedic surgeon, he submits to a training prescribed by a voluntary group of specialists and undergoes an examination at their hands rather than those of a public licensing board. Evidences of distinction are likewise a gift within the sphere of the profession's inner life, rather than the domain of law.

The proposal to compel all engineering students to remain six years or more in college and to take both the arts and the engineering degrees is a counsel of perfection, attractive in theory and unworkable in practice. It has failed when tried principally because employment on attractive terms is widely available to four-year graduates, but also because the typical student of engineering shows an unmistakable craving for action toward the end of the undergraduate period and becomes fed up for a time with formal teaching and study. All our experience suggests that the further possibilities in the mile of voluntary advancement are much more hopeful than those in the mile of compulsory discipline. Growth in voluntary postgraduate enrollments has been going forward at a truly surprising pace. The most recent summary shows that our engineering schools granted 1,326 master's degrees and 108 doctorates in 1940 and that there are enrolled in the present year 4,589 candidates for the former degree and 623 for the latter. Equally encouraging are the gains in liberalizing the engineering curriculum by more adequate inclusion of studies in language and literature, in history and economics and in psychology and social institutions—gains which are being made possible by the progressive transfer of specialized technical studies to the graduate plane. My enthusiasm is stirred by the rapid gain in cultural interest and activity among engineering students, gains in the reading of books, in attendance at the theatre, in hearing and producing music and in the artistic forms of expression.

I am encouraged by these trends to end on a note of prophecy. You are fighting a technological war, and we are entering upon an all-out program of technological defense in which every man under arms must be backed by more than a dozen in industry and in which only one man in four under arms is expected to carry a rifle. This experience is likely to have a profound effect on education. Within a decade we are likely to see technological education, both at the secondary and the higher levels, becoming more and more the dominant type.

The climax of man's effort to subdue nature, shift labour from muscles to machines, to make material abundance available for all, and to abolish poverty and disease, may well fall in the next fifty years. After that human interest may shift from work to leisure, from industry to art. Meanwhile engineers will multiply, research will expand, and industry will grow more scientific. Engineers will find their way into every field where science needs to be practically applied, cost counted, returns predicted and work organized systematically. They will be called upon to share the control of disease with physicians, the control of finance with bankers, the bearing of risks with underwriters, the organizing of distribution with merchants and purchasing agents, the supplying of food with packers and purveyors, the raising of food with farmers and the operation of the home with housewives. In few of these new fields, if any, will engineers be self-sufficient; to be useful they must be team-workers; and they must be prepared to deal with "men and their ways," no less than "things and their forces."

The engineering profession will exercise a far greater influence in civic and national affairs. It will probably never be able to define its boundaries precisely, nor become exclusively a legal caste, nor fix a uniform code of educational qualifications. Its leaders will receive higher rewards and wider acclaim. The rank and file will probably multiply more rapidly than the elite, and rise in the economic scale to only a moderate degree.

Engineering education must break away from its present conventional uniformity. At one extreme, a part of it must become more profoundly scientific; at the other extreme, a vast development of practical technical education for directing production will be in demand. Engineering schools ought to be less alike, less standardized by imitation. The men who are to lead the profession will need a longer training, and one that is both more broadly humanistic and more profoundly scientific. Great numbers of workers in technology could do well with a more intensive type of training. For every *one* who should receive post-graduate training, possibly *four* would find the present course sufficient, and *ten* would find an intensive two-year course more suitable. The science of economy needs to be more strongly emphasized at all levels. A science of human work needs to be created and systematically taught.

The engineer's job will be so varied, and will change so fast, and his tools will so increase in variety and refinement with the advance of science, that no engineer can hope to get a once-and-for-all education in advance. We must expect to re-educate engineers at intervals throughout their careers. The most important development of all may come in after-college education. In the future we shall see large numbers of young engineers coming back to college, some for full time, some for half time, some in the evening, some in correspondence divisions; some to pursue higher work in science, some for new engineering technique, some for training in economics and business, and not a few for broader cultural opportunities. This is as it should be. We should cease to think of education as a juvenile episode. Once these means of adult education are provided in ample degree, the engineering colleges could broaden the scientific and humanistic bases of their curricula, cut down on early specialization, relieve over-crowding, inspire independent work, and show the world the best balanced and best integrated of all modern disciplines.

We have no quarrel with liberal education, nor with the doctrine that it is best for many young people to lay first a foundation of culture and then to erect upon it a superstructure of competency. But we hold that there are even more young people who will do better to lay first a foundation of competency and to build upon it a superstructure of culture and of social understanding. That is precisely what the enlightened engineering school of to-day is undertaking to do. It needs freedom from rigid prescription at the hands of the profession if it is to succeed at all, but it needs even more the united guidance and support of the profession if it is to succeed adequately. To our colleagues of Canada, the heartiest of welcomes to the Engineers' Council for Professional Development and to its goodly fellowship of the second mile. "Whosoever shall compel thee to go one mile—go with him twain."

ENGINEERING AND SOCIAL PROGRESS

Dr. KARL T. COMPTON

Excerpts from a Presidential Address to the Society for the Promotion of Engineering Education.

"If the engineer is to bring his influence to bear on broad public questions he must approach them, not with technical arrogance, but with sympathetic understanding. If he is to counsel the people he must gain the confidence of the people, and this confidence is obtained by placing ministry to the public above all other considerations. This concept of ministering to the public welfare, which is the concept underlying the professional attitude, is the remaining principle that needs to be fully synthesized with other elements that have been combined to form the engineering philosophy . . .

"Buttress by the dignity, altruism, and social responsibility of the true professional spirit, we can proceed with greatest confidence and effectiveness in applying engineering to the solution of the present urgent problems of our national welfare. . . .

"Our people are striving for an improvement in our lagging distribution system, for higher wages, shorter hours of labour, a higher standard of living. Engineering research and engineering methods are essential for the attainment of these goals. Our people want industrial peace, and the engineer, because he stands, by virtue of his professional status, in an intermediate position between capital and labour, has a superlative opportunity to create mutual trust between these two groups. . . .

"The impact of new discoveries sometimes produces technological unemployment even though new discoveries must ultimately increase employment. Improperly used, the products of engineering may promote unrest, multiply hazards, increase congestion, and stimulate materialism corrosive to the human spirit. Engineering creates opportunities and man may use these opportunities to advantage or detriment.

"Let us, first of all, lose no chance to stress the scientific method and its application by the engineer to social purposes. The conviction that Nature is orderly and understandable, the spirit of disinterested curiosity, the passion for truth, the subjecting of hypotheses to the test of irreducible and stubborn facts—these are the elements of the scientific method. Along with them go an unwillingness to manipulate truth for the sake of doctrine, a realization that it is impossible to get something for nothing, and that the skilful use of Nature's forces is the way to produce more. . . .

"Let us lose no chance to emphasize that our modern civilization owes its flourishing to the engineering philosophy, the most fruitful intellectual method and outlook in the world's history, and that a mis-use of it or a departure from it may easily plunge us into a new dark age. Let us also emphasize that the contributions of engineering have not been limited to material accomplishments, important as they have been. Its practical utility has been and will be of lesser consequence than its social and philosophical value. It has helped to make life itself a better thing. Through the moral values of its method, it has elevated our ethical standards. Through the effectiveness of its method, it has promoted confidence, giving us new comprehension, new respect for mind, and greater power over matter and the unknown with a consequent enhancement of the dignity of the human spirit. This dignity and self-confidence is essential if man is not to be a puppet but a citizen, free and freedom-loving."

COLUMNS SUBJECT TO UNIFORMLY DISTRIBUTED TRANSVERSE LOADS—ILLUSTRATING A NEW METHOD OF COLUMN ANALYSIS

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SUMMARY—This paper illustrates a new method of column analysis. It presents four formulae applicable to the pin-ended column with uniform E and I, having at least one axis of symmetry and loaded transversely with a uniformly distributed load in a direction coincident with the axis of symmetry. Each of these formulae has its range of applicability. Two of them (III and V) are in the nature of first approximations; the other two (II and IV) are quite accurate, in fact, more accurate than are the values for E, I and e, which are inevitably involved. Of the two more accurate formulae (II and IV), the range of applicability of one lies outside the field of common engineering experience, that of the other effectively covers the cases generally encountered in engineering practice.

Although this method of analysis as here illustrated is applied to only one special case of column action, it is held that it may be successfully applied to a variety of problems involving stability.

Discussion

The column, subject to uniformly distributed transverse loads (Fig. 1a), does not, strictly speaking, present a problem in stability. That is, instead of failing as the result of sudden buckling, the column will at all times suffer a deflection. The deflections and stresses will vary with changes in value in either the transverse loads kw or in the axial load Q. However, such variations will not be linear; they will not be proportional to the changes in the value of Q. In other words, the principle of superposition does not apply. In the analysis of the beam-column, even though the principle of superposition is inoperative, the elasticity equations may still be used with confidence within certain limits.

If, in Fig. 1a, Q is finite, and kw approaches zero as a limit, then the elastic curve of the column will approach the sine curve, $y = -\triangle \sin\frac{\pi x}{l}$, as a limiting curve. If, on the other hand, kw is finite and Q approaches zero as a limit, then the elastic curve will approach the fourth degree parabola, $y = -\frac{16\triangle}{5l^4}(l^3x - 2lx^3 + x^4)$ as a limiting curve.

Figure 2 shows a number of curves plotted to scale. It may be observed that the sine curve and the fourth degree parabola are so nearly alike as to be almost indistinguishable. The true elastic curve will be one which lies somewhere between these two curves. Since we know the limiting value of the elastic curve and since these limiting values are so close as to be nearly identical, we may assume the elastic curve to be either the fourth degree parabola or the sine curve without introducing an appreciable error.

Once we accept the type of elastic curve which the beam-column will assume, we overcome the difficulty resulting from the fact that the principle of superposition is inoperative.*

In the expression,

$$F\triangle = \int \frac{m\,M\,ds}{EI}, \qquad \text{(Formula I)}$$

F (Fig. 1c) represents an auxiliary load. It is of finite magnitude. However, if we choose we may conceive it to be extremely small. The letter m represents the bending moment induced by the auxiliary load F (Fig. 1d); M represents the bending moment induced by the actual loading kw and Q, and their reactions; F is assumed to be fully acting while the moment M is being applied; $F\triangle$ represents the external work done by F as it is being displaced, the displacement being caused by the application of the actual load. The expression $\int\frac{m\,M\,ds}{EI}$ represents that portion of the total elastic energy growing out of the fact that F and its resulting moment m are fully acting while the actual loadings kw and Q, their resulting reactions, and their bending moment M are being applied. The two expressions, $F\triangle$ and $\int\frac{m\,M\,ds}{EI}$, are identical. This identity is independent of the principle of superposition and is merely contingent on the assumption that m remains constant and that the material is elastic. Since the bending moment M is a function of the elastic curve, the use of Formula I would be extremely involved if this elastic curve itself varied as to type as well as in magnitude. If, on the other hand, we assume this elastic curve for all values of kw and Q to be a sine curve, then Formula I may be easily integrated:

$$M = Qy + \frac{kwl}{2}x - \frac{kwx^2}{2}$$

$$= Q\triangle \sin\frac{\pi x}{l} + \frac{kwlx}{2} - \frac{kwx^2}{2}$$

$$m = \frac{F}{2}x$$

$$F\triangle = \int_A^C \frac{m\,M\,ds}{EI}$$

However, due to symmetry of both m and M about the centre of the span, this equation can be expressed as:

$$F\triangle = \frac{2}{EI}\int_A^B m\,M\,ds$$

If we here introduce the two assumptions which are commonly found to be acceptable, namely l is constant and $ds = dx$, then we may write:

$$EI\,F\triangle = 2\int_A^B m\,M\,ds = 2\int_0^{\frac{l}{2}} m\,M\,ds$$

$$= 2\int_0^{\frac{l}{2}} \frac{Fx}{2}\left(Q\triangle \sin\frac{\pi x}{l} + \frac{kwl}{2}x - \frac{kwx^2}{2}\right)dx$$

and

$$EI\,\triangle = \frac{Q\triangle l^2}{\pi^2} + \frac{5}{384}kwl^4$$

or

$$\left(EI - \frac{Ql^2}{\pi^2}\right)\triangle = \frac{5}{384}kwl^4 \qquad \text{(a)}$$

In the case of a sine curve:

$$y = -\triangle \sin\frac{\pi x}{l}$$

$$\frac{dy}{dx} = -\frac{\pi\triangle}{l}\cos\frac{\pi x}{l}$$

$$\frac{d^2y}{dx^2} = +\frac{\pi^2\triangle}{l^2}\sin\frac{\pi x}{l}$$

The curvature, and therefore the stress in a column of constant E and I, is a maximum when $x = l/2$. The maximum curvature in the column then is:

* See "Euler's Column Formulae," by J. A. Van den Broek, *Michigan Technic*, April, 1939, Vol. LVII, No. 7.

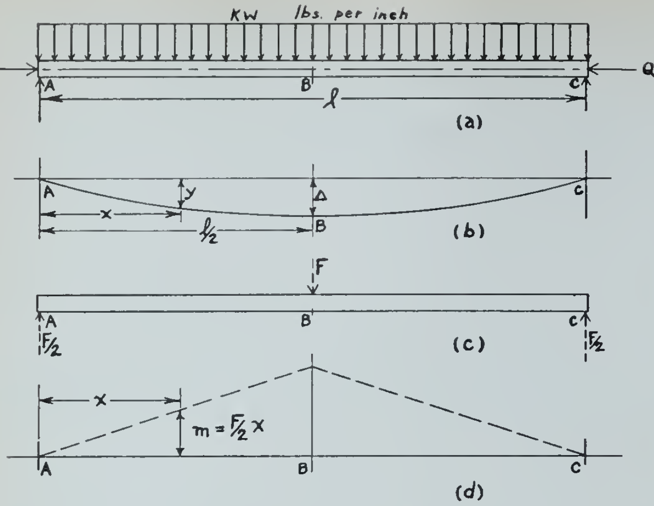

Fig. 1—(a) Column with uniformly distributed transverse load; (b) elastic curve of column; (c) auxiliary load; (d) bending moment due to auxiliary load.

$$\left(\frac{d^2y}{dx^2}\right)_{max} = \frac{\pi^2\triangle}{l^2}$$

The expression d^2y/dx^2 at any point may be given as f/Ec, in which f is stress at the extreme fibre resulting from curvature and c is distance from the neutral axis to the extreme fibre. The stress in the extreme fibre of the midpoint of the column, expressed as a function of the curvature, or as a function of the maximum deflection $\triangle$, would then be:

$$f = Ec\frac{d^2y}{dx^2} = \frac{Ec\pi^2\triangle}{l^2} \qquad \text{(b)}$$

As the load Q is eccentrically applied, relative to a bent column, the stresses throughout the column are augmented by the factor Q/A.

The expression for the controlling stress, the elastic limit stress f_1, as a function of the curvature and of the load Q therefore is:

$$f_1 = \frac{\pi^2 \triangle Ec}{l^2} + \frac{Q}{A}$$

or

$$\triangle = \left(f_1 - \frac{Q}{A}\right)\frac{l^2}{\pi^2 Ec} \qquad \text{(c)}$$

Combining equations (a) and (c) we obtain:

$$\left(EI - \frac{Ql^2}{\pi^2}\right)\left(f_1 - \frac{Q}{A}\right) = \frac{5}{384}kwl^2\pi^2Ec \qquad \text{(d)}$$

or

$$l^2Q^2 - (l^2f_1A + EI\pi^2)Q - \left(\frac{5}{384}kwl^2\pi^2Ec - EIf_1\right)\pi^2A = 0$$

Solving this quadratic equation we obtain:

$$Q = \frac{1}{2}\left\{f_1A + P_{cr} \pm \sqrt{(f_1A - P_{cr})^2 + 5.0734\,kwEcA}\right\} \qquad \text{(e)}$$

We select the — sign in order to obtain the minimum value for Q. Thus:

$$Q = \frac{1}{2}\left\{f_1A + P_{cr} - \sqrt{(f_1A - P_{cr})^2 + 5.0734kwEcA}\right\} \quad \text{Formula II}$$

Q = limiting load which induces elastic limit stress
f_1 = elastic limit stress
A = cross section area
w = weight per unit length
k = constant by which w is to be multiplied to arrive at uniformly distributed transverse load.
c = distance from neutral axis to extreme fibre.

$$P_{cr} = \frac{\pi^2EI}{l^2}$$

At this point the accuracy of Formula II may be checked against the known results which we should obtain in the two limiting cases: either when Q is a maximum and kw is zero, or when kw is a maximum and Q is zero. By making $kw = 0$, in equation (e), we obtain two limiting values for Q, namely, $Q = f_1A$ and $Q = P_{cr}$. When on the other hand the length is such that the elastic limit stress would be reached as the result of the transverse loading only, then $Q = 0$, or, from equation (d)

$$kw = \frac{7.78\,f_1I}{cl^2} \qquad \text{(f)}$$

In case of a simple beam subject to a uniformly distributed capacity load:

$$M = \frac{kwl^2}{8} = \frac{f_1I}{c} \text{ or } kw = \frac{8f_1I}{cl^2} \qquad \text{(g)}$$

The discrepancy between (f) and (g) is clearly the result of our assumption that the elastic curve is a sine curve, whereas, for this limiting case, when $Q = 0$, it is a fourth degree parabola.

In case of very slender beam-columns we may ignore the Q/A factor, in which case equation (d) appears as:

$$\left(EI - \frac{Ql^2}{\pi^2}\right)f_1 = \frac{5}{384}kwl^2\pi^2Ec$$

or

$$Q = P_{cr} - \frac{1.268\,kwEc}{f_1} \quad \text{Formula III (for slender beam columns).}$$

Development of Formulae IV and V

Had we assumed the elastic curve to be the fourth degree parabola instead of the sine curve, then, for M, we would have written:

$$M = \frac{16\triangle Q}{5l^4}(l^3x - 2lx^3 + x^4) + \frac{kwlx}{2} - \frac{kwx^2}{2}$$

and instead of equation (a) we would have obtained:

$$\left(EI - \frac{61}{600}Ql^2\right)\triangle = (EI - 0.10166\,Ql^2)\triangle = \frac{5}{384}kwl^4 \qquad \text{(h)}$$

For the fourth degree parabola the curvature is a maximum when $x = l/2$ and equals:

TABLE I

Values of Q (in lb.) computed from Formulae II, III, IV(a) and V. Column is 1 in. round. f_1 = 40,000 lb./sq. in. E = 40,000,000 lb./sq. in. A = % error between II and III = $\frac{\text{II-III}}{\text{II}}$ x 100; B = % error between IV(a) and V. C = % difference between II and IV(a) = $\frac{\text{II-IV (a)}}{\text{II}}$ x 100; D = II-IV(a).

L/R	L in.	P_{cr} lb.	II lb.	III lb.	A %	IV(a) lb.	V lb.	B %	C %	D lb.
					K = 1					
20	5	581,370	31,410	581,264		31,411	579,291		0	—1
40	10	145,341	31,387	145,235		31,388	144,745		0	—1
60	15	64,598	31,316	64,492		31,318	64,275		—0.01	—2
100	25	23,255	22,866	23,149	—1.2	22,802	23,073	—1.2	+0.3	+64
200	50	5,814	5,685	5,708	—0.4	5,669	5,691	—0.4	+0.3	+16
280	70	2,966	2,850	2,860	—0.4	2,843	2,853	—0.4	+0.2	+ 7
360	90	1,794	1,682	1,688	—0.3	1,680	1,685	—0.3	+0.1	+ 2
800	200	363	257	257	0	259	259	0		—2
					K = 10					
20	5	581,370	31,356	580,312		31,351	578,369		0	— 1
40	10	145,341	31,125	144,283		31,132	143,822		—0.02	— 7
60	15	64,598	30,443	63,540		30,462	63,352		—0.06	—19
100	25	23,255	20,272	22,197	—9.5	20,282	22,150	—9.2	—0.05	—10
200	50	5,814	4,576	4,756	—3.9	4,593	4,768	—3.8	—0.4	—17
280	70	2,966	1,842	1,908	—3.6	1,866	1,930	—3.4	—1.3	—24
360	90	1,794	711	736	—3.5	738	762	—3.3	—3.8	—27
480	120	1,009	0	0		0	0			

TABLE II

Values of Q (in Kips) computed from Formulae II, III, IV(a) and V. Column is 12″ x 3″ x 25 lb. channel; $f_1 = 40{,}000$ lb./sq. in.; $E = 40{,}000{,}000$ lb./sq. in. A = % error between II and III = $\frac{\text{II-III}}{\text{II}}$ x 100; B = % error between IV(a) and V. C = % difference between II and IV(a) = $\frac{\text{II-IV (a)}}{\text{II}}$ x 100; D = II-IV(a)

L/R	L in.	P_{cr} kips	II kips	III kips	A %	IV(a) kips	V kips	B %	C %	D kips
					$K=1$					
20	15.8	5.418.43	292.54	5,413.75		292.54	5,395.48		0	0
40	31.6	1,354.60	291.51	1,349.93		291.54	1,345.47		—0.01	— .03
60	47.4	602.06	288.44	597.39		288.53	595.48		—0.03	— .09
100	79.0	216.74	201.67	212.05	—5.1	201.43	211.45	—5.0	+0.1	+ .24
200	158.0	54.19	48.57	49.50	—1.9	48.55	49.45	—1.9	0	+ .02
280	221 2	27.64	22.56	22.95	—1.7	22.63	23.00	—1.6	—0.3	— .07
360	284.8	16.72	11.83	12.03	—1.7	11.92	12.11	—1.6	—0.8	— .09
480	379.2	9.40	4.64	4.71	—1.5	4.76	4.83	—1.5	—2.6	— .12
800	632.0	3.38	0	0		0	0			
					$K=10$					
20	15.8	5,418.43	290.14	5,371.75		290.20	5,354.75		—0.02	— .06
40	31.6	1,354.60	280.08	1,307.92		280.36	1,304.74		—0.1	—0.28
60	47.4	602.06	253.58	555.38		254.30	554.75		—0.3	— .72
100	79.0	216.74	131.56	169.84	—29.1	132.79	170.52	—28.4	—0.9	—1.23
200	158.0	54.19	6.26	7.29	—16.5	7.36	8.52	—15.8	—17.6	—1.10

TABLE III

Values of Q (in kips) computed from Formulae II, III, IV(a) and V. Column is 5¾″ x 9½″ x 40 lb. subway column. $f_1 = 40{,}000$ lb./sq. in.; $E = 30{,}000{,}000$ lb./sq. in. A = % error between II and III = $\frac{\text{II-III}}{\text{II}}$ x 100; B = % error between IV(a) and V; C = % difference between II and IV(a) = $\frac{\text{II-III}}{\text{II}}$ x 100; D = II-IV(a).

L/R	L in.	P_{cr} kips	II kips	III kips	A %	IV(a) kips	V kips	B %	C %	D kips
					$K=1$					
20	48.6	8,705.01	469.88	8,695.90		469.89	8,666.59		0	— .01
40	97.2	2,176.24	467.90	2,167.12		467.94	2,160.02		-0.01	— .04
60	145.8	967.24	461.92	958.12		462.09	955.11		-0.04	— .17
100	243.0	348.20	319.74	339.09	—6.1	319.48	338.18	—5.9	+0.1	+ .26
200	486.0	87.05	76.17	77.94	—2.3	76.22	77.92	—2.2	—0.1	— .05
280	680.4	44.41	34.57	35.30	—2.1	34.72	35.42	—2.0	—0.4	— .15
360	874.8	26.86	17.40	17.75	—2.0	17.59	17.93	—1.9	—1.1	— .19
480	1166.4	15.11	5.88	6.00	—2.0	6.11	6.22	—1.8	—3.9	— .23
640	1555.2	8.50	0	0		0	0			
					$K=10$					
20	48.6	8,705.01	465.20	8,613.92		465.32	8,587.09		—0.03	— .12
40	97.2	2,176.24	445.65	2,085.14		446.17	2,080.52		—0.1	— .52
60	145.8	967.24	395.47	876.14		396.83	875.61		—0.3	—1.36
100	243.0	348.20	193.39	257.06	—32.9	195.70	258.65	—32.2	—1.2	—2.31
200	486.0	87.05	0	0		0	0			

$$\frac{d^2y}{dx^2} = \frac{9.6\ \triangle}{l^2}$$

The curvature expressed in terms of the extreme fibre f gives:

$$\frac{d^2y}{dx^2} = \frac{f}{Ec}$$

Therefore,

$$\frac{9.6\ \triangle}{l^2} = \frac{f}{Ec}$$

or

$$f = \frac{9.6\ \triangle\ Ec}{l^2} \qquad \text{(i)}$$

The stress which controls the strength of the column is the elastic limit stress f_1. If we include the direct loading effect, we obtain:

$$f_1 = \frac{9.6\ \triangle\ Ec}{l^2} + \frac{Q}{A}$$

or

$$\triangle = (f_1 - \frac{Q}{A})\frac{l^2}{9.6\ Ec} \qquad \text{(j)}$$

Combining equations (h) and (j) we obtain:

$$(EI - 0.101667\ Ql^2)\ (f_1 - \frac{Q}{A}) = \frac{5\ kwl^2 \times 9.6\ Ec}{384}$$

$$= 0.125\ kwl^2Ec \qquad \text{(k)}$$

When we solve this equation for Q we obtain:

$$Q = \qquad \text{(l)}$$

$$\frac{1}{2}\left\{f_1A + \frac{9.836\ EI}{l^2} \pm \sqrt{(f_1A - \frac{9.836\ EI}{l^2})^2 + 4.918\ kwEcA}\right\}$$

For the minimum value of Q we have:

$$Q =$$

$$\frac{1}{2}\left\{f_1A + \frac{9.836\ EI}{l^2} + \sqrt{(f_1A - \frac{9.836\ EI}{l^2})^2 + 4.918\ kwEcA}\right\}$$

Formula IV(a)

When $w = 0$, then $Q = f_1A$, or $Q = \frac{9.836\ EI}{l^2}$.

When $Q = 0$, then from equation (k)

$$kw = \frac{8f_1I}{cl^2} \qquad \text{(m)}$$

Comparing (m) with (g) we find that they are identical, which was to be anticipated since Formula IV(a) was derived on the assumption that the elastic curve is a fourth degree parabola, being the curve which the beam would assume under a transverse load kw while Q is zero.

In case of slender beam-columns the factor Q/A may be ignored. Equation (k) then becomes:

$$(EI - 0.101667\ Ql^2)\ f_1 = 0.125\ kw\ l^2\ Ec$$

or

$$Q = \frac{9.836\ EI}{l^2} - \frac{1.2295\ kw\ Ec}{f_1}$$

Formula V (for slender beam-columns)

Table I shows the values of the limit load Q computed on the basis of Formulae II, III, IV(a) and V. These values apply to a beam-column consisting of a solid round steel rod of one inch diameter. Table II shows similar values for a 12 in. × 3 in. × 25 lb. standard channel, while Table III shows such values for a 5¾ in. × 9½ in. × 40 lb. subway column.

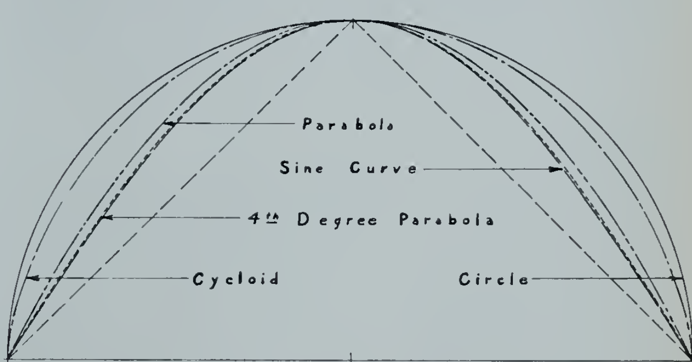

Fig. 2—Comparison of various elastic curves.

In Table I, Q is expressed in pounds. In Tables II and III, Q is given in kips.

The values recorded in the tables have been computed with greater accuracy than would be justified in practice. However, this procedure is here justified in that it permits us to confirm certain theoretical conclusions.

In comparing one with another the results obtained by means of Formulae II, III, IV(a) and V (as listed in Tables I, II and III), it should be realized that Formulae III and V give values consistently too high. This is so because, in

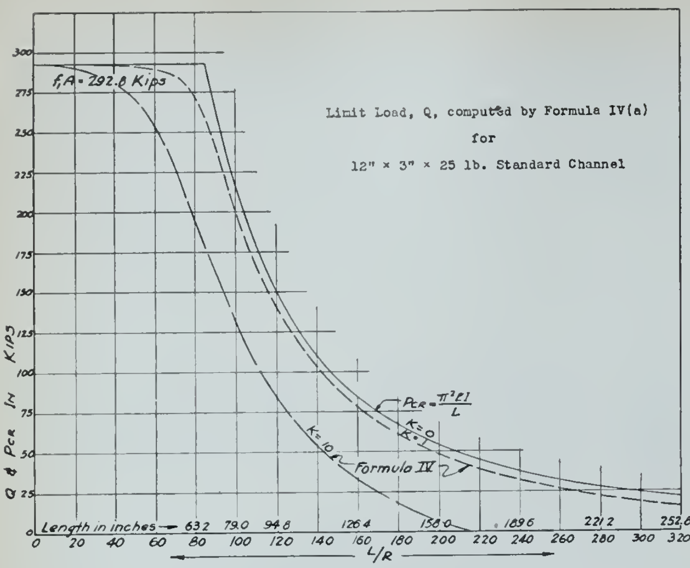

Fig. 3—Limit load (Q) computed by Formula IV(a) for 12″ x 3″ x 25 lb. standard channel.

their derivation, the factor Q/A was ignored. The magnitude of this error is quantitatively illustrated in columns A and B in the tables. These results bear out our earlier contention to the effect that for relatively slender columns and small values of k the Q/A effect on the critical axial load Q is negligible. This conclusion, however, is only of academic interest since the engineering profession frowns on the use of slender columns and is in the habit of ignoring the transverse load effect entirely when k is of the order of magnitude of, say, 1 or 2. A change in this practice is not recommended and we conclude, therefore, that Formulae III and V are not to be used for design purposes.

In comparing the results obtained by Formula II with those derived from Formula IV(a) we find our earlier contention confirmed. We held that, when the axial load predominates (that is, where the values or l/r and of k are small), the elastic curve is most nearly a sine curve. Under these conditions Formula II gives the higher and, therefore, the more nearly correct result. (See Columns II, IV(a), C and D, Tables I, II and III).

It appears that, theoretically, there might be cases in which Formula II must be given a slight preference over Formula IV(a). However, this is true only when the value of kc is small. When kc is of the order of magnitude of unity the engineering profession is in the habit of disregarding the

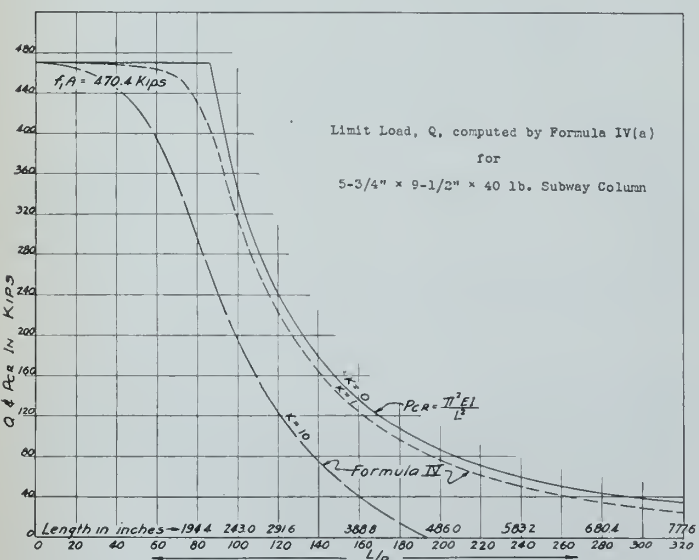

Fig. 4—Limit load (Q) computed by Formula IV(a) for 5¾″ x 9½″ x 40 lb. subway column.

effect of transverse loads on columns. In the light of this analysis no change in this practice is advocated, except possibly in the case of deep columns. In conclusion, then, it is recommended that, of the several formulae studied, Formula IV(a) be adopted.

Figures 3 and 4 show graphically the results obtained by Formula IV(a) as applied to the 12 in. × 3 in. × 25 lb. channel and to the 5¾ in. × 9½ in. × 40 lb. subway column respectively.

Formula IV(a), when divided through by the cross section area of the column, appears as:

$$\frac{Q}{A} = \frac{1}{2}\left\{f_1 + \frac{9.836\ E}{\left(\frac{l}{r}\right)^2} - \sqrt{\left(f_1 - \frac{9.836\ E}{\left(\frac{l}{r}\right)^2}\right)^2 + 4.918\frac{W}{A}E\,kc}\right\}$$

Formula IV(b)

in which w/A is weight per cubic inch of column. In this form it lends itself to graphical representation on one diagram and applies to columns of varying length, varying cross section dimensions and varying intensity of transverse loading, but is restricted to pin-ended columns with at least one axis of symmetry in the direction of the transverse load.

Figure 5 shows the graphs of Formula IV(b) plotted for varying values of kc and for structural steel of elastic limit

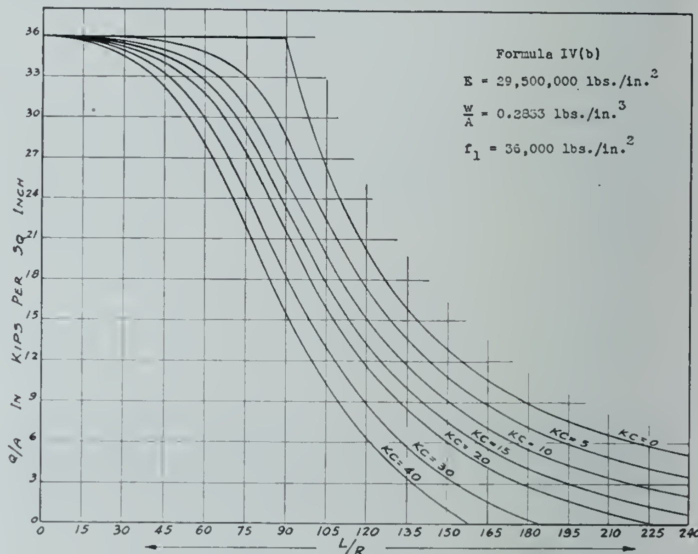

Fig. 5—Average axial limit load $\left(\frac{Q}{A}\right)$ computed by Formula IV(b) for steel of elastic limit f_1=36,000 lb. / sq. in.

$f_1 = 36{,}000$ lb. per sq. in., of modulus $E = 29.5 \times 10^6$ lb. per sq. in., and of unit weight $w/A = 0.2833$ lb. per cu. in.

Figure 6 shows similar graphs for a steel of an elastic limit of 54,000 lb. per sq. in.

Figure 7 shows similar graphs for the aluminum alloy 24S-T, having an elastic limit stress $f_1 = 30{,}000$ lb. per sq. in., a modulus $E = 10.3 \times 10^6$ lb. per sq. in., and a unit weight $w/A = 0.100$ lb. per cu. in.

Figure 8 shows how the average axial limit load Q/A is affected by a change in the value of the elastic limit f_1, all other factors remaining constant. It also shows how the value of Q/A is affected by a change in the modulus of elasticity E.

It is of interest that whereas the graph for Euler's formula, as we are familiar with it, shows the theoretical value Q/A = infinity when $l/r = 0$, the graph for Euler's formula as expressed by Formula II (for the case of $k = 0$) or the graph for Formula IV(b) (for the case of $k = 0$) appears as a limiting curve with $Q/A = f_1$ for all values of l/r less than critical.

In structural engineering the effect of transverse loading (the dead weight effect of a top chord of a bridge) is generally ignored. The limit axial strength of a column appears to be a function of one of the absolute dimensions of the

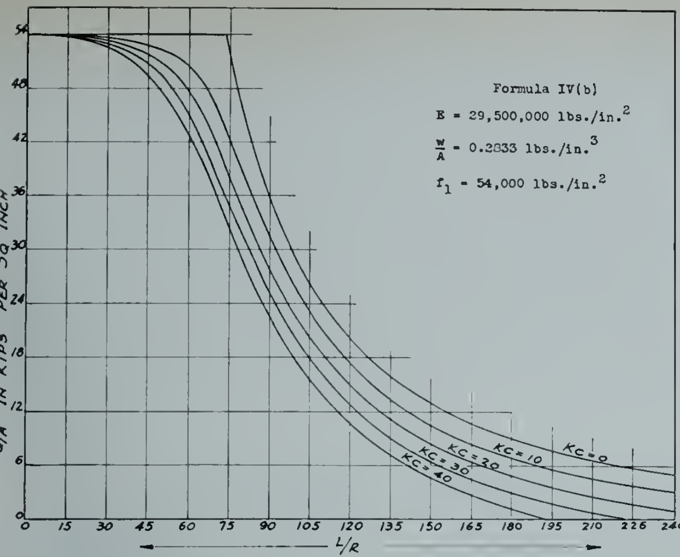

Fig. 6—Average axial limit load $\left(\frac{Q}{A}\right)$ computed by Formula IV(b) for steel of elastic limit f_1=54,000 lb. / sq. in.

column, namely, the value of c. For a pin-ended top chord, having a depth of 40 inches with only the dead weight acting ($k = 1$)*, c would be of the order of magnitude of 20 inches ($kc = 20$). It appears from Fig. 5 that, for such a column of an $l/r = 120$, the value of Q/A is approximately only 60 per cent of P_{cr}/A. For a 12 in. × 3 in. × 25 lb. channel in a horizontal position, with flanges upward of an $l/r = 120$, the limit axial load is 94 per cent of P_{cr} (see Table II). While it appears justified to ignore the dead weight effect on a horizontal channel section subject to compression, a similar dead weight effect on a deep column section is of much greater significance. It would appear, therefore, that in the design of large-size, horizontal columns the dead weight effect should be taken into account.

In aero engineering the transverse air loading on wing members subject to compression is generally taken into account. Every strut in inclined position, making an angle α with the normal force, is subject to transverse inertia loading of $kw \sin \alpha$, in which k represents the coefficient expressing the maximum accelerations encountered as a multiple of the accelerations of gravity. It seems that Formula IV not

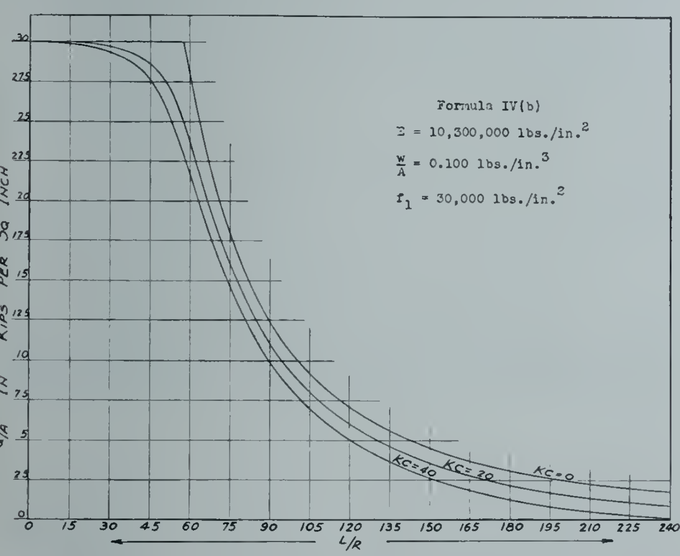

Fig. 7—Average axial limit load $\left(\frac{Q}{A}\right)$ computed by Formula IV(b) for aluminum alloy 24S-T of elastic limit f_1=30,000 lb. / sq. in.

*Even without transverse loading other than the dead weight, the factor k should be taken larger than unity in order that it may include the inertia effect resulting from the vibration of the bridge. See Dynamic Stress Analysis of Railway Bridges, by R. K. Bernhard, Proceedings Am. Soc. C. E. Jan. 1941.

only provides a means of designing members more effectively than is done by present methods, but it also offers a convenient way of including the inertia effect on airplane columns which are more or less perpendicular to the normal force.

It is recognized that the perfect pin-ended column is an academic abstraction. The fixed-ended column, however, is even more fictitious. Even as Euler's formula for pin-ended columns, though little used, serves as a standard for other column formulae, so Formula IV, and the method of its development, may well serve as a standard for other formulae which take into account such factors as varying degrees of end fixity, variations in loading, or variations in cross section dimensions.

For example, a first approximation formula for a fixed-ended column may be derived by the simple process of changing the factor l in Formula II to $l/2$, which gives:

$$Q = \frac{1}{2}\left\{f_1A + 4P_{cr} - \sqrt{(f_1A - 4P_{cr})^2 + 5.0734\, kw\, Ec\, A}\right\}$$

Formula VI(a)

or

$$\frac{Q}{A} = \frac{1}{2}\left\{f_1 + \frac{4\pi^2E}{\left(\frac{l}{r}\right)^2} - \sqrt{\left(f_1 - \frac{4\pi^2E}{\left(\frac{l}{r}\right)^2}\right)^2 + 5.0734\, \frac{w}{A}\, E\, kc}\right\}$$

Formula VI(b)

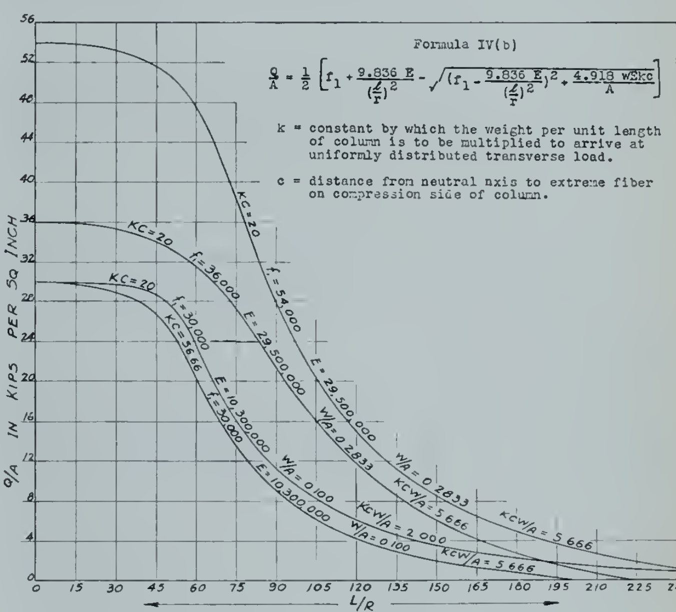

Fig. 8—Average axial limit load $\left(\frac{Q}{A}\right)$ as affected by change in value of elastic limit (f_1) or modulus E.

This formula involves the assumption that the elastic curve of the fixed-ended column is a sine curve. This assumption is probably not far from the truth. A closer approximation formula, however, may be obtained by a detailed study of the shape which the elastic curve of a fixed-ended column will assume—when such a column is subject to transverse loading. The author does not want to undertake this problem at this time because, first, he does not believe that fixed-ended columns occur in practice, and, second, the determination of the degree of end-fixity occurring in practice, which the engineering profession would be willing to accept as being on the safe side, is a matter for detailed and intensive separate study.

It should be pointed out, however, that where either Formula II or IV, which ignore end fixity, give results that are on the safe side, Formula VI would not give such safe results. The similarity between Formulae II and VI suggests that, if it seems safe and desirable to include the strengthening effect of the partial end-fixity of the column, this may be done by the selection of suitable coefficients in the place of the factor 9.836, as given in Formula IV. Or, if we are to allow a certain strengthening effect due to the partial fixity of the ends, this may be done by the simple process of using diagrams (Fig. 5, 6 or 7), and determining the value of Q/A for an l/r which has been reduced from the overall l/r of the column by a certain percentage. Thus, a structural steel 12 in. × 3 in. × 25 lb. channel, loaded transversely with a weight 10 times as great as its dead weight, would have a factor $c = 2.367$, and a factor $kc = 23.67$. From Fig. 5 it appears that such a channel (of an $l/r = 160$), if pin-ended, would develop an average critical load: $Q/A = 4.80$ kips per sq. in. For the same channel, having the same overall $l/r = 160$ and the same $kc = 23.67$, but with its ends completely fixed, the average critical load it could carry would correspond to the reduced value of $l/r = 80$ (Fig. 5), namely, $Q/A = 24$ kips per sq. in. For the same channel, again having the same overall l/r and the same $kc = 23.67$, but with its ends partially fixed, the average critical load it could carry would correspond to a partially reduced value of l/r, say, $l/r = 140$ (Fig. 5), namely, $Q/A = 7.5$ kips per sq. in.

Acknowledgement is expressed to Mr. C. M. Goodrich, M.E.I.C., formerly chief engineer of the Canadian Bridge Company, and to Professors Lloyd H. Donnell, of Armour Institute of Technology, and E. W. Conlon, of the University of Michigan, for their helpful suggestions and criticisms; to Mr. A. G. Clark for his assistance in preparing tables and graphs; and to the Horace H. Rackham School of Graduate Studies of the University of Michigan, for aid received.

THE FIFTY-FIFTH ANNUAL GENERAL MEETING

Convened at Headquarters, Montreal, on January 23rd, 1941, and adjourned to the Royal Connaught Hotel, Hamilton, Ontario on February 6th, 1941

The Fifty-Fifth Annual General Meeting of The Engineering Institute of Canada was convened at Headquarters on Thursday, January twenty-third, nineteen hundred and forty-one, at eight fifteen p.m., with Councillor J. L. Busfield, M.E.I.C., in the chair.

The General Secretary having read the notice convening the meeting, the minutes of the fifty-fourth annual general meeting were submitted and, on the motion of I. S. Patterson, M.E.I.C., seconded by H. G. Angell, M.E.I.C., were taken as read and confirmed.

Appointment of Scrutineers

On the motion of R. H. Findlay, M.E.I.C., seconded by L. H. Burpee, M.E.I.C., Messrs A. H. Chisholm, M.E.I.C., R. S. Eadie, M.E.I.C., and I. S. Patterson, M.E.I.C., were appointed scrutineers to canvass the Officers' Ballot and report the result.

There being no other formal business, it was resolved, on the motion of R. E. Heartz, M.E.I.C., seconded by J. W. Simard, M.E.I.C., that the meeting do adjourn to reconvene at the Royal Connaught Hotel, Hamilton, Ontario, at ten o'clock a.m., on the sixth day of February, nineteen hundred and forty-one.

ADJOURNED GENERAL MEETING AT THE ROYAL CONNAUGHT HOTEL, HAMILTON, ONTARIO

The adjourned meeting convened at eleven o'clock a.m., on Thursday, February 6th, 1941, with Vice-President J. Clark Keith in the chair.

The chairman opened the meeting by asking the General Secretary to read a communication from Dr. Hogg, in which the President expressed his regret at being unable to attend and his wishes for a successful meeting.

The chairman explained the President's enforced absence, and expressed the opinion of the entire meeting when he acknowledged the successful year that the Institute had experienced under Dr. Hogg's guidance. He referred to the agreements which had been reached with two of the provincial professional associations, the series of radio broadcasts, the affiliation with the Engineers' Council for Professional Development, and the elimination of the classification of Associate Member, all of which had been brought to fruition during Dr. Hogg's period of office.

Past-President Challies, following the tradition of the Institute, paid a tribute to the retiring President, and concluded with a resolution, which was seconded by Past-President Mitchell, to the effect that the General Secretary should send the President a formal motion of appreciation for the work which he had done during his term of office.

The General Secretary announced the membership of the Nominating Committee of the Institute for the year 1941 as follows:

Nominating Committee—1941

Chairman: R. A. Spencer, M.E.I.C.

Branch	*Representative*
Border Cities	C. G. R. Armstrong
Calgary	H. B. LeBourveau
Cape Breton	S. C. Mifflen
Edmonton	C. E. Garnett
Halifax	I. P. MacNab
Hamilton	W. J. W. Reid
Kingston	A. Jackson
Lakehead	E. L. Goodall
Lethbridge	C. S. Donaldson
London	V. A. McKillop
Moncton	R. H. Emmerson
Montreal	A. Duperron
Niagara Peninsula	A. W. F. McQueen
Ottawa	J. G. Macphail
Peterborough	W. M. Cruthers
Quebec	A. O. Dufresne
Saguenay	J. R. Hango
Saint John	A. A. Turnbull
St. Maurice Valley	A. C. Abbott
Saskatchewan	A. M. Macgillivray
Sault Ste. Marie	J. S. Macleod
Toronto	J. M. Oxley
Vancouver	E. Smith
Victoria	K. Moodie
Winnipeg	C. V. Antenbring

Awards of Medals and Prizes

The General Secretary announced the awards of the various medals and prizes of the Institute as follows, stating that the formal presentation of these distinctions would be made at the Annual Dinner of the Institute on Friday evening:

Sir John Kennedy Medal to Lieut.-General A. G. L. McNaughton, M.E.I.C.

Duggan Medal and Prize to M. S. Layton, Jr.E.I.C., for his paper, "Coated Electrodes in Electric Arc Welding."

Gzowski Medal to Elizabeth G. M. MacGill, M.E.I.C., for her paper, "Factors Affecting the Mass Production of Aeroplanes."

Plummer Medal to O. W. Ellis for his paper, "Some Developments in Alloys during the last Twenty Years."

Leonard Medal to R. G. K. Morrison, M.C.I.M.M., for his paper, "Points of View on the Rock Burst Problem."

Julian C. Smith Medals (Inaugural Awards), "For Achievement in the Development of Canada," to W. D. Black, M.E.I.C., R. J. Durley, M.E.I.C., A. Frigon, M.E.I.C., F. W. Gray, M.E.I.C., Sir Herbert Holt, M.E.I.C., R. S. Lea, M.E.I.C., Beaudry Leman, M.E.I.C., C. A. Magrath, M.E.I.C.

Students' and Juniors' Prizes

John Galbraith Prize (Province of Ontario), to W. C. Moull, S.E.I.C., for his paper, "Electrification of a Modern Strip Mill."

Phelps Johnson Prize (Province of Quebec—English), to Léo Brossard, S.E.I.C., for his paper, "Geology of the Beaufor Mine."

Ernest Marceau Prize (Province of Quebec—French), to Marc R. Trudeau, S.E.I.C., for his paper, "Points Fixes et Lignes d'Influence."

Report of Council, Treasurer's Report, and Report of the Finance Committee

On the motion of F. P. Shearwood, seconded by R. L. Dunsmore, it was *resolved* that the report of Council for the year 1940, the Treasurer's report, and the report of the Finance Committee, as published in the February, 1941, *Journal*, be accepted and approved.

Reports of Committees

On the motion of A. W. Sinnamon, seconded by A. H. Meldrum, it was *resolved* that the reports of the following committees be taken as read and accepted: Publications; Papers; Training and Welfare of the Young Engineer; Library and House; International Relations; Professional Interests; Legislation; Radio Broadcasting; Deterioration of Concrete Structures; Membership; Board of Examiners and Education; Employment Service.

Branch Reports

On the motion of H. J. Vennes, seconded by R. E. Heartz, it was *resolved* that the reports of the various branches of the Institute be taken as read and approved.

Rewording and Rearrangement of the By-Laws

Vice-President Keith reported that in accordance with Section 75 of the By-laws, the reworded and rearranged by-laws of the Institute, as published in the August, 1940, *Journal*, had been approved by a majority of members of Council upon letter ballot, and by the resolutions of the executive committees of a majority of the Institute branches, and were now presented for approval by this annual general meeting.

Dr. Challies drew attention to the tremendous amount of work involved in the complete rearrangement of the by-laws as now presented. Most of this work had been done by Secretary-Emeritus Durley, who was assisted materially by Mr. Gordon Pitts. It was unanimously agreed that the thanks and appreciation of the Institute be extended to these two members.

On the motion of E. P. Muntz, seconded by L. F. Creighton, it was *resolved* that the rewording and rearrangement of the Institute by-laws, as published in the August, 1940, *Engineering Journal*, be approved.

Election of Officers

The General Secretary read the report of the scrutineers appointed by Council to canvass the officers' ballot for the year 1941, as follows:

President.......................... C. J. Mackenzie

Vice-Presidents:

Zone A (Western Provinces).......... A. L. Carruthers
Zone B (Province of Ontario)......... K. M. Cameron
Zone C (Province of Quebec).......... deGaspé Beaubien

Councillors:

Vancouver Branch.................. H. N. Macpherson
Edmonton Branch................... J. Garrett
Saskatchewan Branch............... I. M. Fraser
Lakehead Branch................... J. M. Fleming
Border Cities Branch.............. E. M. Krebser
London Branch..................... J. A. Vance
Toronto Branch.................... A. E. Berry
Peterborough Branch............... H. R. Sills
Kingston Branch................... D. S. Ellis
Ottawa Branch..................... W. H. Munro
Montreal Branch................... G. McL. Pitts
H. J. Vennes
Saint Maurice Valley Branch....... J. H. Fregeau
Saguenay Branch................... M. G. Saunders
Saint John Branch................. H. F. Morrisey
Halifax Branch.................... S. W. Gray

On the motion of J. A. McCrory, seconded by H. G. O'Leary, it was *resolved* that the report of the scrutineers be adopted, that a vote of thanks be tendered them for their services in preparing the report, and that the ballot papers be destroyed.

Vice-President Keith announced that the newly elected officers would be inducted at the Annual Dinner on the following night.

On the motion of R. H. Findlay, seconded by E. S. Mattice, it was unanimously *resolved* that a hearty vote of thanks be extended to the Hamilton Branch in recognition of their hospitality and activity in connection with the holding of the fifty-fifth Annual General Meeting.

On the motion of Past-President S. G. Porter, seconded by L. A. Duchastel, it was unanimously *resolved* that the sincere thanks of the Institute be extended to the retiring president and councillors in appreciation of the work which they have done for the Institute during the past year.

The General Secretary reported that the Institute had been approached by the Citizens' Committee for Troops in Training, with a suggestion that the Institute, in company with certain other engineering organizations, might undertake to raise $760.00 for the purchase of band instruments for the Royal Canadian Engineers at Petewawa Camp.

The request had been considered by Council at its meeting on the previous day, and while it was felt that the Institute could not officially participate in such an endeavour, the Council was entirely in sympathy with the objective, and the suggestion was made that the money might be collected on a voluntary basis from the members attending the annual meeting. Accordingly, a collection had been taken up at the Council meeting, and the General Secretary now stated that he or his assistant would be glad to receive further contributions from any members who felt they would like to support this worthy object.

There being no further business, the meeting adjourned at eleven thirty-five a.m.

THE GENERAL PROFESSIONAL MEETING

At the luncheon on Thursday, the mayor of Hamilton, W. E. Morrison, extended a hearty welcome to the members and guests. His breezy remarks contained some good-natured references to the plight of neighbouring cities perhaps less bountifully endowed with natural beauty than is Hamilton. He was followed by W. D. Black, who spoke on **Industrial Morale** and its importance in the war effort. It is hoped to publish this thoughtful address in a later issue of the Journal, together with those given later during the meeting which dealt with similar problems of engineering interest at this time.

The special afternoon session, over which Vice-President deGaspé Beaubien presided, was devoted to a paper on **Technical Training for National Defence,** prepared by Dean A. A. Potter of Purdue University. This was presented by Dr. A. A. Cullimore and was well discussed, together with the report of H. F. Bennetts' Committee on the Training and Welfare of the Young Engineer.

That report and notes of the discussions upon it will be published in an early issue of the Journal.

Dr. J. O. Perrine

Dr. A. R. Cullimore

Dean A. A. Potter

J. A. McCrory, M.E.I.C.

A. S. Runciman, M.E.I.C.

A. T. E. Wanek, M.E.I.C.

T. S. Mills, M.E.I.C.

E. R. Jacobsen, M.E.I.C.

J. T. Thwaites, M.E.I.C.

In reference to the paper presented by Dr. Cullimore, E. P. Muntz pointed out that Canada's defence activities would call for at least five thousand more technically trained men. He urged prompt action on this matter. Professor W. L. Malcolm, now of Cornell University, outlined the courses established there as an aid to industry. Dean Brown of McGill and Professor C. R. Young of Toronto referred to the difficulties already caused in our engineering schools by wartime exigencies.

Friday morning's Technical programme comprised three papers on electrical subjects. Mr. McCrory described the important hydro-electric power development at La Tuque, and noted that the addition of almost 200,000 h.p. to the Dominions resources has been of great value to our war effort. Dean Brown gave interesting information regarding the studies on which the runner design for La Tuque was based, obtaining increased power and avoiding cavitation troubles. J. T. Thwaites followed with a paper on the use of Ignitron Rectifiers in war industries, particularly where electro-metallurgical processes are carried out. The paper by A. S. Runciman on Earth Crust Resistance gave valuable data on the protection of transmission lines from lightning damage. Vice-president DuBose was in the chair during this Session.

An address by Secretary George T. Seabury of the American Society of Civil Engineers was the principal feature at the luncheon on Friday when E. P. Muntz presided. He gave to the members present an interesting account of the organization and manifold activities of the **Engineers' Council for Professional Development**, the important consultative organization which the Institute has been privileged to join as the first member body located outside the United States. Mr. Seabury's remarks made it clear that The Engineering Institute of Canada will receive most valuable help from this membership in dealing with Canadian professional problems, and that in return the Engineers' Council will be able to profit by experience gained in Canada under conditions which are necessarily somewhat different from those in the United States.

Vice-president J. Clark Keith took the chair at the Friday afternoon session in the Starlight Room, where A. T. E. Wanek of the British Air Purchasing Mission, New York, gave a timely paper on the estimation of production costs of aircraft.

Next on the programme was a series of excellent coloured moving pictures taken during a journey over the Banff-to-Jasper Highway, illustrating a paper presented by T. S. Mills, which was commented on by J. M. Wardle, under whose supervision much of this scenic road was constructed.

Meanwhile in Dining Room "A," E. R. Jacobsen gave his paper on Moment Distribution and Analysis of a Continuous Truss of Varying Depth—K. M. Cameron presiding. A five-span highway bridge truss was taken as an example of the application of a new method of analysis, for which machine calculations are not necessary, which determines the moments directly, and requires less work than the conventional method of procedure. The discussion which followed was extensive and highly technical.

Joint Meeting

An unusual feature this year was the joint dinner and demonstration shared with the Niagara District Electric Club. This dinner was held in the Starlight Room and over six hundred were in attendance. The demonstration was given in the Ball Room by Mr. J. O. Perrine, assistant vice-president of the American Telephone and Telegraph Company.

The principal feature of this remarkable performance was "Voder" an electrical mechanism for producing the sound and formations of the human voice. By means of this apparatus, and the skilful young lady who controlled the keyboard, words could be produced that contained the identical sounds and inflections of the human voice. "Synthesized speech" is a good description of it.

The whole demonstration was unusually interesting, and an audience that exceeded the capacity of the room voiced its approval in no uncertain terms.

Another outstanding event of the meeting was of course the Annual Banquet of the Institute. Everyone regretted that Dr. Hogg could not be in the chair, but his place was ably filled by Vice-President DuBose, who presented the various prizes and medals of the Institute. The award of the Gzowski Medal to Miss Elizabeth MacGill in particular met with the enthusiastic approval of the large audience.

The army was well represented

The officers and distinguished guests at the head table included: Chairman McNeely DuBose and Mrs. DuBose; Dean C. J. Mackenzie, president, The Engineering Institute of Canada and acting president, National Research Council, and Mrs. Mackenzie; Dr. Wm. E. Wickenden, president of the Case School of Applied Science, Cleveland, Ohio; George T. Seabury, secretary, American Society of Civil Engineers, and secretary, Engineers' Council for Professional Development; R. J. Magor, chairman of the board of the Canadian Chamber of Commerce, and president, National Steel Car Corporation, Mrs. Magor and John Magor; W. A. T. Gilmour, chairman of the Hamilton Branch and Mrs. Gilmour: W. P. Dobson, representing the Dominion Council of Professional Engineers, and Mrs. Dobson; Professor R. E. Jamieson, president of the Corporation of Professional Engineers of Quebec; Burwell R. Coon, president, Royal Architectural Institute of Canada, and Mrs. Coon; and His Worship the mayor of Hamilton, W. E. Morrison.

A luncheon group made up of Messrs. Eadie, Brown, McCrory, Challies, all of Montreal, and General Mitchell (Toronto)

The principal speaker was President W. E. Wickenden

W. D. Black (Hamilton) was the luncheon speaker on Thursday. McNeely DuBose and H. A. Cooch were among head table guests

The "Pay-off"—next day John Dunbar squares off the hotel account while Bill Brown gives his approval.

George T. Seabury (New York) tells of the aims and purposes of E.C.P.D He is secretary of that body and also of the American Society of Civil Engineers.

Dr. A. R. Cullimore (Newark) presents Dean Potter's paper onTechnical Training for National Defense, and adds considerable material of his own. De Gaspé Beaubien is chairman.

Dean Brown (Montreal) left, supplements the material given in J. A. McCrory's paper on the La Tuque Development.

An interesting "father and son" group. R.J.Durley and Tom Durley(Montreal).

Past President F. P. Shearwood (Montreal) discusses the Jacobsen paper.

Jacobsen's paper on Moment Distribution and the Analysis of a Continuous Truss was discussed for over two hours. Here is the author.

Arthur Runciman (Montreal) describes some new things that have been found out about "Earth's Crust Resistance and Lightning".

Joe Thwaites (Hamilton) delivers his paper on Ignitrons.

Chairman R. L. Dunsmore (Halifax) discusses the papers with A. T. Wanek (New York), left, and J. M. Wardle (Ottawa), right.

Between meetings—left to right, L. H. Robinson of Oakville and H. L. Bucke of Niagara Falls.

Left to right, K. M. Cameron (Ottawa), Bill Bonn (Toronto) and John Stirling (Montreal) ask the General Secretary some questions.

Geoffrey Stead (Saint John) keeps up his unbroken string of 25 annual meetings, while Marc Trudeau (Montreal) takes in his first one.

Bill Reid (Hamilton) exhibits his radio personality.

Dr. W. E. Wickenden delivers his excellent address.

of the Case School of Applied Science, Cleveland. He took for his text a verse from the Gospel according to St. Matthew but his discourse was adorned with several anecdotes of more worldly origin. Its title was **The Second Mile**—a reference to a commandment in the Sermon on the Mount —which, according to Dr. Wickenden, represents that voluntary effort, over and above the regular required task, which distinguishes the efficient and willing from the mediocre performer. His address was full of humour and gave food for much thought regarding professional status and dignity.

At the close of the dinner the induction of the newly elected president took place, and Dean Mackenzie gave a brief message to the Institute.

The banquet was followed by a dance. Members and guests were received by Dean and Mrs. C. J. Mackenzie, Mr. and Mrs. W. A. T. Gilmour, and Mrs. Hugh Lumsden.

On Wednesday, previous to the general activities, there were two important functions, i.e., the council meeting and the president's dinner.

Council Meetings

As usual, incoming councillors were invited to this Council meeting, as well as past-presidents and certain other members whose interests and activities brought them into close contact with the Institute. In all, there was an attendance of forty-one. In the absence of the president, Vice-President Sauder presided at both the morning and the afternoon sessions. The details of the meeting are printed elsewhere in this number of the *Journal*.

The new council met at two-thirty on the afternoon of Friday, with the new president, C. J. Mackenzie, in the chair. In accordance with the usual custom, chairmen of standing and special committees were appointed and other routine business attended to. The detailed report of this meeting is also printed elsewhere in this *Journal*.

President's Dinner

The pleasant custom of the retiring president entertaining at dinner, the officers and councillors of the Institute and certain other members who have assisted him in his term of office, was maintained this year, even though the host himself could not attend. It was Dr. Hogg's firm desire that his accident would not rob the annual meeting of a pleasant feature and deny him the privilege of expressing in this way his appreciation of the aid and assistance which had been given him so generously. The dinner was held at the Tamahaac Club outside of Hamilton.

J. M. R. Fairbairn presided, an honour due him as the senior past-president present. To support him he had at the head table Past-Presidents Porter, Shearwood, Lefebvre and Challies, and President-Elect C. J. Mackenzie, Vice-Presidents Sauder, DuBose and Keith. Mr. N. S. Braden, vice-president of the Canadian Westinghouse Company, was a special guest.

Mr. Fairbairn, after expressing his regret at Dr. Hogg's absence, asked each past-president and each new councillor to make a speech. In view of the fact that absolutely no warning had been given, the results were extremely amusing but satisfactory. The past-presidents in particular acquitted themselves nobly, and indicated clearly that they had not lost their sense of humour.

The Committee on the Welfare and Training of the Young Engineer—left to right, Messrs. R. F. Legget (Toronto), R. E. Heartz (Montreal), Harry Bennett (London), chairman, A. E. Macdonald (Winnipeg). This is not the Mural Room.

Dean Mackenzie spoke on the future of the Institute and the profession, with particular reference to wartime conditions. He expressed his appreciation of his election to the presidency, and asked the support of all councillors throughout what would be a trying and decisive year.

The concluding feature of the evening was the showing of a sound movie depicting the collapse of the Tacoma Bridge. The party returned to the hotel by bus to join the ladies and break up the bridge session which was underway.

THE PRESIDENT'S DINNER

Head table—Chairman J. M. R. Fairbairn warns Jack Challies that he is going to be called on for a speech. Other past presidents are Sam G. Porter (Calgary), O. O. Lefebvre (Montreal), F. P. Shearwood (Montreal) just out of the camera's range. President-elect C. J. Mackenzie is in the foreground

N. S. Braden (Hamilton), centre, explains on his fingers, much to the amusement of McNeely DuBose (Montreal) and Clark Keith (Border Cities).

With characteristic gesture, Geoff Gaherty (Montreal) tells Hal Cooch (Hamilton) something he should know about transformers.

Even without their hair you can recognize Gordon O'Leary (Lakehead) "the darling of the profession," Charlie Sisson, R. B. Young and Barry Watson, all of Toronto.

Reg Findlay, at the "low" end of the table, tells another one to John Hall (left) and Harold Vennes (right), all of Montreal.

The Ottawa contingent—right to left, Messrs. W. F. Bryce, W. H. Munro, J. H. Parkin with Huet Massue (Montreal), Harry Bennett (London) and D. S. Ellis (Kingston) in the background

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Harry Bennett presents branch prizes to L. C. Sentance and to M. D. Stewart.

Any paper that holds the audience like this for two hours must be good.

The reception line—left to right, Mrs. Hugh Lumsden, Mrs. Mackenzie, The President, Mrs. Gilmour and W. A. T. Gilmour, chairman of the branch.

A president is installed. Dean Mackenzie takes over from chairman McNeely DuBose.

Miss McGill (Fort William) winner of the Gzowski Medal, George Seabury (New York), Dr. Wickenden (Cleveland) and the luncheon chairman Eric Muntz.

The Ladies

A very complete programme for the ladies, taking up the better part of three days, was provided by the ladies' committee under the chairmanship of Mrs. Hugh Lumsden. Without having participated in it, it is impossible to describe every function, but judging from the printed programme and from the reports of those who did take part, everything was very satisfactory.

J. J. Mackay (Hamilton) explains a serious point. Left to right, J. A. Vance (Woodstock), L. A. Fraikin (Montreal), J. J. Mackay, D. L. Mackinnon (Montreal).

On Wednesday evening, while the councillors were at the Tamahaac Club, guests of the president, the ladies joined together for a modest bridge tournament.

And the ladies played bridge—from left to right, Mrs. F. P. Shearwood (Montreal), Mrs. C. J. Mackenzie (Ottawa), Mrs. Louis Trudel (Montreal), Mrs. W. H. Munro (Ottawa), Mrs. G. Moes (Hamilton), but Mrs. Hugh Lumsden (Hamilton) would not face the camera.

On Thursday afternoon it was the ladies' turn to visit the Tamahaac Club, where tea was served. The same night a special dinner was arranged for them at the Wentworth Arms Hotel.

Friday morning saw several ladies embarking on a prearranged shopping tour. Others visited certain industries in the locality, and all returned in time for lunch at the hotel. All ladies were guests of the Hamilton Branch for both luncheons, and for tea and dinner as well—a very much appreciated innovation.

The Hamilton ladies made a splendid showing in their part as hostesses. Mrs. Hugh Lumsden gathered together a competent and enthusiastic group that contributed much towards the success of the whole meeting.

RAILWAYS AND THE WAR

From *The Railway Magazine*, (London), December, 1940

Twelve months have passed since we published an article under the title of "Railways and the War." The previous instalment concluded by pointing out that, as we have readers in all parts of the world, we are naturally sensible to the necessity for maintaining perspective, and bear in mind that the incidence of war upon railways, as upon the lives of individuals, is important, but not all-embracing. From time to time, therefore, we have made references to the war as it has affected railways and now propose to give a general review of some of the more important events of 1940.

In Great Britain the events of last winter may be summarized as comprising the reduction of passenger services and their subsequent part-restoration, the difficulties of travellers due to the imposition of severe blackout restrictions; the giving of preference to freight traffic over passenger traffic; and the coincidence of very severe weather conditions with war conditions. By the early spring, shaded white light had been gradually restored to most passenger trains, and practically all are now so equipped, although the supply of current through the switch in the guard's control depends upon whether or not the passengers keep the blinds drawn.

The withdrawal of the B.E.F. and large numbers of the French Forces from Northern France through Dunkerque, provided the British railways, and the Southern in particular with an extraordinary test of organization and initiative in transporting some 320,000 from the Channel ports. It fell to the lot of the Southern Railway Company to initiate the arrangements, and all four railways contributed their quota of trains, of which 186 were used. A detailed report of this movement was given in The Railway Magazine for July. It will also be recalled that during the period of intensive B.E.F. evacuation, the British railways carried in addition some 20,000,000 passengers and 6,000,000 tons of freight. In the middle of the year the Minister of Transport decided that to conserve steel for essential war purposes, the new works of the London Passenger Transport Board in conjunction with the G.W.R. and the L.N.E.R. should be suspended. About the same time the Ministry of Home Security defined certain districts of the country as defence areas into which movement was restricted. Persons wishing to enter the specified areas for business purposes were not prevented from doing so, but holiday and pleasure visits were banned. Later these areas were subject to considerable extension, and roughly comprised a strip of varying width inland from the coast from Berwick-on-Tweed to Weymouth. Suspension of free movement into these areas naturally occasioned a considerable reduction in travel on certain sections of lines.

After the withdrawal of the British Forces from France and the subsequent movement to the French coast of the Germany army, the Local Defence Volunteer corps was formed for home defence purposes. Railway units of this force were formed by all the main-line companies, and these have done much valuable work in the general guarding of premises and key points on the systems. Later in the year the title of Local Defence Volunteer was changed to the more appropriate one of Home Guard. In October, the Ministry of Transport announced that railway station names which early in the war had been obliterated or greatly reduced in visibility might be displayed more freely. The object of the removal of names had been to avoid giving indications of the area concerned to low-flying aircraft, or to parachute troops. The Minister's intimation in the autumn of this year was to the effect that names might be displayed more freely provided they could not be read from a highway or by low-flying aircraft.

In the various parts of this country and also abroad, derelict tunnels have been made available as air raid shelters, and with the intensification of the war in the air, have become of increasing value to the public. Examples of tunnels put to this use are those at Southwark and King William Street, London, and at Dundee, Harrogate, Edinburgh and Ramsgate. Abroad an outstanding example of tunnel shelters is provided by Malta.

Air raids on London, which first began on an intensive scale on September 7, occasioned a certain amount of disorganization to the transport services of all kinds. Railway targets naturally proved attractive to the enemy, and on some occasions it has been necessary to divert or suspend the train services, although usually the periods involved have been very brief. A special group of buses has been formed to replace train services interrupted between certain points in the Metropolitan area. Repairs to damaged lines have been quickly undertaken, and services restored with a minimum of delay. Notwithstanding the difficult conditions under which operations have been conducted on many occasions, traffic in general has been kept moving with remarkable freedom. The work of the engineers indeed speaks well not only for the enterprise of individuals in the engineering departments when faced with emergencies, but also for the preparatory measures which had been taken by the railways in anticipation of troubles the exact nature of which, could, of course, not be foreseen. The easiest type of damage to repair is the straight-forward bomb crater. Where a bomb falls clear of the tracks, it may affect their alignment and level, and cover them with debris. The repair is then merely a matter of clearing and re-adjusting. Should a bomb fall upon the track it may necessitate bringing to the site material for filling the crater and relaying the damaged lines. Cables, both traction and signal, and conductor rails, not to mention telegraph wires, may have been damaged and these also have to be repaired. Traffic may, however, be resumed under hand signalling pending the re-establishment of the normal controls. Delayed action bombs may cause but small damage immediately, but until they are extracted and removed, a proceeding which has proved possible in many instances, they inevitably cause traffic interruption. Station buildings have been the victims of aerial bombardment, but restoration has been astonishingly rapid and in some instances train service is only very slightly interrupted.

The greatest problems both in nature and magnitude have, of course, been presented by damage to bridges and viaducts, and the ingenuity displayed in devising means of restoration, as well as the concentrated hard work which has gone to its realization, has astonished many who have had the opportunity of seeing what has had to be tackled. One instance of quick repair may be mentioned. A bomb fell on a brick arch viaduct supporting eight running lines carrying an intensive traffic. It penetrated through the brick arch and exploded with great violence wrecking several arches and shattering everything within a large radius. Traffic had to be suspended on all lines, and it was decided that the quickest method of restoration was to build retaining walls at each side of the viaduct, demolish the worst of the wrecked masonry and fill in and consolidate the whole formation. Filling, consisting of quarry refuse which packs quickly and solidly, was brought to the site in trains of hopper wagons. Two of the tracks were reopened to traffic within eight days, two more ten days later, and a further two very soon afterwards. Here and there fire has been a trouble, and there is an instance of an important station carried on a steel viaduct in which the terminal ends of all but one platform were badly damaged before the conflagration could be extinguished. Trains which were standing at the platforms at the time were attacked by the flames, but all were removed before extensive damage had been done, except one with wooden-centred wheels which, when burnt, let the axles drop. These vehicles thus became immovable and were destroyed. The scene immediately after this fire was one of desolation, but nevertheless so quickly and methodically was the wreckage handled that within 48 hours it was possible to work trains in and out of one platform. Five days later two more platforms were again in use providing sufficient accommodation for the traffic.

MODERN PROBLEMS IN HIGHWAY CONSTRUCTION

CHARLES M. BASKIN
Asphalt Technologist, Imperial Oil Limited, Toronto, Ont.

Abstract of paper delivered before the Toronto Branch of the Engineering Institute of Canada, November 21st, 1940.

Road construction to-day is more of a problem than it ever was in pre-modern times. The principal reason for this is that we are inclined to regard every road job as a standardized task. Actually, the modern motor road is a combined social, economic and technical problem.

Taking the railway as a basis for comparison, the speaker stated that the railway developed along standardized lines with little, if any, confusion, principally because, as a private enterprise, it tended towards massive unit construction and concentration in the most populated areas. Under these circumstances there was little incentive, on the part of the privately-owned railway, to pioneer in localities of doubtful return. Moreover, there is a definite minimum standard and, therefore, minimum cost of railway per mile, beyond which one cannot go. This minimum cost was still economically impossible for low revenue areas. But there can be a multitude of types of roads—from the massive four-lane highway to the graded earth road. Yet the heaviest motor vehicles can negotiate the earth road during relatively dry periods; hence the confusion in standards and specifications in highway construction as contrasted with the railway.

In a sense, roads are like a consumable commodity, where capacity to consume is always greater than ability to supply. The motorist's demand is both for mileage and for quality —mileage to get ever farther away from the over-concentrated areas—quality in form of safety, comfort and reduction of wear on the motor vehicle. The primary demand, however, is for mileage and this always outstrips the revenue that can be exacted from the motorist. Under such circumstances, the engineer followed the most obvious procedure. Where traffic was low, he tried to get by with the old time low-cost construction methods, resulting in a road of low bearing capacity. Where traffic was high, he based his design on the assumption that the pavement alone will have to support the total traffic load as, at certain times of the year, the supporting value of the subgrade may be nil.

Demand for road mileage not only outstripped increase in revenue, but was considerably ahead of technological developments on how to build a structurally adequate road at a cost compatible with available funds and mileage required. The speaker emphasized that lack of fundamental data on causes of road failures has driven us to massive construction which, in itself, is only a temporary palliative. It is only recently that systematic investigations have yielded data on behaviour of soils in presence of water. Effect of water has been the chief cause of most of our road failures.

He then expounded the theory of design of roads as a composite structure of several layers, consisting of the soil subgrade, the base course and the wearing surface, each layer intended to have and to retain a certain minimum bearing capacity, the sum total of which is adequate to support the heaviest wheel loads. In this connection, he outlined the newly developed methods of base course construction using natural clay as binder and gravel and sand as aggregate. Admixture of extremely small quantities of bitumen makes such masses of clay cemented aggregates water-repellent, thereby retaining the clay bond.

He further pointed out that such methods of base course construction have widened enormously the range of aggregates that can be used, thereby reducing costs and obtaining bases several times the structural strength of the unscientifically constructed macadam or gravel base. Add to this the mechanically improved road bed, and the combined bearing capacity of such composite structure (soil road bed and base) is more than adequate to support the heaviest traffic. This type of design obviates the necessity of massive pavements. A thin resilient wearing course is entirely satisfactory—hence the all-weather, high bearing capacity road at a low cost.

He further emphasized that even with massive pavements, we shall have to go to more scientific methods of drainage, soil compaction and construction of mechanically waterproofed base courses, otherwise our maintenance bills will continue to mount.

Our need for road mileage is increasing at a far greater rate than our revenues from motor vehicles. We are, in addition, faced with increasing weaknesses and even failure of both expensive and low-cost roads constructed over unstable soil and poorly designed bases. It is, therefore, essential that we constantly keep in mind that the only manner in which we will ever balance our budget is to have the scientific theories of to-day developed and made into the practice of to-morrow.

GAS

From *Aeronautics*, (London), December, 1940

Ashes to ashes and dust to dust; and gas to sewage and sewage to gas. Something of that kind, seems to be the fundamental process underlying the cycle of nature. Dr. Lawrie, in an important book which is reviewed in our book page, directs attention at the possibilities of using methane, or marsh gas, as a fuel for internal combustion engines. According to his examination of the problem we could find in this country a sufficient supply of methane to reduce markedly our imports of fuel.

The gas is given off when sewage is being treated by the bacterial method. At present we secure our supplies of aviation spirit through the good offices of the Navy, and the Royal Air Force does not forget that it owes its success to the Navy, for without the constant stream of tankers reaching our ports it would not be able to take off. But anything that can reduce that burden on our shipping is of immediate value.

Some might argue that the war has progressed so far that the introduction of new sources of fuel supply would come too late to be of value. But this is a false view, for if we can provide some of our own fuel we gain in peace as well as in war. Moreover the cyclic principle is gaining ground as the basic principle which should guide all human proceedings, agricultural and other. It is from the rotting leaf that the best fertilizer comes. Sewage undoubtedly contains material that is more valuable than gold. In the past the procedure was usually to throw it away. Now a wiser view tends to prevail and there is a better understanding of the cyclical processes which go to renew life and energy.

That we should take our aviation spirit from sewage is in train with this application of the cyclical principle. Dr. Lawrie's book deserves the closest attention from all those who are dealing to-day with the problems of the nation's supplies.

A NEW INDUSTRY IN SWEDEN

Abstracted by Emil Skarin, m.e.i.c.

Producer gas, made directly from either charcoal or wood, is rapidly substituting gasoline as fuel for the motor vehicle traffic in Sweden.

The war has necessitated this change. When hostilities broke out in September, 1939, Sweden had in operation 280,000 motor vehicles of all types. The greater portion of these had to be laid up for lack of gasoline. There being no restriction on the use of wood or charcoal, many trucks resorted to the use of producer gas, derived from charcoal, as was done in the first great war.

Charcoal is made from wood, both assiduous and dissiduous wood, preferably in dry condition. In Sweden, fairly large quantities are produced each year, usually from slabs, tree tops, and waste, surrounding the lumber industry. When charcoal was again required as fuel for the motor vehicles, the supplies were soon exhausted, and no cheap, dry wood supply was readily available. Nothing else was left except plain green wood.

The equipment used in the first great war, to facilitate the use of producer gas, had in the meanwhile been greatly improved. It was soon found that wood, cut into small cubes of about two inches, served almost equally as well, though the rate of burning was more difficult to control.

The use of wood directly is the outstanding and rather startling development, there being no scarcity of wood, and, furthermore, useless, crooked and twisted pieces could be used. Already 35,000 motor vehicles, mostly trucks, have been equipped for use of producer gas as fuel. Many more are ready to become so, as soon as equipment can be got ready. To serve these with supplies of wood, or charcoal, new depots are springing up all over the country along the highways, and a great number of people are finding new and profitable employment.

The equipment consists in the main of a pot, or retort, placed on a trailer behind the vehicle.The retort, somewhat similar to the tub of a washing machine, though larger, has on top a refueling lid which is kept tight. There is a slow draft allowed from the bottom, and the gas and smoke produced from the burning of the wood or charcoal in the retort is sucked into the engine by way of a tube. Evidently the only change to the engine equipment is a new or altered carburettor. The retort has to be cleaned out once in a while, like any other stove or furnace must be.

The above information is gathered from articles appearing in a Swedish road journal called "Svenska Vägföreningens Tidakrift." In one of these articles, Sten Gyllensverd, Civil Engineer, describes a trip by car, using charcoal as fuel, in which he himself took part.

The trip was made in the summer of 1940, in an ordinary six-cylinder, two-door car, with three passengers and one dog. The journey started from Halmstad in the south, and contacted Trollhätan, Karlstad, Rattvik, Falun, Örebro, Jönköping and back to Halmstad, a total distance of 1,859 kilometers, or 1,161 miles. The fuel consumption for this distance was 24¾ hectolitres of charcoal, or 75 kilometers per hectolitre of fuel. One hectolitre is 100 liters, and one gallon is 4.54 litres. Thus one hectolitre is about 22 gallons, or almost three bushels, since one bushel is eight gallons.

The cost of charcoal was five kroner per hectolitre, or in Canadian money $1.25. This averaged to 6.67 ore per Kilometer, or 2.6 cents per mile. The gasoline would have cost at the then prevailing prices in Sweden, about 26 per cent more. It may be mentioned that a six-cylinder, light car, can be operated here in western Canada for from 2 to 2½ cents per mile for gasoline, at 32 cents per gallon.

In addition to the above data, the author of the article states that no discernible quantity of lubricating oil had been used on the trip, since a very small quantity of oil is required with producer gas as fuel. The retort was cleaned twice on the trip. Best results were obtained when the retort was kept well filled with fuel. Each filling required from one to three hectolitres, and thirteen fillings were made. Rough roads, with downhill slopes helped the burning of the fuel and thus increased the effective power of the engine. The average speed made was 46.4 kilometers per hour, or 29 miles.

From the above we may conclude that very shortly other combustible material such as weed, brush, and perhaps straw, can be adopted to fuel for farm tractors and trucks hauling in far-off places. As indicated before, the really big step in the improvement of equipment, was made when it was possible to substitute wood for charcoal. With this advance made, it should be possible, with some further improvements, to regulate the burning of other material as indicated.

BRITAIN AFTER THE WAR

From Robert Williamson, London, Eng.

British scientists are working hard for the day when the sound of the builder's hammer will succeed the thud of the bomb.

At the Building Research Station, Watford, near London, they are looking ahead to peace time when Britain will multiply by many times the £200,000,000 which she used to spend on building in a year. Their work ranges over materials, for quality and suitability; over design, for light and warmth. They can tell, by consulting their Electric Man whether any given room, because of the materials of walls and ceiling, requires much heating or little.

This Electric Man is a cylinder with the same surface as an average human body. An electric current keeps him at body heat and a thermostatic control keeps this temperature constant. He is wheeled into a room and his consumption of electricity shows how much of it is needed to keep this constant.

And they have a section of the universe itself set up in miniature in their laboratory at Watford. An artificial sun is slotted in a vertical column and set at the appropriate altitudes of the changes of the seasons. A six-inch house model on a disc swung on pivots is orientated to season, latitude, and time of day.

So the helidon, this ingenious instrument showing the earth moving round the sun, tells the architect how the shadows will actually fall upon his finished house and show him where he may amend his design to get all the sunshine there may be.

WATER POWER IN THE PHILIPPINES

By Filemon C. Rodriguez, Chief Engineer, National Power Corporation

From *The Philippine Engineering Record* (Manila) 4th Quarter 1940.

There is nothing on record to show when water power was first introduced in the Philippines, but it is known that during the time of Spanish rule over these islands water power was made use of in little mills for the grinding of grain, for the pressing of sugar cane, for pumping water, and for other purposes. The remains of some of these crude, simple water wheels, mostly undershot and breast wheels, can still be seen in many parts of the Philippines, and some of them are still in use to this day.

Since the American occupation, some progress has been made in the development of water power. A number of projects of small to moderate size have been built, and improved design and manufacture have been adopted not only in the wheels but in the plants themselves. Hydro-electric plants were put up and the power has been made available to farther places than was possible under the direct drive system that was used before.

It is to be noted that only a total of 33,481.1 hp. has so far been developed, of which the Botocan hydro-electric plant of the Manila Electric Company has 22,800 hp. or 68 per cent of the whole. It could therefore be stated that outside of the Botocan plant there has been no hydro-electric development of consequence that has been undertaken.

That hydro-electric development throughout the Philippines has been very slow can be shown by a comparison with the development in other countries. Assuming a population of 16,000,000, the developed horse power per 1,000 population in the Philippines amounts to 2.12. The corresponding figures in some of the other countries for 1934 are as follows:

Country	*Hp. per 1000 Population*
Alaska	617
Canada	727
Mexico	27.2
Newfoundland	561
United States	131
Brazil	15.5
Chile	26.6
Austria	134
Finland	104
France	103
Germany	30.0
Italy	48
Norway	855
Spain	48.7
Switzerland	566
Soviet Russia	6.5
Japan	60.5
New Zealand	100
Tasmania	350

The growth of hydro-electric development in the Philippines and the growth of the electric power industry have not fully kept pace with the growth of the other industries. If the Botocan plant which was financed by the Associated Gas and Electric System is not included, we would have only 10,242 hp.

Potential Power Resources

The estimate given in the Almanac for the potential water power resources of the Philippines is 1,500,000 hp. There has been no investigation of the potential water power possibilities of the country, and there is, therefore, no way by which an intelligent and accurate inventory of the power sites in the Philippines capable of successful development can be made. However, it should be stated that certain general conditions favouring the economic utilization of water power are present in the Philippines, and a successful large scale development of our water power resources may be undertaken.

The record of the Weather Bureau shows that no droughts of dangerous proportions have visited this country. At the beginning of every dry season, the ground water storage of our watersheds is always filled to capacity from the rains during the preceding rainy season so that the flow of the streams during the dry season, though reduced, is more or less constant from year to year, thus making the prime power available therein also practically uniform from year to year.

Most of the larger islands composing the Archipelago have mountain areas and upland regions where the rain falls with greater intensity and from which the rivers originate and flow down the mountains in varying slopes through winding channels down to the oceans passing through the lowlands and valleys on which population has been concentrated. The steep slopes of these rivers as they emerge from the mountains into the lowlands provide a drop which could be utilized for power development. According to the data furnished by the Coast and Geodetic Survey, the total land area of the Philippines is 296,000,000,000 sq. m. and the average elevation of this land area above sea level is about 580 meters. From a rainfall map of the Philippines prepared from data gathered by the Weather Bureau, the average total amount of rain that falls over the Philippines in one year is about 670,740,000 cu.m. If it is conservatively considered that about 40 per cent of this volume of water flows through our streams, the maximum estimated potential water power available in this country can be placed at 342,000,000,000 kwh. a year. It is admitted that this figure presupposes complete regulation of all river systems and utilization of all available head which is beyond the realm of human capacity. It is merely noted here to serve as a limit for any guess that may be given of the power resources of the country. If it is assumed that the utilizable power of the streams is only 2 per cent, then the ultimate goal that might be set for hydro-electric development could be placed at 6,800,000,000 kwh. a year.

VOCATIONAL INSTRUCTION DURING MILITARY SERVICE

From the *Journal of the Institution of Civil Engineers* (London), December, 1940

The Board of Education having expressed the desire of the Army Council for the establishment of courses for persons under training for various professions in civil life who wish to continue their studies while temporarily serving in His Majesty's Forces, the Institution of Civil Engineers, together with the Institutions of Mechanical and Electrical Engineers, is co-operating with the Board of Education and the Advisory Council for Education in the Forces in the organization of courses in engineering subjects.

During the last war there was a break in the studies of a whole generation of engineers, with serious consequences to the profession; many on attempting to rejoin it had difficulty in resuming their studies and in passing examinations, and were consequently handicapped in completing their professional qualifications. The Council will regard it as an immense benefit if this experience could be avoided in the present war and consider that the provision of courses of engineering study will, should the conditions of the war allow a measure of study, help those whose engineering training has been interrupted to keep in touch with technical knowledge, and in some cases to complete a portion of their engineering qualifications whilst so serving.

It is hoped that it will be found possible to allow students to attend evening classes at a technical college where one is within convenient reach, but where the distance is too great it may be found possible when a sufficient number of students come forward in large camps, to arrange for the delivery of regular courses of lectures by qualified teachers. There must, however, remain a large number of cases, such as those of outlying and small stations, in which courses of private study, either by guided reading or a modified form of correspondence course, would be the only possible method.

Any student of the Institution of Civil Engineers or approved candidate for election to Corporate Membership who wishes to prepare himself for Section A and B of the Associate Membership Examination of The Institution under this scheme should apply to his Commanding Officer or to the Unit educational officer for information as to the method of procedure and for copies of the curricula.

From Month to Month

News of the Institute and other Societies, Comments and Correspondence, Elections and Transfers

ANNUAL MEETING

Another Annual Meeting has come and gone, and left behind it a splendid record of achievement. With a registration of over five hundred and a banquet attendance of about the same figure, with well attended and thoroughly discussed technical meetings, with speakers of the highest order, and an excellent spirit of friendliness over all, Council and the Hamilton Branch may well feel pleased and satisfied.

This year's meeting was the third occasion on which the Hamilton Branch has acted as the host of the Institute members and guests for the principal gathering of the Institute year. The assembly which has just concluded fully maintained the Branch reputation for effective organization, unstinted hospitality, and the efficient preparatory staff work on which the success of such an affair depends.

The attendance was unusually large, particularly as regards the members of the many neighbouring branches in south-western Ontario. The technical sessions dealt with a variety of matters of timely interest which led to active discussion. At several of the sessions, at the luncheons and at the banquet the speakers' addresses were devoted to various aspects of the great problem which now confronts the engineering profession in Canada, namely, how best to ensure that continuous and ample supply of trained engineers and technicians which is essential in the present war, how to develop and maintain their efficiency and morale, and how to bring these needs into line with the orderly progress of the profession as a whole.

An unusually high note was struck by the banquet speaker, Dr. Wm. E. Wickenden, whose address is printed as the leading article in this number of the *Journal*. Dr. Wickenden's pleasant delivery and the excellence of his material marked the high spot of the whole programme. It is to be hoped that this thought provoking and inspirational address may come to the attention of every member of the profession in Canada.

At our Annual Meetings it is always a pleasure to welcome so many distinguished visitors from the United States. This year, in addition to Dr. Wickenden, we were happy to have Mr. Seabury with us again, and to receive the important data contained in his address. Further, Dr. Cullimore and Dr. Perrine were able representatives of the educational and technological sides of present-day engineering.

A review or a commentary on the meeting could not be complete without mention of the absence of the retiring president, Dr. Hogg. Only the good news of his excellent recovery made possible the pleasant and cheerful tone of the whole meeting. At every function he was referred to, and many messages of appreciation are recorded in the several minutes. It is regrettable that he could not be present to see the culmination of his successful year of office, and to receive in person the praise and thanks of the many members.

The invitation of the Montreal Branch to hold the 1942 meeting in Montreal was accepted by the new Council, and already the committee is discussing ways and means of maintaining the standards set by previous gatherings. The branch is greatly encouraged by the success of the Hamilton meeting, and is looking forward with pleasurable anticipation to being host to the Institute early in 1942.

THE SECOND MILE

So much favourable comment has been received about Dr. Wm. E. Wickenden's address at the annual banquet that special attention is called to the fact that it is reproduced herewith in full. Members are recommended to read it even though they attended the banquet. It is one of those addresses that merits reading and study over and over again. It is one of the soundest, best reasoned and most thoughtful talks that have been heard in Canada for a long time. It is a clear, intelligent call to the highest things in the profession.

Believing that messages of this kind are good for the whole profession, copies of Dr. Wickenden's address have been sent by Headquarters to many Canadian publications, in an endeavour to get the widest possible distribution for it. Reprints are in stock and can be obtained by members from Headquarters.

WARTIME BUREAU OF TECHNICAL PERSONNEL

Under this title the Minister of Labour at Ottawa recently announced the creation of an organization whose purpose was to find technically trained persons who could fill the wartime needs of industry, government and the active service forces.

This announcement marked the culmination of over two years interest in such a proposal by the technical societies themselves. In December, 1938, at the request of the Minister of Defence, a survey was made by the Canadian Institute of Mining and Metallurgy, the Canadian Institute of Chemistry, and the Engineering Institute of Canada, and from the information gathered a file was established and turned over to the government.

The present proposal goes much further than the previous one, due to the fact that the situation is much clearer now and the needs much more apparent than they were in 1939. The Department of Labour has estimated the needs for skilled and unskilled help for 1941, and from these figures can estimate the needs for technical help for the same period. It was evident that some additional assistance would be necessary if these requirements were to be met. Hence the establishment of the Bureau.

The request for co-operation came to the three national institutes from the Minister of Labour. A series of meetings in Ottawa led to the acceptance of the responsibility by the institutes and within a short time this responsibility will be passed on, through several additional organizations, to engineers and chemists throughout Canada.

The Bureau is to be operated by a Director selected by the societies themselves. It is a very fortunate circumstance that makes it possible to secure the services of E. M. Little, B.A.SC., who is referred to elsewhere in this issue, for this important task. Mr. Little will establish a Board representative of the various co-operating organizations, which will assist him on matters of policy and in direct dealing with the societies. The Headquarters of the Bureau will be at Ottawa, although it may be necessary to establish offices in Toronto, Montreal and elsewhere.

It is an important matter for all engineers that the government has come to the engineers themselves for this assistance. It is both a compliment and a challenge. To do this work to the satisfaction of everyone involved, and to the best interests of the war endeavours, is a task of no mean dimensions. It can be accomplished only if all engineering organizations and industry pull together as a team, determined that it shall be accomplished. Herein lies an opportunity for every member of the engineering profession—every chemist—to organize his profession on a national basis and to support his government in its endeavour to utilize technical man power to the utmost—and incidentally to prove that the greatest things are possible only by co-operation.

The Engineering Journal in company with the regular publications of the other societies, will endeavour to keep the profession well informed of the developments within the Bureau. It is felt that as this activity belongs to the whole profession, every effort should be made to keep the members in close touch with it. It is intended that every technical man in Canada shall be communicated with shortly by direct mail, and that subsequent contacts shall be maintained principally through the technical journals and the press.

ELLIOTT MENZIES LITTLE

Director of The Wartime Bureau of Technical Personnel

The recent announcement by the Minister of Labour of the setting up of this Bureau brings to the forefront of wartime activity the name of another engineer. Mr. Little is one of the outstanding figures in the pulp and paper field, and is well known to many engineers across Canada.

E. M. Little

His appointment to this position was made upon the recommendation of the Canadian Institute of Mining and Metallurgy, the Canadian Institute of Chemistry, and the Engineering Institute of Canada. The Minister's decision to hand over to the engineers the operation of the Bureau began with the appointment of a Director of their own choosing, authorized to set up his own organization. As all engineers and chemists will be hearing about and from Mr. Little, the *Journal* feels that some biographical information will be interesting and appropriate.

Mr. Little was born in Beachburg, Ontario, in 1899, but when he was three years old his parents moved to Haileybury. It was here that he attended public and high school. In 1914 he began his successful career in the paper business with the Abitibi Power and Paper Co. Limited, at Iroquois Falls, where he started at the bottom as office boy.

For about fourteen years he remained with the company, going through every department in the business, including office and mill, and finishing up as assistant mill manager.

His service with Abitibi was interrupted early in 1918 when he joined the Air Force, enlisting at Montreal. After demobilization in 1919 he entered the Faculty of Applied Science and Engineering at the University of Toronto, and was graduated as a B.A.SC. in electrical engineering in 1925, having been out one year because of a death in the family. Upon graduation he returned to the Abitibi Company as plant electrical engineer and remained there until 1932, at which time he joined the Anglo-Canadian Pulp and Paper Mills at Quebec City. In 1933 he was made general superintendent of this company, and in 1937 he became associated with the Gaspesia Sulphite Company—an affiliated organization. He is now general manager of both companies.

Mr. Little has taken a leading part in the affairs of the Canadian Pulp and Paper Association, being a member of the Executive Committee, and vice-chairman of the joint administrative committee in charge of research in the industry. He has also been chairman of the technical section of the Association.

His residence is in Quebec, and his services are made available to the government through the generosity of the officers of the two companies by which he is employed.

REGISTRATION IN THE FACULTIES OF APPLIED SCIENCE OR ENGINEERING IN CANADIAN UNIVERSITIES, SESSION 1940-1941

By direction of Council, enquiries have been addressed to the engineering schools in Canada, asking for particulars of their undergraduate registration for the current year in the various branches of engineering.

The following table has been compiled from the information furnished in reply.

University	Year	General Course	Agriculture	Architectural	Ceramic	Chemical Engrg. and Chemistry	Civil	Electrical	Forestry	Geology and Mineralogy	Mechanical	Metallurgy	Mining	Physics, Engrg.	Total
Nova Scotia Technical College	1st	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	2nd	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	3rd	..	..	..	..	..	7	10	..	..	16	..	2	..	35
	4th	1	..	..	..	..	4	6	..	..	10	..	5	..	26*
Total	.....	1	..	..	..	..	11	16	..	..	26	..	7	..	61
New Brunswick	1st	..	..	..	..	..	9	25	17	..	..	..	..	..	51
	2nd	..	..	..	..	..	19	22	22	..	..	..	..	..	63
	3rd	..	..	..	..	..	7	20	14	..	..	..	..	..	41
	4th	..	..	..	..	..	18	9	12	..	..	..	..	..	39*
Total	.....	..	..	..	..	..	53	76	65	..	..	..	..	..	194
Ecole Polytechnique de Montreal.	1st	107	..	..	..	..	..	..	..	..	..	..	..	..	107
	2nd	69	..	..	..	..	..	..	..	..	..	..	..	..	69
	3rd	40	..	..	..	..	..	..	..	..	..	..	..	..	40
	4th	45	..	..	..	..	..	..	..	..	..	..	..	..	45
	5th	33	..	..	..	..	..	..	..	..	..	..	..	..	33*
Total	.....	294	..	..	..	..	..	..	..	..	..	..	..	..	294*
McGill	1st	142	..	14	..	..	..	..	..	..	..	..	..	..	156
	2nd	74	..	3	..	30	..	..	..	..	..	..	..	..	107
	3rd	..	..	3	..	26	11	24	..	..	36	11	17	..	128
	4th	..	..	1	..	19	6	12	..	..	27	8	9	..	82*
	5th	..	..	6	..	..	..	..	..	..	..	..	..	..	6*
Total	.....	216	..	27	..	75	17	36	..	..	63	19	26	..	479
Queens	1st	167	..	..	..	..	..	..	..	..	..	..	..	..	167
	2nd	164	..	..	..	..	..	..	..	..	..	..	..	..	164
	3rd	..	..	..	..	31	8	15	..	1	30	17	23	1	126
	4th	..	..	..	..	29	17	16	..	2	16	14	29	6	129*
Total	.....	331	..	..	..	60	25	31	..	3	46	31	52	7	586
Toronto	1st	..	..	7	4	95	48	45	..	1	75	13	20	30	338
	2nd	..	..	9	2	65	30	42	..	3	54	21	24	15	265
	3rd	..	..	9	2	42	18	24	..	5	39	23	19	12	193
	4th	..	..	2	..	38	22	32	..	7	34	15	27	9	186*
	5th	..	..	2	..	..	..	..	..	..	..	..	..	..	2*
Total	.....	..	..	29	8	240	118	143	..	16	202	72	90	66	984
Manitoba	1st	86	..	..	..	..	..	..	..	8	..	..	..	..	94
	2nd	53	..	..	..	..	..	..	..	4	..	..	..	..	57
	3rd	..	..	..	..	..	16	16	..	5*	..	..	..	..	37
	4th	..	..	..	..	..	12	15	..	..	..	..	..	..	27*
Total	.....	139	..	..	..	..	28	31	..	17	..	..	..	..	215
Saskatchewan	1st	175	..	..	..	..	..	..	..	..	..	..	..	..	175
	2nd	..	8	..	5	16	24	..	..	3	55	..	..	9	120
	3rd	..	8	..	1	15	13	..	..	7	48	..	..	4	96
	4th	..	4	..	7	9	19	..	..	8	26	..	..	6	79*
Total	.....	175	20	..	13	40	56	..	..	18	129	..	..	19	470
Alberta	1st	115	..	..	..	..	..	..	..	..	..	..	..	..	115
	2nd	72	..	..	..	..	..	..	..	..	..	..	..	..	72
	3rd	..	..	..	..	14	14	8	..	..	..	..	53	4	93
	4th	..	..	..	..	17	6	11	..	..	..	..	18	1	53*
Total	.....	187	..	..	..	31	20	19	..	..	..	..	71	5	333
British Columbia	2nd	176	..	..	..	..	..	..	..	..	..	..	..	..	176
	3rd	103	..	..	..	..	..	..	..	..	..	..	..	..	103
	4th	..	..	..	..	26	6	15	9	10	19	3	14	..	102
	5th	..	..	..	..	19	6	13	4	8	18	4	10	..	82*
Total	.....	279	..	..	..	45	12	28	13	18	37	7	24	..	463
Grand Total	.....	1622	20	56	21	491	340	380	78	72	503	129	270	97	4079

*Indicates those graduating in the spring of 1941—Total 744.

DEAN C. J. MACKENZIE, M.C., M.C.E., M.E.I.C.

PRESIDENT OF THE ENGINEERING INSTITUTE OF CANADA, 1941

The following chronological account of the career of the new president will indicate immediately the outstanding contribution he has made to the literature and to the development of the profession in Canada. Consultant, lecturer, teacher, public servant and leader, he has been a strong figure in Western Canada for thirty years, and has given sympathy and aid to every worthwhile proposal that has come to him. He is a noteworthy example of the broad minded, public spirited type of engineer of which so much has been written and heard in recent years.

Dean C. J. Mackenzie, M.C., M.C.E., M.E.I.C.

Chalmers Jack Mackenzie was born in St. Stephen, N.B., and received his B.E. from Dalhousie in 1909 and his M.C.E. from Harvard in 1915. He began his professional career in the Maritimes, but as early as 1910 he had moved west as resident engineer in charge of the construction of three municipal electric plants. In 1912-13, during the winter months, he inaugurated the engineering courses at the University of Saskatchewan, and was appointed Professor of Civil Engineering in 1915.

When the war broke out he was also a member of the firm of consulting engineers of Maxwell and Mackenzie at Edmonton, designing and building numerous structures such as waterworks and sewage systems and sewage disposal plants, electric power plants, etc.

From 1916 to 1918 he was overseas with the 54th Battalion, C.E.F., and was awarded the Military Cross.

From 1919 to 1939, he carried on a great variety of activities, including his university work and a consulting practice. During this time he took charge of the design and construction of the two large reinforced concrete bridges over the North and South Saskatchewan Rivers at Saskatoon. He was also chairman of the City of Saskatoon City Planning Commission, and directed the work of formulating the City Planning and Zoning By-laws which were adopted.

In 1921 he was appointed Dean of College at Saskatoon, and since that time has set up a remarkable record for growth and stability of an educational institution. In twenty years the attendance has gone from forty to almost five hundred.

In 1935 he was appointed to the Advisory Council of the National Research Council, and in 1939 was made Acting President when Lieutenant General McNaughton was given charge of the Canadian Active Service Force overseas.

Besides the several accomplishments which have been referred to, Dean Mackenzie has held the following offices:

1925 Chairman of the Saskatchewan Branch of the Institute;
1929-30 Vice-President of the Institute;
1930 President, Association of Professional Engineers of Saskatchewan;
1921-39 Member, Saskatchewan Council of Public Health;
1929-30 Alderman, City of Saskatoon;
1930-31 Member Advisory Board, Royal Military College;
1931-34 Member Saskatchewan Drought Commission;
1937-39 Chairman Board of Directors, Saskatoon City Hospital;
1937 to date Director, Canadian Geographical Society.

Dean Mackenzie has presented many papers to scientific and engineering societies in Canada and the United States, and over twenty-five have been published in the organs of the societies. He has already spoken to many branches of the Institute and to many public bodies. He is well known in all parts of Canada, and his elevation to the presidency of the Engineering Institute of Canada places him in a position to carry on to an even greater extent his activities on behalf of the profession.

He joined the Institute as a Junior in 1911, transferred to Associate Member in 1914, and to Member in 1920.

CORRESPONDENCE

The Canadian Government Trade Commissioner

Melbourne, Australia,
January 17th, 1941.

L. Austin Wright, Esq., M.E.I.C.,
Editor,
"The Engineering Journal,"
2050 Mansfield St.,
Montreal, Quebec.

Dear Sir,

I am sure you will be interested in the attached copy of a letter which I have received from Captain E. C. Johnston, Assistant Director-General of the Commonwealth Civil Aviation Department, Melbourne. Captain Johnston's letter refers to the article commencing on page 452 of the November, 1940, issue of your Journal, which I send to him for perusal.

With best wishes to The Engineering Institute of Canada for 1941, I am

Yours very truly,

(*Signed*) Frederick Palmer, M.E.I.C.
Canadian Trade Commissioner.

Commonwealth of Australia
Department of Civil Aviation

Melbourne, C.I.,
8th January, 1941.

Dear Mr. Palmer,

Thank you for sending me the November issue of "The Engineering Journal." I have read the article by Wilson with very much interest. Certainly your people have done a wonderful job on these aerodromes under the very difficult conditions that prevail, particularly as regards the winter months. I am dropping a note to Wilson to congratulate him on the job and on his excellent account of it.

As the article will be of interest to several other senior officers of this Department, I am taking the liberty of passing the Journal around to them before I return it to you. I hope you don't mind this but I will see that it is returned to you within a few days.

With all best wishes for 1941, I am

Yours sincerely,

(*Signed*) E. C. Johnston.

MEETINGS OF COUNCIL

Minutes of a meeting of the Council of the Institute held at the Royal Connaught Hotel, Hamilton, Ontario, on Wednesday, February 5th, 1941, at ten-thirty a.m. with Vice-President P. M. Sauder (Edmonton) in the chair. There were also present Past-President J. B. Challies (Montreal); Vice-Presidents McNeely DuBose (Province of Quebec), and J. Clark Keith (Province of Ontario); Councillors G. P. F. Boese (Calgary), W. F. M. Bryce (Ottawa), R. H. Findlay (Montreal), J. G. Hall (Montreal), W. R. Manock (Niagara Peninsula), H. Massue (Montreal), W. L. McFaul (Hamilton), C. K. McLeod (Montreal), J. H. Parkin (Ottawa), B. R. Perry (Montreal), H. R. Sills (Peterborough), C. E. Sisson (Toronto), and J. A. Vance (London); Treasurer deGaspé Beaubien, Secretary-Emeritus R. J. Durley, General Secretary L. Austin Wright, and Louis Trudel, Assistant to the General Secretary; Past-Presidents J. M. R. Fairbairn (Montreal), O. O. Lefebvre (Montreal), S. G. Porter (Calgary), and F. P. Shearwood (Montreal); President-Elect C. J. Mackenzie; Councillors-Elect E. M. Krebser (Windsor), W. H. Munro (Ottawa), and H. J. Vennes (Montreal).

The following were also present by invitation: S. R. Frost, president, and M. B. Watson, registrar, of the Association of Professional Engineers of Ontario; C. C. Kirby, honorary president of the Dominion Council of Professional Engineers and secretary of the Association of Professional Engineers of New Brunswick; G. A. Gaherty, chairman of the Committee on Western Water Problems; H. F. Bennett, chairman, and D. S. Ellis, R. E. Heartz (also chairman, Montreal Branch), R. F. Legget, and A. E. Macdonald, members of the Committee on the Training and Welfare of the Young Engineer, and the following branch chairmen: R. L. Dobbin (Peterborough), W. A. T. Gilmour (Hamilton), and H. G. O'Leary (Lakehead).

The general secretary reported that President Hogg was making satisfactory progress, which was noted with much gratification by all present.

On taking the chair, Mr. Sauder extended a welcome to all councillors and guests, and introduced each person present to the meeting.

The report of the Committee on Western Water Problems was presented and accepted by Council, and a committee was appointed to see what further action could be taken.

There was a general expression of appreciation of the excellent work done by the committee, which finally resulted in the unanimous approval of a motion that Council place itself on record as passing a vote of thanks to the committee and the sub-committee for the tremendous amount of work which they had completed and for the excellence of their conclusions and recommendations.

The general secretary pointed out that in view of the fact that the Council's final policy had not yet been determined the report should be kept strictly confidential.

The general secretary reported that Professor C. R. Young had accepted appointment as the Institute's representative on the E.C.P.D. Committee on Professional Ethics. This was noted with satisfaction.

The general secretary presented a letter from Squadron Leader A. J. Taunton advising that in view of the pressure of his present work he found it necessary to resign as councillor representing the Winnipeg Branch. This resignation was accepted with regret, and on the recommendation of the Winnipeg Branch it was unanimously RESOLVED that J. W. Sanger, M.E.I.C., be appointed as councillor to represent the Winnipeg Branch until the 1942 annual elections.

The secretary read a letter from the Steel Controller pointing out that under the stimulus of wartime consumption by industry, Canadian steel mills are faced with the necessity of greatly expanding their production of rolled steel products while simultaneously meeting urgent demands for early deliveries. To meet this situation the mills, with the approval of the Department of Munitions and Supply, have embarked upon a programme of standardization of all rolled products for the duration of the war. Continuing the progress, and turning their attention to reinforcing steel, the Department proposes to adopt as standard those sizes concurrently established as such by the Canadian Engineering Standards Association. The Steel Controller asked for the approval of the Institute with regard to the adoption of these standards throughout Canada.

After considering the proposals in detail, it was unanimously RESOLVED that the Institute support these recommendations.

The general secretary reported that the Deputy Minister of Labour, Dr. Bryce Stewart, had approached the three national Institutes, which had drawn up a register of technically trained men in 1938 and 1939, to ask if they would take over the handling of this register and the placing of technical personnel for the duration. Subsequently, a meeting was held with the Deputy Minister at Ottawa, at which the presidents and secretaries of the three Institutes were present. The outcome of this conference was that a direct proposal was made to the Department. Mr. Wright now reported that in a telephone conversation the day previous to the Council meeting the Deputy Minister had informed him that the proposal had been accepted and that an Order-in-Council had been passed giving authority for the work and providing the necessary funds.

The Deputy Minister had recommended that the three Institutes select a representative who could be installed as director or controller and be responsible to the government for the conduct of the work. The general secretary explained that a gentleman had been agreed upon between the three organizations, but that final acceptance had not been received, although it was expected this detail would be fixed up within a very few days.

It was explained that this gentleman had requested the Institute to make available to him the part time services of the general secretary in order to assist him in the operations of the Technical Bureau. After some discussion, participated in by Messrs. Challies, Hall, Mackenzie and Vance, it was agreed that Council was prepared to co-operate with the Department of Labour to the full extent of its ability, and that the Finance Committee be authorized to do whatever is necessary to make Mr. Wright's services available to the Minister.

The general secretary reported that President Hogg had intended to discuss with the Hon. Mr. Howe the desirability of appointing an engineer to fill the vacancy on the International Joint Commission, but had unfortunately been unable to do so. It was pointed out that Mr. C. A. Magrath, an eminent engineer, had acted as chairman of the Canadian Section for a great many years, and it was considered very desirable that an engineer should now be appointed to fill the present vacancy. After some discussion, it was unanimously agreed that Dr. Challies and Dr. Lefebvre be appointed a committee to make inquiries and appropriate representations to the government on behalf of the Institute.

Mr. C. C. Kirby, representing the Dominion Council of Professional Engineers, explained that a resolution had been passed at a meeting of the Council held in Toronto on January 20th and 21st, with respect to the co-ordination of the engineering societies in Canada, and it was hoped that it would be favourably received by the Engineering Institute and the other societies.

Following some discussion, it was unanimously RESOLVED that the resolution be referred to the Committee on Professional Interests for consideration and report.

The general secretary presented a letter from the Citizens' Committee for Troops in Training suggesting that the Institute might contribute towards a fund for the purchase of band instruments for the Royal Canadian Engineers now training at Petawawa.

It was pointed out that the Institute had no funds that could be appropriated for such a purpose, but the members present felt that it would be very desirable to help in this worthy object if at all possible. It was finally decided to take up a voluntary collection from members of Council present, and also from members attending the Annual General Meeting.

Mr. Harry Bennett, chairman of the Institute's Committee on the Training and Welfare of the Young Engineer, reported that his committee had been meeting all day, and was now prepared to report to Council. He pointed out the importance to the profession and to the Institute of the selection and guidance of engineering students and the training of the young engineer. It was the opinion of the committee that the Institute, with its many branches across Canada, had a splendid opportunity of assisting the educationalists. He pointed out the good work that could be done by bringing to the attention of prospective students some of the characteristics necessary to success in the profession. He mentioned that this matter had been discussed at a meeting of the Dominion Council of Professional Engineers, which he had been invited to attend, and that the Dominion Council had indicated that they were ready to assist his committee in this work if such co-operation could be of benefit. Accordingly, Mr. Bennett's committee, by resolution, proposed that Council shall invite the Dominion Council to co-operate with the Institute's committee to the fullest extent.

Mr. Bennett referred to the recent report of his committee which appeared with the annual report of Council. He explained that this was not as complete as he would like to have seen it, but that it was a further step along the way. He dwelt on the student activities within the branches, and explained that after to-day's meeting his committee was ready to present to the branches a scheme of counselling whereby members of the Institute would make their services available for the guidance of the student and the young engineer.

Mr. Bennett also referred to the manuscript for the new booklet which is to be printed by the Engineers' Council for Professional Development (E.C.P.D.). His committee thought this booklet could be revised to a considerable extent, but that as the material had been prepared for some time and was already in the hands of the printers, it would be difficult to make the desired changes. He pointed out that his committee was recommending that a smaller pamphlet be prepared which would be definitely Canadian, and which would have more direct application to the situation in this country. He also thought that a certain number of copies of the more complete booklet prepared by E.C.P.D. should be secured for distribution to the libraries and the heads of educational institutions. He wanted to see a publication in Canada that would readily indicate that the Institute is willing and prepared to promote and advance the welfare of the profession of engineering.

He explained that the problem of what the Institute could do for the young man after graduation still required a lot of thought and attention. He believed that if pre-engineering guidance were available so that contacts would be established with the students, it would be easier to carry on the work after graduation.

Mr. Bennett also touched on the question of engineering education, explaining that his committee had made a study of the recent report issued by the Society for the Promotion of Engineering Education. Their investigation confirmed the original belief that the most important element was a sound fundamental training and the inclusion of certain of the humanities or cultural subjects. He again emphasized the importance of the branches keeping in touch with the student and the young engineer.

A very thorough discussion followed Mr. Bennett's report, and finally, it was moved that the recommendation of the committee concerning the booklet be accepted, involving the revision, if possible, of the E.C.P.D. booklet "Engineering as a Career," and the provision of a booklet prepared by the Institute to cost not more than $250.00. This was approved unanimously.

Council then dealt with the recommendation of the committee that the offer of the co-operation of the Dominion Council be accepted. Accordingly, it was moved that the offer of the Dominion Council be accepted. Following this resolution, Mr. Bennett requested Council to add Mr. Kirby's name to the membership of his committee. This was agreed to unanimously.

By virtue of the co-operative agreement with the Association of Professional Engineers of Alberta, the following number of members of the Association, having indicated their desire to become members of the Institute, have been admitted to the classifications indicated:

Admissions

Members	20
Students	11

Transfers

Junior to Member	1
Student to Member	1
Student to Junior	1

Student membership in the Institute for one year, including the Journal subscription, has been awarded to the six successful contestants at the Annual Students Night of the Toronto Branch, held on January 16th, 1941:

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

Admissions	
Member	1
Juniors	3
Affiliate	1
Students	12

Transfers	
Junior to Member	6
Student to Member	1
Student to Junior	5

The Council rose at five-thirty p.m.

Minutes of a meeting of the Council of the Institute held at the Royal Connaught Hotel, Hamilton, Ontario, on Friday, February 7th, 1941, at two-thirty p.m., with President C. J. Mackenzie in the chair. There were also present, Vice-Presidents deGaspé Beaubien, K. M. Cameron, and McNeely DuBose; Councillors G. P. F. Boese, J. G. Hall, E. M. Krebser, W. R. Manock, H. Massue, W. H. Munro, J. H. Parkin, G. McL. Pitts, H. R. Sills, C. E. Sisson, J. A. Vance and H. J. Vennes; Past-Vice-Presidents E. P. Muntz and P. M. Sauder; Past Councillors W. F. M. Bryce, P. E. Doncaster and O. Holden; H. G. O'Leary, chairman of the Lakehead Branch; Secretary-Emeritus R. J. Durley and General Secretary L. Austin Wright.

On the motion of Mr. Vance, seconded by Mr. Sisson, it was unanimously RESOLVED that L. Austin Wright be reappointed general secretary of the Institute.

On the motion of Mr. Cameron, seconded by Mr. Vennes, it was unanimously RESOLVED that Mr. John Stadler be appointed treasurer of the Institute.

On behalf of the Striking Committee, consisting of Dean C. J. Mackenzie, R. J. Durley, O. Holden and C. E. Sisson, appointed at the last meeting of Council to make recommendations regarding the chairmen of the various Institute committees for the year 1941, Mr. Holden presented the committee's recommendations, which were unanimously approved and adopted as follows:

	Chairman
Finance Committee	deGaspé Beaubien
Library and House	B. R. Perry
Papers	J. A. Vance
Publication	C. K. McLeod
Legislation	E. M. Krebser
Board of Examiners	R. A. Spencer
Past-Presidents' Prize	R. DeL. French
Gzowski Medal	H. O. Keay
Leonard Medal	A. D. Campbell
Plummer Medal	J. F. Harkom
Duggan Medal	F. P. Shearwood
International Relations	C. R. Young
Professional Interests	J. B. Challies
Western Water Problems	G. A. Gaherty
Radio Broadcasting	G. M. Pitts
Deterioration of Concrete Structures	R. B. Young
Membership	H. N. Macpherson
The Young Engineer	H. F. Bennett

At the request of Mr. Beaubien, the members of last year's Finance Committee were reappointed as follows: deGaspé Beaubien, chairman; J. E. Armstrong, G. A. Gaherty, J. A. McCrory, F. Newell.

An invitation to hold the 1942 Annual Meeting in Montreal was presented from the Montreal Branch.

After some discussion, it was unanimously RESOLVED that the invitation of the Montreal Branch be accepted, and that no decision be made at the present time as to the detailed plans for the meeting, in view of war conditions.

Mr. Pitts referred to the establishment of the Bureau of Technical Personnel by the Department of Labour, and suggested that the man who was appointed as director should be acceptable to the various co-operating organizations. The general secretary explained that the Deputy Minister had asked the three Institutes to select some person acceptable to all of them whom he could appoint as director or controller. The gentleman who had been selected was known to the officers of the three societies, and to the Deputy Minister himself, and his suitability to the task was agreed to by all. Mr. Wright also explained that it was intended to set up a Board or Advisory Committees which would be representative of the various co-operating organizations. Mr. Pitts indicated that the architects might be interested in joining with the engineers in such a Bureau. The general secretary explained that there had already been some discussions with the architects, and there appeared to be no reason why they could not participate if they so desired.

On the motion of Mr. Massue, seconded by Mr. Vennes, it was unanimously RESOLVED that a hearty vote of thanks be extended to the Hamilton Branch for their hospitality, and for the very efficient manner in which the annual general meeting had been conducted.

On the motion of Mr. Boese, seconded by Mr. Vennes, it was unanimously RESOLVED that the thanks of Council be extended to the retiring President and councillors for their efforts during the past year; much valuable time had been given to committee meetings and to meetings of Council, all of which had been very greatly appreciated.

It was left with the president and the general secretary to decide on the date for the next meeting of Council.

The Council rose at three thirty p.m.

COMING MEETINGS

Canadian Region of the Illuminating Engineering Society, Toronto—First Annual Convention, March 19th.

Corporation of Professional Engineers of The Province of Quebec—Annual Meeting, Montreal, 2050 Mansfield St., March 29th. Registrar C. L. Dufort, 354 Ste-Catherine St. East, Montreal.

American Society of Tool Engineers—1941 Annual Meeting and Machine Tool Progress Exhibition, Fort Shelby and Book-Cadillac Hotels, Detroit, Mich., March 24th to 29th.

American Society of Mechanical Engineers—1941 Spring Meeting, Hotel Biltmore, Atlanta, Ga., March 31st to April 3rd.

Midwest Power Conference—Sponsored by Illinois Institute of Technology and seven nationally known midwest colleges and universities, Palmer House, Chicago, April 9th to 10th. Alexander Schreiber, Illinois Institute of Technology, Chicago.

Electrochemical Society—79th Annual Meeting to be held at the Hotel Cleveland, Cleveland, Ohio, April 16th to 19th.

American Institute of Electrical Engineers—Summer Convention, Royal York Hotel, Toronto, Ont., June 16th to 20th. National Secretary, H. H. Henline, 33 West 39th St., New York, N.Y.

American Water Works Association—Annual Convention, Royal York Hotel, Toronto, Ont., June 22nd to 26th. Secretary, Harry E. Jordan, 22 E. 40th St., New York.

Canadian Section, American Water Works Association—Annual Meeting, Royal York Hotel, Toronto, Ont., June 23rd. Secretary Dr. A. E. Berry, Ontario Dept. of Health, Parliament Buildings, Toronto, Ont.

Canadian Electrical Association—51st Annual Convention, Seigniory Club, Quebec, June 25th to 26th. Secretary, B. C. Fairchild, 804 Tramways Building, Montreal, Quebec.

NEWLY ELECTED OFFICERS OF THE INSTITUTE

DeGaspé Beaubien, M.E.I.C., consulting engineer of DeGaspé Beaubien and Company, Montreal, is the newly elected vice-president for the province of Quebec. He is joint chairman of the National War Savings Committee, member of the Electrical Commission of Montreal and director of several industrial firms. He is president of the Rotary Club of Montreal, and immediate past-president of the Canadian Club of Montreal. He was born in Outremont, Que., the son of the Hon. Louis Beaubien of Montreal. Upon his graduation from McGill University in 1906 with the degree of B.Sc., Mr. Beaubien became demonstrator at that university. In 1908 he entered the Westinghouse Electric and Manufacturing Company at East Pittsburgh, having obtained experience with the Montreal Light, Heat and Power as early as 1903. From 1908 until 1922 he was in practice as consulting engineer in his own name, then under the name of Beaubien, Busfield and Company, from 1922 until 1929 when the present firm was established.

Mr. Beaubien joined the Institute as a Student in 1903, becoming an Associate Member five years later, and being elected a Member in 1921. For the last three years Mr. Beaubien had been treasurer of the Institute, as well as its representative on the executive committee of the Canadian Chamber of Commerce.

deGaspé Beaubien, M.E.I.C.

K. M. Cameron, M.E.I.C.

John Stadler, M.E.I.C.

K. M. Cameron, M.E.I.C., chief engineer of the Department of Public Works of the Dominion at Ottawa, is the newly elected vice-president for Ontario. He was born in western Ontario and received his early education at the Strathroy Collegiate Institute and at London. After matriculating, Mr. Cameron went to the Royal Military College at Kingston, from which he was graduated in 1901 with honours and with the silver medal for general proficiency. In April of the following year he received from McGill University the degree of B.Sc. in civil engineering. Then for two years he was office and inspecting engineer with the Canadian Niagara Power Company at Niagara Falls. From 1905 to 1906 he lectured at McGill University in surveying and geodesy. In 1906 Mr. Cameron went to the States and was engaged on various engineering projects until 1908 when he returned to Canada to work for Smith, Kerry and Chace, consulting engineers of Toronto. Shortly after he joined the Department of Public Works of the Dominion, being first located in London, Ont., and later in Sherbrooke, Que. He came to Ottawa as senior assistant in the dredging branch of the department in 1912. He became assistant chief engineer of the department in 1918 and was appointed chief engineer in 1923.

Mr. Cameron joined the Institute as a Student in 1901 being transferred to Associate Member in 1907 and becoming Member in 1920.

A. L. Carruthers, M.E.I.C., is the newly elected vice-president for the western provinces. He is bridge engineer with the Department of Public Works of the Province of British Columbia at Victoria, B.C. He was born in Sarnia Township, Ont., and was educated at the University of Toronto. In 1904 he joined the Canadian Northern Railway and was employed as an instrumentman, bridge inspector, resident engineer, and from 1911 until 1917 as a divisional engineer. At that time he became district engineer for the Department of Public Works of British Columbia at Prince Rupert, B.C. He was appointed bridge engineer of the department at Victoria in 1923.

Mr. Carruthers joined the Institute as an Associate Member in 1915 and he became a Member in 1921.

John Stadler, M.E.I.C., has been appointed treasurer of the Institute. Born in Bavaria, he is a graduate in engineering from the Polytechnical Institute at Munich. After a few years with Helios Company, of Cologne, as field engineer on construction of hydro-electric and industrial plants, he came to the United States of America in 1902. In 1905 he joined the staff of the Shawinigan Water and Power Company; he was superintendent of the Shawinigan Falls power house until 1906 when he joined the Belgo-Canadian Pulp and Paper Company, as plant engineer in full charge of design and construction. In 1913 he became assistant manager of the company, and occupied that position until 1924 when he went with the Newfoundland Power and Paper Company at Cornerbrook. In 1927 he was appointed general manager of the Lake St. John Power and Paper Company. Since 1929 Mr. Stadler carries a successful consulting practice in Montreal, specializing in pulp, paper and power. Mr. Stadler is a recognized authority in the pulp and paper industry.

A. E. Berry, M.E.I.C., is the newly elected councillor representing the Toronto Branch. He was born at St. Mary's, Ont., and was educated at the University of Toronto, where he was graduated in civil engineering with honours in 1917. Four years later he received the degree of M.A.Sc.. and in 1923 he was awarded the degree of C.E. in the University of Toronto. He obtained his Ph.D. degree in 1926. Following his graduation in 1917 he was employed

A. E. Berry, M.E.I.C.

D. S. Ellis, M.E.I.C.

J. M. Fleming, M.E.I.C.

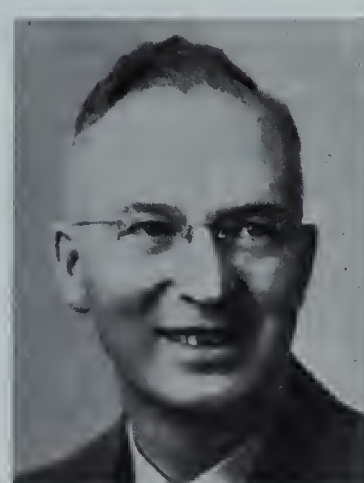
I. M. Fraser, M.E.I.C.

J. H. Fregeau, M.E.I.C.

J. Garrett, M.E.I.C.

S. W. Gray, M.E.I.C.

E. M. Krebser, M.E.I.C.



H. N. Macpherson, M.E.I.C.

H. F. Morrisey, M.E.I.C.

W. H. Munro, M.E.I.C.

G. McL. Pitts, M.E.I.C.

with the Ontario Department of Health for a short period, after which he went overseas and served with the Royal Engineers. On his return to Canada he joined the engineering staff of the Department of Health and in September, 1919, he became assistant sanitary engineer. In 1926 Dr. Berry became director of the Sanitary Engineering Division of the Ontario Department of Health, a position which he still holds.

D. S. Ellis, M.E.I.C., is the newly elected councillor representing the Kingston Branch. He was born at Cobourg, Ont., and received his education at Queen's University where he was graduated in 1910. In 1911 he became employed with the International Waterways Commission. During 1913 and 1914 he was engineer for the Commission on St. Lawrence Ship Channel. During the war 1914 to 1918 he served with the 6th Field Company, Royal Canadian Engineers. In 1918 he was lieutenant-colonel and chief instructor at the Canadian School of Military Engineering. Mr. Ellis was appointed assistant professor of civil engineering at Queen's University in 1919, later becoming professor. Last year he was appointed head of the department of civil engineering at Queen's.

J. M. Fleming, M.E.I.C., the newly elected councillor for the Lakehead Branch, was born at Winnipeg, Man., and received his education at the University of Manitoba. Upon his graduation in 1921 he became a designer with the Manitoba Power Company on the Great Falls development, and in 1923 he was resident engineer on the construction of the Tulsa aqueduct, in Oklahoma, U.S.A. In 1924 he joined the staff of C. D. Howe and Company, consulting engineers, Port Arthur, Ont., as a structural designer, engaged on the construction of grain elevators, docks and heavy structures. In 1933 he was appointed chief engineer and since 1936 he is the president and general manager of the firm.

I. M. Fraser, M.E.I.C., professor of mechanical engineering at the University of Saskatchewan, is the newly elected councillor for the Saskatchewan Branch. He was born at Pictou, N.S., and was educated at Dalhousie, and at McGill University where he received the degree of bachelor of science in 1919. In 1920 he was a lecturer at McGill University, and the following year he worked as a draughtsman on the staff of the Dominion Engineering Works Limited at Montreal. In 1921 he was appointed assistant professor of mechanical engineering at the University of Saskatchewan, becoming professor in 1926. He is, at present, head of the department at the University of Saskatchewan.

J. H. Fregeau, M.E.I.C., has been elected councillor to represent the St. Maurice Valley Branch. He was born at Beebe Plain, Que., and received his education at McGill University. Upon his graduation in 1910 he joined the staff of Shawinigan Water and Power Company and has always remained with the firm. From 1911 to 1914 he was in charge of the electrical installations at various stations. From 1915 to 1923 he was in charge of the construction of transmission lines. In 1923 he was transferred to Three Rivers as superintendent and in 1927 he became divisional manager, a position which he still holds. Since 1939 Mr. Fregeau is also manager of the St. Maurice Transport Company.

Julian Garrett, M.E.I.C., is the newly elected councillor for the Edmonton Branch. He was born at Hyde Park, Mass., U.S.A., and received his education at Harvard College and Lawrence Scientific School. Upon his graduation in 1924 he became engaged in railway engineering work in the States. From 1906 he was resident engineer for the Grand Trunk Pacific Railway After a number of years, during which time he was not connected with engineering work, he became secretary-treasurer of the Northwestern Utilities Limited at Edmonton, Alta., in 1924. Since 1928 he is manager of the company in charge of the operation of the Natural Gas System.

S. W. Gray, M.E.I.C., is the newly elected councillor for the Halifax Branch. He was born at Westville, N.S., and was educated at the Nova Scotia Technical College where he was graduated with the degree of B.Sc. in civil engineering in 1914. From 1914 to 1916 he was engaged in railway work and from 1916 to 1919 he was on active service in Canada, England and France. After some time spent as industrial surveyor with the Department of Soldiers Civil Re-establishment at Halifax, he joined the Nova Scotia Power Commission in 1924, and has been with this organization ever since. He is, at present, assistant hydraulic engineer.

E. M. Krebser, M.E.I.C., has been elected councillor representing the Border Cities Branch. He was born at Cambridge, Vermont, U.S.A., and was educated at the University of Vermont where he received the degree of bachelor of science in 1924. In 1925 he joined the staff of the Canadian Bridge Company Limited at Walkerville, Ont., as a draughtsman. In 1929 he was appointed assistant to the operating manager and in 1930 he became assistant shop superintendent. He is, at present, superintendent of Plant No. 2 of the company.

H. N. Macpherson, M.E.I.C., is the newly elected councillor representing the Vancouver Branch. He was born at Carleton Place, Ont., and was educated at the University of Toronto. Upon his graduation in 1914 he entered the Highways Department of Saskatchewan in the bridge branch. During 1915 and 1916 he was shell examiner with the Imperial Ministry of Munitions. In 1917 he was located

M. G. Saunders, M.E.I.C.

H. R. Sills, M.E.I.C.

J. A. Vance, M.E.I.C.

at Edmonton as chief examiner and in 1918 and 1919 he was assistant inspector of shells at Montreal. In 1920 he was chief engineer of O'Connor Bros. Ltd., road contractors, Montreal. From 1921 to 1923 he did contracting work on bridges in Saskatchewan. In 1926 he was manager in Regina of Regina Creosoted Products Ltd., and from 1927 to 1931 he was engineer and sales manager with the Alberta Wood Preserving Company Ltd., at Calgary. Since 1931 he has been the general manager of Permanent Timber Products Ltd., at Vancouver, B.C.

Mr. Macpherson has been a member of the executives of the Saskatchewan, Calgary and Vancouver Branches of the Institute.

H. F. Morrisey, M.E.I.C., the newly elected councillor of the Saint John Branch, is district engineer with the Department of Transport at Saint John. He was born at Saint John, N.B., and was educated at the University of New Brunswick where he received the degree of B.Sc. in 1912. He was awarded the M.Sc. degree in 1915. From 1912 to 1920 he was assistant engineer on the River St. Lawrence Ship Channel except for the time when he was overseas. In 1920 he became district engineer of the Marine Department at Saint John and was engaged in the construction and maintenance of wharves. He has been with the Department of Marine, and later the Department of Transport, ever since.

W. H. Munro, M.E.I.C., is the newly elected councillor representing the Ottawa Branch. He was born in Peterborough, Ont., and was educated at the University of Toronto, where he was graduated in 1904. For two years after graduation he travelled in the States visiting industrial firms and studying shop methods. In 1907 he joined the staff of J. B. McRae, consulting engineer, Ottawa, and was engaged on the design and supervision of the construction of hydro-electric power plants. In 1909 and 1910 he did the same kind of work with Smith, Kerry and Chace, consulting engineers, Toronto. From 1910 to 1915 he was manager of the Peterborough Light, Power and Gas Company. He went overseas in 1915 as a workshop officer, and he was later appointed officer commanding the 3rd Canadian Ammunitions Sub Park. Upon demobilization in 1919 he held the rank of Major. He stayed in England and joined the staff of Vickers Limited, London, in the hydro-electric department later becoming senior hydraulic engineer and chief of the department. He returned to Canada in 1925 as sales manager of Canadian Vickers Ltd., at Montreal. From 1926 to 1928 he was manager of the Nova Scotia Tramways and Power Company Ltd., at Halifax. In 1928 he joined the staff of the Montreal Engineering Company Limited and the following year he was appointed manager of the Bolivian Power Company Limited at La Paz, Bolivia. In 1933 he joined the Ottawa Electric Company at Ottawa. In 1935 he became general manager of the Ottawa Electric Company and the Ottawa Gas Company. In 1939 he was elected to the Board of Directors of each of these companies.

G. McL. Pitts, M.E.I.C., one of the newly elected councillors representing the Montreal Branch, is an engineer and architect. A native of Fredericton, N.B., Mr. Pitts was graduated from McGill University in 1908 with the degree of B.Sc., and in 1909 received the degree of M.Sc. In 1916 he received the degree of B.Arch. In 1906 Mr. Pitts was an engineer on construction with the Canadian Pacific Railway and in 1908 was a senior draughtsman with the Transcontinental Railway at Ottawa, Ont. In 1909 he joined the staff of P. Lyall and Sons Construction Co. Ltd., as engineer and superintendent, and in 1912 was supervising engineer for the construction of the Montreal High School for the Protestant Board of School Commissioners. He was assistant to John A. Pearson, architect for the Parliament Buildings at Ottawa. In 1919 he joined the firm of Edward and W. S. Maxwell, architects of Montreal, forming the firm of Maxwell and Pitts in 1923, thereby maintaining one of the oldest architectural practices in Canada.

Mr. Pitts is a past president of the Province of Quebec Association of Architects. He is, at present, honorary treasurer of the Royal Architectural Institute of Canada and president of the McGill University Graduates' Society. He has always been very active in Institute affairs, particularly as chairman of the Committee on Consolidation and chairman of the Radio Broadcasting Committee.

M. G. Saunders, M.E.I.C., has been elected the councillor representing the Saguenay Branch. He was born at Elgin, N.B., and educated at Acadia University and at the Nova Scotia Technical College. During the last war he served overseas with the Royal Canadian Engineers and with the Royal Air Force. From 1923 to 1926 he was instructor in engineering at Acadia University and in 1926 he became assistant professor in engineering. In 1927 he joined the staff of the Aluminum Company of Canada Limited, at Arvida, as a mechanical engineer. In 1931 he was appointed mechanical superintendent, a position which he holds at the present time.

H. R. Sills, M.E.I.C., is the newly elected councillor representing the Peterborough Branch. He was born at Kingston, Ont., and was educated at Queen's University. Upon his graduation in 1921 he joined the Canadian General Electric Company and has remained with the firm ever since. In 1922 he became engaged in the design of synchronous motor and A.C. generators and has now specialized in the design of such machinery.

J. A. Vance, M.E.I.C., was re-elected councillor to represent the London Branch. He was born in the County of Oxford, Ont., and was educated at the University of Toronto. On

H. J. Vennes, M.E.I.C.

the death of his father in 1914 he took over the contracting business and became responsible for the administration, engineering and construction of steel and concrete highway bridges. From 1919 the business grew to include the design and construction of factory buildings, sewers, dams and various concrete and steel structures. Mr. Vance is, at present, the proprietor and engineer of the firm of J. A. Vance, contractor, at Woodstock, Ont.

H. J. Vennes, M.E.I.C., has been elected councillor to represent the Montreal Branch. He has long been an active member of the Institute and on several occasions has delivered papers on various advanced subjects, some of which have been published in the Journal. Born in Norway, Mr. Vennes came to the United States in 1892. He was graduated from the University of Minnesota in 1916 with a B.A. degree, and spent five years at the Bell Telephone Laboratories in New York. Coming to Canada from New York in 1921, when the first carrier current telephone systems were being installed here, he remained in this country ever since, becoming a Canadian citizen and an outstanding communications engineer. He has had much to do with the design and installation of the many carrier current telephone and telegraph systems, radio broadcasting stations, sound pictures and public address systems in this country since their introduction, and was largely responsible for the many allied developments of Northern Electric in this country including the famous first radio "Peanut" tube and radio receivers in which it was used, and also other electrical devices now so generally used in communication systems, motion picture, aviation radio devices and the Hammond electric organ. He is, at present, special products engineer with the company in Montreal.

ELECTIONS AND TRANSFERS

At the meeting of Council held on February 5th, 1941, the following elections and transfers were effected:

Member

Anderson, Harry Clyde, district engr., Dept. of Public Works, Prov. of B.C., New Westminster, B.C.

Juniors

Bridgewater, Albert William, B.Sc., M.Sc. (Univ. of Sask.), struct'l. designer, Defence Industries Limited, Montreal, Que.

Glenn, John B., B.Sc. (Mech.), (Univ. of Sask). engr., Link Belt Ltd., Toronto, Ont.

Raynor, Warren, B.Sc. (Mech.), (Queen's Univ.), jig and tool designer, Canadian Car & Foundry Co. Ltd., Fort William, Ont.

Affiliate

Gung, Simon Fenwick, chief dftsman., engrg. dept., De Havilland Aircraft of Canada Ltd., Toronto, Ont.

Transferred from the class of Junior to that of Member

Bentley, Kenneth E., B.Sc. (Civil), (N.S. Tech. Coll.), mtce. engr., Imperial Oil Limited, Dartmouth, N.S.

Booth, Keith Alexander, B.Sc. (Elec.), (Univ. of Man.), B.Eng. (Mech.), (McGill Univ.), engr. i/c operating records dept., Kenogami newsprint mill, Price Bros. & Co. Ltd., Kenogami, Que.

Boucher, Raymond, B.A.Sc., C.E. (Ecole Polytechnique), M.Sc. (Mass. Inst. Tech.), associate professor of hydraulics, Ecole Polytechnique, Montreal, Que.

Colpitts, Gordon L., B.Sc. (Mech.), (N.S. Tech. Coll.), chief engr., Barranca Bermeja refinery, Tropical Oil Company, Colombia, S.A.

Henson, George Stanley Gordon, B.Sc. (Elec.), (Univ. of Man.), asst. engr., real estate, taxes, insurance dept., Winnipeg Electric Company, Winnipeg, Man.

Wilson, Thomas Whiteside, B.A.Sc. (Univ. of Toronto), Lieut., R.C.E., Petawawa Military Camp, Ont.

Transferred from the class of Student to that of Member

Moore, Robert Hugh, B.Sc. (C.E. and E.E.), (Univ. of Man.), mech. designer and machine erector, Hudson Bay Mining & Smelting Co. Ltd., Flin Flon, Man.

Transferred from the class of Student to that of Junior

Beach, John Edward, B.Sc. (Elec.), (Univ. of Alta.), asst. engr., Trinidad Leaseholds Ltd., Pointe-a-Pierre, Trinidad, B.W.I.

Delisle, Lucien, B.A.Sc., C.E. (Ecole Polytechnique), divn. engr., Dept. of Roads, Prov. of Quebec, Waterloo, Que.

Hammond, Rowland Ernest, B.A.Sc., M.A.Sc. (Univ. of Toronto), engr., Northern Electric Co. Ltd., Montreal, Que.

Loomis, James Gordon Mann., B.Eng. (Mech.), (McGill Univ.), engrg. dftsman., Cand. International Paper Co., Gatineau Mills, Que.

McMillan, Colin Brock, B.Sc. (Civil), (Queen's Univ.), civil engr., Saguenay Power Co. Ltd., Arvida, Que.

Students Admitted

Cole, Robert Arnold (Univ. of N.B.), 52 Shore St., Fredericton, N.B.

Collins, Kenneth Fawcett (Queen's Univ.), 196 University Ave., Kingston, Ont.

Courtright, James Milton (Queen's Univ.), 44 Second Ave., Ottawa, Ont.

Downman, Bernard Hugh Courtenay (Univ. of N.B.), Fredericton, N.B.

Hamilton, Harry Irwin (Queen's Univ.), 47 Clergy St., Kingston, Ont.

Heppner, Selwyn Alexander (Univ. of Man.), 22 The Roslyn Apts., Winnipeg, Man.

Heron, Alexander deForest (McGill Univ.), 433 Laird Blvd., Town of Mount Royal, Que.

Kinghorn, William Wallace (Univ. of N.B.), 206 Smythe St., Fredericton, N.B.

Knights, Kenneth Ronald (Univ. of Man.), 135 Maryland St., Winnipeg, Man.

McDougall, William Allan Jr. (Univ. of N.B.), 685 Charlotte St., Fredericton, N.B.

Tkacz, William (Queen's Univ.), 178 Johnson St., Kingston, Ont.

Van Damme, Joseph (Queen's Univ.), Arvida, Que.

ANNUAL FEES

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INSTITUTE PRIZE WINNERS

Lieutenant-General A. G. L. McNaughton, M.E.I.C., is the recipient of the Sir John Kennedy Medal for 1940. General McNaughton was born at Moosomin, Sask. He was educated at McGill University, receiving the degrees of B.Sc. in 1910 and of M.Sc. in 1912. After a few years on the teaching staff in the department of electrical engineering at the University, he entered private engineering practice for a brief period in 1914.

At the outbreak of the first Great War, he organized the 4th Battery, Canadian Field Artillery, which formed part of the 2nd C.F.A. Brigade of the First Canadian Division. He was wounded at the second battle of Ypres in April, 1915, but returning to France, commanded the 21st Howitzer Battery of the Second Canadian Division. Promoted to lieutenant-colonel in March, 1916, he took over the 11th Brigade, C.F.A., of the 3rd Canadian Division and commanded it through the battles of the Somme and until February, 1917, when he was appointed counter-battery staff officer of the Canadian Corps. After recovering from wounds received at Soissons, General McNaughton continued to carry out his duties until October, 1918, when he became General Officer Commanding the Canadian Corps heavy artillery. He was mentioned three times in dispatches, was awarded the D.S.O. and was made a C.M.G. Upon his return to Canada in May, 1919, he served with the Department of National Defence in numerous positions until 1929, when he was appointed to the highest military office in Canada and served four years as Chief of the General Staff.

Lieut.-General A. G. L. McNaughton, M.E.I.C.

E. M. G. MacGill, M.E.I.C.

O. W. Ellis

General McNaughton temporarily retired from the active list of the Canadian Militia to become president of the National Research Council on June 1st, 1935. As head of the Council, he was primarily responsible for building up an electrical engineering laboratory, especially for high voltage work, a subject in which he had done post-graduate work at McGill University. He was also directly responsible for development of the aeronautics laboratory and the cathode ray direction finder. In the summer of 1939 he accompanied a delegation of Canadian industrialists to Great Britain in connection with war supply contracts.

At the outbreak of the present war, General McNaughton was appointed officer commanding the first division of the Canadian Active Service Force, and went overseas late in 1939. Last summer he was promoted to the rank of Lieutenant-General, and appointed to command an army corps in England.

Elizabeth M. G. MacGill, M.E.I.C., has been awarded the Gzowski Medal for 1940, for her paper, "Factors Affecting the Mass Production of Aeroplanes," which was published in the July, 1940, issue of *The Engineering Journal.* Miss MacGill was born at Vancouver, B.C. She is a bachelor of applied science in electrical engineering from the University of Toronto, 1927, a master of science in engineering from the University of Michigan, and has taken two years post graduate study at the Massachusetts Institute of Technology leading towards a doctorate degree. She now occupies the position of chief aeronautical engineer of the Canadian Car and Foundry Company, and is located at Fort William, Ont.

She is the daughter of the late J. H. MacGill, M.A., barrister of Vancouver. Her mother is Judge of the Juvenile court, holder of an Honorary LL.D. of the University of British Columbia, and a bachelor of Music of the University of Toronto.

Miss MacGill has made previous contributions to the art and science of flying. Four years ago, for instance, before the Ottawa Branch of the Royal Aeronautical Society she read a paper on "Simplified Performance Calculations of Airplanes" which was valued for its practical application to a complicated subject. She has also contributed several papers before various branches of the Institute. Last year she delivered a paper at the Annual Meeting in Toronto. Miss MacGill is an Associate Fellow of the Royal Aeronautical Society.

R. G. K. Morrison, M.C.I.M.M., has been awarded the Leonard Medal for 1940 for his paper on "Points of View on the Rock Burst Problem" which was published in the August, 1939, issue of the *Canadian Mining Bulletin.* Mr. Morrison is a graduate of the University of Toronto in mining engineering, from the class of 1923. For a few years after graduation he was engaged in surveying and mining construction work in central Manitoba. In 1928 he went to India as chief assistant surveyor with the Oorgaum Gold Mining Company. From May, 1923, to November, 1936, he was underground superintendent of the Mysore Gold Mining Company, and since November, 1936, to date he has been superintendent of the Nundydroog Mines Ltd. During the summer of 1940 Mr. Morrison acted in a consulting capacity to various Ontario mining companies deeply concerned with the problem of rock burst. These companies were unanimous in their appreciation of his services.

Mr. Morrison resides at Oorgaum, South India.

O. W. Ellis is the recipient of the Plummer Medal for 1940 for his paper presented at the Annual Meeting of the Institute last year at Toronto on "Some Developments in Alloys during the Last Twenty Years." After serving an appren-

Léo Brossard, S.E.I.C.

W. C. Moull, S.E.I.C.

Marc R. Trudeau, S.E.I.C.

ticeship in England he came to Canada in 1910 and joined the Canadian Pacific Railway Company. In 1911 he entered the Department of Metallurgy at the University of Birmingham, England, and received his degree of B.Sc. in metallurgy in 1914. During the war 1914 to 1918 he worked as a metallurgist in the Royal Ordnance Factories. In 1916 he received the degree of M.Sc. from the University of Birmingham. At the end of the war he was appointed chief metallurgist at the Royal Laboratory Department of the Royal Ordnance Factories, and in 1920 he was called upon to reorganize all the metallurgical laboratories of the Factories. In 1921 he returned to Canada as an assistant professor of metallurgical engineering at the University of Toronto, a position which he retained until 1925. At that date he was appointed an Industrial Fellow at the Mellon Institute of Industrial Research, University of Pittsburgh, where he carried out work on metals for bearings. From 1926 to 1929 he was in the research department of the Westinghouse Electric and Manufacturing Company. In 1929 he was appointed to his present position as Director of Metallurgical Research at the Ontario Research Foundation, Toronto. Mr. Ellis is the author of numerous papers on metallurgical subjects, both ferrous and non-ferrous. He is a contributor to the National Metals Handbook. His prize winning paper was published by the Institute in July 1940 as a technical supplement to *The Engineering Journal.*

M. S. Layton, Jr. E.I.C., is the recipient of the Duggan Medal and Prize for 1940, for his paper "Coated Electrodes for Electric Arc Welding". He was born at Bury-St.-Edmuds, England, in 1914 and was educated at McGill University where he was graduated in 1935. Upon graduation he joined the staff of the Steel Company of Canada at Montreal. He resigned the position of assistant chemical engineer to enlist with the R.C.A.F. last October. He is at present located in Toronto. Mr. Layton's paper was published in the July 1940 issue of the *Journal.*

Léo Brossard, S.E.I.C., has been awarded the Phelps Johnson Prize for 1940, for his paper entitled "Geology of the Beaufor Mine". He was born at Laprairie, Que., in 1912. He received his early education at the Collège de Montréal, and in 1931 entered the Ecole Polytechnique where he obtained the degree of B.Sc.A. in 1936. Upon graduation he engaged in geological surveys and prospecting in northern Quebec. Returning to Montreal in 1938, he became attached to the teaching staff at the Ecole Polytechnique. In 1939 he was geologist with the Cournor Mining Company, Perron, Que. Last year, Mr. Brossard did post graduate work at McGill University, and received his M.Sc. degree in geology.

W. C. Moull, S.E.I.C., is the recipient of the John Galbraith Prize for 1940, for his paper "Electrification of a Modern Strip Mill". He was born at Seaforth, Ont., in 1916. and received his early education at the Collegiate Institute of Owen Sound, Ont. He entered the University of Toronto in 1935, and obtained his degree of B.A.Sc. in electrical engineering in 1939. Since graduation he has been with the Canadian General Electric Company, and is, at present, located in Toronto.

Marc R. Trudeau, S.E.I.C., has been awarded the Ernest Marceau Prize for 1940, for his paper "Points Fixes et Lignes d'Influence". He was born at Montreal, Que., in 1915, and received his early education at the Collège de Montréal. He entered the Ecole Polytechnique of Montreal in 1935, and was graduated with honours in 1940. He also holds the B.A. degree from the University of Montreal. Since graduation, Mr. Trudeau has been connected with the firm of Lalonde and Valois, consulting engineers of Montreal.

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JULIAN C. SMITH MEDALLISTS

WILLIAM DUNCAN BLACK

An engineer of high standing, William Duncan Black throughout his career has been on the lookout for opportunities to render service to the Canadian public and to his fellow members of the engineering profession. After building up an important heavy manufacturing industry, he is now at the head of a Canadian company which is actively devoting its equipment, plant and organization to vital munitions work. When president of the Industrial Relations Committee of the Canadian Manufacturers' Association, he was appointed employers' delegate to the International Labour Conference held in Geneva in 1934; later he served as president of that Association.

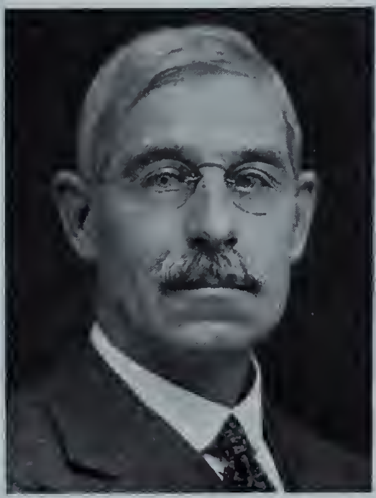
In these and other activities he has taken effective part in guiding Canadian industry. As a director of the Bank of Canada he shares responsibility for the financial policy of the Dominion.

RICHARD JOHN DURLEY

A mechanical engineer—a Whitworth Scholar—his career has included service as professor of mechanical engineering in McGill University, as consulting engineer, and in munitions inspection. He was the first secretary of the Canadian Engineering Standards Association. After thirteen years as secretary of the Engineering Institute of Canada, he now occupies a less onerous but more sedate position as its secretary-emeritus.

A former councillor of the Institute, he has just been honoured by election as the Canadian member of the Council of the Institution of Civil Engineers.

W. D. Black, M.E.I.C.



R. J. Durley, M.E.I.C.

A. Frigon, M.E.I.C.

AUGUSTIN FRIGON

After obtaining scientific training and engineering experience in France and the United States as well as in Canada, Augustin Frigon, at the head of the Ecole Polytechnique, Montreal, led in placing the engineering education of French-Canadian youth on a firm basis. His public services have also included membership in many important government commissions; he has served on the Council of the Institute. He now occupies a prominent and responsible position in the Canadian Broadcasting Corporation, to whose success he has materially contributed.

FRANCIS WILLIAM GRAY

A Yorkshireman by birth, who is at the same time an author, an artist and an authority on undersea coal mining, Francis William Gray has long been a staunch supporter of professional engineering bodies. He is a past president of the Canadian Institute of Mining and Metallurgy, and of the Mining Society of Nova Scotia, and a past councillor of the Engineering Institute of Canada, and a member of the Institution of Mining Engineers (Gt. Britain).

After long residence in the Maritimes, he holds a consultative and advisory position in one of the most important industries of that region. His breadth of view, technical knowledge and power of expression and industrial leadership have gained for him an enviable reputation throughout the Dominion.

SIR HERBERT SAMUEL HOLT

A member of the Institute for fifty-three years, Sir Herbert Holt's long and successful experience in civil engineering, in industrial administration, and then in finance, has qualified him for the prominent position he has so long held in the industrial and banking worlds. He has played a principal part in the industrial and commercial development which has carried Canada forward so rapidly during the last forty years. At the head of a great public utility and a leading bank, he has found time for activity on the councils of two great hospitals and a great university. His unobtrusive benefactions are administered by the foundation which bears his name.

RICHARD SMITH LEA

An educationalist and consultant who is internationally known as an authority in the field of hydraulic engineering, Richard S. Lea is a native of "The Island," which has given Canada so many distinguished sons. He was for some years assistant professor of civil engineering and lecturer in mathematics at McGill University. Later, in his extensive practice as consulting engineer, he had to deal with many of the different problems which have presented themselves during the rapid growth of Canada's urban populations. His ability and technical knowledge of these, and of river questions generally, have led to his being retained as adviser to federal and provincial Government departments—including the Hydro-Electric Power Commission of Ontario—as well as to municipalities and several of the principal hydro-electric companies in Canada.

BEAUDRY LEMAN

Seldom does an engineer engaged in hydro-electric developments and municipal engineering become president of the Canadian Bankers' Association. But this has happened in the career of Beaudry Leman.

Born in Montreal, he studied engineering in France and in Canada, graduating at McGill University in 1900. He has been a member of the Engineering Institute for over

F. W. Gray, M.E.I.C.

Sir Herbert S. Holt, M.E.I.C.

R. S. Lea, M.E.I.C.

Beaudry Leman, M.E.I.C.

C. A. Magrath, M.E.I.C.

forty years. In 1912, he transferred his activities to the art or science of banking. His early technical training has enabled him to serve on Royal Commissions such as the Canadian Advisory Committee on the St. Lawrence Waterway in 1927-28, on the Railways and Transportation Commission in 1931-32 and latterly on the Allied War Supplies Corporation.

His influence and counsel have been sought in the solution of public and municipal financial problems as well as in the administration of many companies of which he is a director. As president of a great Canadian bank he occupies an outstanding position in the realm of finance.

CHARLES ALEXANDER MAGRATH

A pioneer in the development of the West, a surveyor qualified to practise in every province, and an expert in the conservation and use of water resources, Charles Alexander Magrath in the long past was a member of the Territorial Assembly at Regina, and later of the Dominion Parliament. He took an important part in the work of the International Joint Commission as chairman of the Canadian Section. He succeeded the late Sir Adam Beck as chairman of the Hydro-Electric Power Commission of Ontario. During the last war he was Fuel Controller of Canada, and among other deliberative bodies on which he has served may be mentioned the War Trade Board, the Patriotic Fund executive, and the Newfoundland Royal Commission. Throughout his long career he has made a special study of questions connected with Canada's growth and development, particularly in the western provinces.

JANUARY JOURNALS REQUIRED

There has been an unusual demand for extra copies of the January 1941 issue of the *Engineering Journal* and it would be appreciated if members who do not retain their copies would return them to Headquarters, at 2050 Mansfield Street, Montreal, Que.

Personals

News of the Personal Activities of members of the Institute, and visitors to Headquarters

Dr. T. H. Hogg, M.E.I.C., has recovered sufficiently from the injuries suffered in a recent accident that he has been able to leave the hospital. He is now convalescing at Nassau, Bahamas, and is expected back at his office in Toronto early in April.

Lieut. Commander C. P. Edwards, M.E.I.C.

Lieutenant Commander C. P. Edwards, O.B.E., M.E.I.C., has recently been appointed Deputy Minister of the Department of Transport at Ottawa. The position was left vacant by the death of Colonel V. I. Smart, M.E.I.C., last fall. Commander Edwards is chiefly known for his work in radio and wireless telegraphy, and played a large part in building up Canada's networks of radio and wireless facilities. A Welshman, he has spent the greater part of his life in Canada. He first entered the field of wireless communication in 1903 when Guglielmo Marconi erected a demonstration station at Chester, Eng., just over the Welsh border from Dodleston, Cmdr. Edwards's birthplace. Through his work with that pioneer wireless station he became a junior technical assistant on Marconi's staff, and in 1904 came to Canada to supervise the construction of stations at Camperdown, N.S., and on Sable Island. His appointment as radio director in the Marine Department came in 1909 and he took charge of all wireless and radio activities. Cmdr. Edwards has been the Dominion's representative at practically all the international and North American radio conferences held since 1912. He was chairman of the committee which drew up regulations for the compulsory equipment of ships with radio at the International Conference for the Safety of Life at Sea in 1929, and since 1936 has been chief of Canadian air services.

As Deputy Transport Minister he will have charge of civilian aviation under direction of Hon. C. D. Howe, Minister of Munitions and Supply, and in the transport division he will operate under the authority of the Transport Minister, the Hon. P. J. A. Cardin.

H. E. T. Haultain, M.E.I.C., who resigned from his position as professor of mining engineering at the University of Toronto, two and a half years ago, was granted laboratory facilities for continuing his research work by President Cody and the Board of Governors. He is actively continuing his work not only in the University laboratories, but in co-operation with some of the mines. Two of his instruments have become well known as the Superpanner and Infrasizer. The Superpanner is a piece of laboratory apparatus for concentrating small batches of ore for testing purposes and makes separations according to difference of specific gravity of finer particles and with less differences of specific gravity than any other instrument. The Infrasizer is also a piece of laboratory apparatus and is used for the size analysis of particles finer than the finest wire sieves. Professor Haultain has undertaken the distribution of these instruments not as a commercial proposition but under a sense of professional obligation to supply them to those who really need them. They are manufactured in Toronto for him under his personal supervision. There has been no advertising or selling campaign and yet one or both of these instruments have been sold to all parts of the world. Most recent orders for these instruments have come from Ecuador and Russia. Professor Haultain continues to develop the applications of these instruments and is also actively engaged on other research work on aids to the milling problems.

W. A. Newman, M.E.I.C., was recently appointed general manager of Federal Aircraft Limited, a Crown company handling much of Canada's war-time aircraft production. Mr. Newman is the chief mechanical engineer of the Canadian Pacific Railway Company. He was graduated from Queen's University in 1911 and entered the service of the Canadian Pacific Railway Company upon graduation. In 1913 he became lecturer in mathematics at Queen's and then from 1914 to 1916 he was assistant professor in mechanical engineering. Mr. Newman returned with the Canadian Pacific Railway in 1916 and successively occupied the positions of assistant mechanical engineer, engineer of locomotive construction, mechanical engineer, and since 1928, chief mechanical engineer.

Major W. G. Swan, M.E.I.C., is now district engineer officer for M.D. No. 11 at Victoria, B.C. At the outbreak of war he was director of construction of the War Supply Board.

Huet Massue, M.E.I.C., has been elected on the Council of the Chambre de Commerce du District de Montréal. Mr. Massue, who is on the staff of the Shawinigan Water and Power Company at Montreal is a councillor of the Institute.

J. A. Baird, M.E.I.C., is now on the executive staff of the Union Gas Company of Canada Limited, at Chatham, Ont. A graduate of the University of Toronto, Mr. Baird has for a number of years carried a consulting practice as an engineer and surveyor at Sarnia, Ont.

H. C. Beck, M.E.I.C., has relinquished his position as manager of the Substation Department of the English Electric Company, Stafford, England, to become personal assistant to the chief electrical engineer of the Southern Railway at Dorking, Surrey, England.

Squadron Leader C. W. Crossland, M.E.I.C., is now located at Trenton, Ont., at No. 6 Repair Depot, R.C.A.F. He was graduated from McGill University in 1931, and after taking a post graduate course in aeronautical engineering at the Massachusetts Institute of Technology obtained the degree of M.Sc. After spending a few years in England with aircraft manufacturing firms he returned to Canada and became assistant engineer in the aeronautical branch of the Department of National Defence at Ottawa. He joined the R.C.A.F. last year. In 1933, Squadron-Leader Cross was awarded the John Galbraith Prize of the Institute for his paper on "The Rationalization of Load Factors for Aeroplane wings."

H. B. Dickens, M.E.I.C., has returned to Canada after having filled a two year appointment with the British War Office at Woolwich Arsenal, Woolwich, England. He is, at present, attached as a consultant to the General Engineering Company at Toronto.

K. Y. Lockhead, M.E.I.C., has received an appointment in the aeronautical engineering branch of the R.C.A.F. He was previously located at Vancouver with the Hudson's Bay Company.

J. B. Nelson, M.E.I.C., has been appointed sales engineer with the London Structural Steel Company Limited at London, Ont. He was lately chief engineer of Plate and Structural Steel Products Company, Toronto, and formerly with the Hamilton Bridge Company.

W. B. Crombie, M.E.I.C., has left the Great Lakes Power Company, Sault Ste. Marie, to accept a position with the Hydro-Electric Power Commission of Ontario as chief resident engineer on the Ogoki Diversion project. He is now located at Ferland, Ont.

K. A. Truman, M.E.I.C., is now located at Nelson, N.B., with the Canadian Pacific Railway Company. He was previously located at Regina, Sask.

J. G. D'Aoust, M.E.I.C., has left his position with the Powell River Company Limited, at Powell River, B.C., and is now employed with Defence Industries Limited, Montreal. He was graduated from the University of British Columbia in 1927 and joined the Powell River Company as a mechanical draughtsman in 1934.

J. R. Carter, M.E.I.C., has been transferred from the head office of Canadian Industries Limited, Montreal, to the Nylon Division, Kingston, Ont. He was graduated from the University of Toronto in 1931.

A. H. Douglas, M.E.I.C., has been appointed pilot officer in the aeronautical engineering branch of the R.C.A.F. He was previously in the Department of Highways of Saskatchewan at Regina as an assistant bridge engineer.

Paul Vincent, M.E.I.C., has been appointed chief engineer of works in the Department of Colonization of the Province of Quebec. He has been with the Department since 1937 when he joined as district engineer for the roads and bridge division. Last year he had been appointed chief of the technical section in the Department. Mr. Vincent is the secretary-treasurer of the Quebec Branch of the Institute.

C. A. Norris, M.E.I.C., has joined the staff of the Montreal Locomotive Works at Montreal. He was previously editor of the *Engineering and Contract Record* at Toronto, Ont.

A. N. Gunter, Jr.E.I.C., has been transferred from McMasterville, Que., to the Nobel, Ont., plant of Defence Industries Limited. He was graduated in chemical engineering from the University of Alberta in 1938.

F. J. Hastie, Jr.E.I.C., is now with the East Kootenay Power Company at Coleman, Alta. Upon graduation in electrical engineering from the University of Alberta in 1936 he joined the Canada Packers Limited at Edmonton, Alta., as an assistant engineer. In 1939 he became shift engineer.

J. R. C. Macredie, Jr.E.I.C., is now employed with the Department of Defence at Ottawa as structural draughtsman. He was graduated from the University of New Brunswick in 1931 and for several years was employed with the Department of Highways at New Brunswick.

C. B. McMillan, Jr.E.I.C., is now employed with the Canadian National Railways at Montreal. Upon graduation in civil engineering from Queen's University in 1936 he went with the Ontario Paper Company at Baie Comeau, Que. The following year he joined the staff of the Aluminum Company of Canada Limited, as a junior engineer at Arvida, Que. In 1938 he was transferred to the staff of the Saguenay Power Company, at Arvida, and remained in that position until the end of last year.

W. E. Seely, Jr.E.I.C., is now assistant engineer in the works and building division of the R.C.A.F. at Montreal. He was graduated in civil engineering from the University of New Brunswick in 1930 and has since been employed on several construction projects.

Squadron-Leader M. M. Hendrick, Jr.E.I.C., is now located at No. 3 Wireless School at Winnipeg, Man.

J. E. Thom, Jr.E.I.C., has joined the staff of Defence Industries Limited, in Montreal. He was previously located at Regina, Sask.

F. C. Morrison, Jr.E.I.C., is sales-combustion engineer with the Dominion Steel and Coal Corporation Ltd., at Halifax, N.S. Mr. Morrison joined the company upon his graduation in electrical engineering from Nova Scotia Technical College in 1936. Lately he was located with the Dominion Coal Company Ltd., a subsidiary, at Montreal.

H. M. Howard, S.E.I.C.

H. M. Howard, S.E.I.C., has accepted a position as metallurgical sales engineer with E. Long, Limited, at Orillia, Ont. He was graduated in mining engineering from the University of Toronto, in 1940 and spent several months with Fraser-Brace Engineering Company at Nobel, Ont.

W. L. Garvie, S.E.I.C., has been transferred from Peterborough to the Davenport electric works, Canadian General Electric Company Ltd., Toronto, Ont. He was graduated from the University of British Columbia in 1939.

Second-Lieutenant W. J. Milhausen, S.E.I.C., has received a commission with the Royal Canadian Engineers and is stationed at the Petawawa Military Camp. He was graduated in civil engineering from the University of Manitoba in 1940.

A. K. Cameron, S.E.I.C., is now located at Brownsburg, Que., with Canadian Industries Limited. He was graduated in mechanical engineering from McGill University in 1938. Lately he was connected with F. S. B. Heward & Company Ltd., at Toronto, Ont.

W. F. Jarrett, S.E.I.C., has joined the staff of the Saguenay Power Company, as a junior engineer at Arvida, Que. Upon graduation from the University of Manitoba in 1939 he joined the Manitoba Power Commission as a draughtsman at Winnipeg.

ERRATUM

In reporting the appointment of C. J. Jeffreys, M.E.I.C., to the staff of Allied War Supplies Corporation in Montreal, it was erroneously stated that Mr. Jeffreys had been, for the past two years, resident engineer at Powell River, B.C., with Powell River Company, Limited. On checking over the record we find that he was assistant engineer and that Mr. Neville Beaton, M.E.I.C., who is now the resident engineer has occupied that position for the past seven years.

VISITORS TO HEADQUARTERS

Past-President A. J. Grant, M.E.I.C., from St. Catharines, Ont., on January 28th.

John E. Cade, M.E.I.C., assistant chief engineer, Fraser Companies Limited, from Edmundston, N.B., on January 29th.

H. B. Dickens, M.E.I.C., Royal Ordnance Factory, from South Wales, England, on January 29th.

Geoffrey Stead, M.E.I.C., from Saint John, N.B., on February 5th.

J. E. Gill, M.E.I.C., resident engineer, Rapid No. 7, Quebec Streams Commission, from Cadillac, Que., on February 5th.

W. R. C. Taylor, Jr.E.I.C., from Winnipeg, Man., on February 6th.

Major G. G. M. Carr-Harris, M.E.I.C., D.O.M.E., M.D. No. 11, from Esquimalt, B.C., on February 7th.

W. J. Piercy, Jr.E.I.C., O'Brien Gold Mines Limited, from Kewagama, Que., on February 13th.

R. J. Askin, M.E.I.C., manager, Thunder Bay Paper Company Ltd., from Port Arthur, Ont., on February 17th.

H. B. Stuart, M.E.I.C., field engineer, Hamilton Bridge Co. Ltd., from Toronto, Ont., on February 17th.

P. Codd, S.E.I.C., from Moose Jaw, Sask., on February 24th.

Obituaries

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Edgar Thomas John Brandon, M.E.I.C., died at his home in Toronto on September 23rd. 1940. He was born at Toronto on December 20th, 1880, and was educated at the School of Practical Science of the University of Toronto, where he was graduated in 1902. He was then employed until 1905 with the Ontario Power Company at Niagara Falls. From 1905 until 1908 he was in the States working on the design of power developments. In April, 1908, he joined the Hydro-Electric Power Commission of Ontario as a designer and rose to the position of chief electrical engineer.

E. T. J. Brandon, M.E.I.C.

Owing to ill health he had retired from active duties late in 1938.

Mr. Brandon joined the Institute as a Student in 1904, transferring to Associate Member in 1911.

Edgar Murray McCheyne Hill, M.E.I.C., died at Winnipeg, Man., on August 14th, 1940. He was born at Guelph, Ont., on October 13th, 1882. He was educated at the University of Toronto where he was graduated in 1904, from the School of Practical Science. His entire professional career was spent in the service of what is now the Canadian National Railways in the west. Upon graduation he joined the company as a resident engineer on the construction of the main line at Battleford, Sask., and at Edmonton, Alta. In 1907 he became in charge of location parties, west of Edmonton. From 1911 to 1914 he carried out reconnaisance and exploration work in connection with possibilities of railway development in northern Alberta. In 1914 he was divisional engineer in charge of construction of the Calgary-MacLeod branch. From 1914 to 1916 he carried out location work in Alberta. He enlisted with the Royal Canadian Engineers in 1916 and was transferred to the Royal Engineers in 1917 and served until 1919 attaining the rank of captain. Upon demobilization he returned to the Canadian National Railways at Winnipeg. In 1932 he was appointed engineer of construction and in 1935 he also took over the duties of regional right-of-way agent. On January 1st, 1940, he was appointed chief engineer with Headquarters at Winnipeg, Man.

Mr. Hill joined the Institute as a Student in 1907 and he was transferred to Member in 1919.

William Cooper Lumbers, M.E.I.C., died on August 29th, 1940. He was born at Toronto on March 5th, 1887. He was educated at Jarvis Collegiate and University of Toronto, graduating from the School of Practical Science in 1901. From 1902 to 1907 he was employed with the Canadian Pacific Railway. From 1907 to 1912 he was employed with F. A. James, Toronto, and from 1912 to 1916 he was with Frank Barber, civil engineer, Toronto. After some time spent on inspection work on munitions in 1916 he returned with Mr. Barber, and stayed with the firm until 1923. He joined the staff of the Hydro-Electric Power Commission of Ontario in March, 1924. At the time of his death he was employed in the transmission section of the electrical engineering department.

Mr. Lumbers joined the Institute as an Associate Member in 1921.

William Henry Sullivan, M.E.I.C., for twenty years principal assistant engineer in charge of the Welland Ship Canal, died at his residence at St. Catharines, Ont., on January 20th, after a brief illness. He was born at Kingston, Ont., on August 23rd, 1871, the son of the late Senator Michael Sullivan, M.D., of Kingston. He was educated at private schools, and at the Kingston Collegiate Institute. He entered the Royal Military College of Canada in September, 1888, graduating in June, 1892, when he was commissioned as an officer in the Royal Canadian Engineers. He entered the Canadian Government service in September, 1892, being first engaged on the Ontario St. Lawrence Canal, later being appointed assistant engineer in charge of the Cornwall Canal enlargement. In September, 1900, he was transferred to the Prince Edward Island Railway as principal assistant engineer in charge of construction of the Hillsboro bridge and Murray Harbour bridge and railway, and in 1904 was appointed engineer in charge of that work. In October, 1905, Mr. Sullivan was transferred to the position of assistant superintending engineer of the Welland Canal at St. Catharines, Ontario, and was promoted to superintending engineer on January 1st, 1912. In November, 1913, he was appointed principal assistant engineer in charge of the Welland Ship Canal construction, of which the late Mr. J. L. Weller was then engineer in charge. Mr. Sullivan retained this position until December 31, 1923, when he retired because of ill health.

In November, 1901, Mr. Sullivan married Miss Adele Marion, eldest daughter of the late Sir William Sullivan, then Chief Justice of Prince Edward Island, who survives him, together with four sons: Lieutenant Michael V. Sullivan, R.C.N.V.R., Halifax, N.S., Gerald F. Sullivan of Toronto, William W. Sullivan and Philip H. Sullivan of St. Catharines, and two sisters, Mrs. C. J. Crookall of Brooklyn, N.Y., and Miss Frances Sullivan of Kingston, Ont.

Mr. Sullivan joined the Institute as an Associate Member in 1899, becoming a Member in 1920. He had been made a Life Member shortly after his retirement in 1924.

W. Dixon Craig, K.C., who passed away at Edmonton, Alta., on January 27th, 1941, was born in Toronto, son of the late T. Dixon Craig, M.P., for many years member for East Durham. After taking a brilliant course in Arts and Science at the University of Toronto (class '97), he went to Midland, Ont., as mining geologist and metallurgist for the Canada Iron Corporation of Montreal. In 1913 Mr. Craig left the east and made his home in Edmonton, where he began the study of law at the University of Alberta, graduating with distinction (Chief Justice Gold Medal) in 1917. He immediately joined the law firm of Woods, Field, Craig and Hyndman. However, Mr. Craig always kept a live interest in his former profession. He was a member of the Association of Professional Engineers of Alberta, member of the Canadian Institute of Mining and Metallurgy, vice-consul of the Netherlands, member of the Faculty of Law, University of Alberta. He held many prominent offices in the Church of England, and for many years was Chancellor of the Diocese of Edmonton, and Registrar of the Diocese of Athabasca. Mr. Craig is survived by his wife and two daughters, Mrs. F. E. L. Priestly of Vancouver and Mrs. Joseph Fisher of Toronto.

News of the Branches

Activities of the Twenty-five Branches of the Institute and abstracts of papers presented

BORDER CITIES BRANCH

W. P. Augustine, M.E.I.C - *Secretary-Treasurer*
J. B. Dowler, M.E.I.C. - - *Branch News Editor*

The first meeting of the Border Cities Branch in the new year was held in the Prince Edward Hotel on January 14th. The meeting was presided over by the newly-elected chairman, George E. Medlar. After dinner and a short business meeting, J. F. Bridge introduced the speaker of the evening, Mr. R. K. Scales of the research department of the Ethyl Gasoline Corporation of Detroit. The subject of the address was **Fuels and Engines of the Future.**

The future, Mr. Scales said, is a very dangerous subject; predictions can only be based on past performances. However, the aviation industry may be said to be pioneering for the automotive industry so that some basis for prediction may be established. This is because the great expanse of the aviation engine allows room for the most advanced engineering.

Over the past ten years the average size of the automotive engine has become relatively smaller while the horsepower and compression ratio have gone up. The compression ratio is controlled by the anti-knock qualities of the fuels available. The octane (anti-knock) number of fuels commercially sold today is on the average ten points higher than in 1940. The petroleum industry strives at all times to make the best fuel commercially possible. The automotive industry at the same time strives to improve engine design to take full advantage of improved fuels.

Some extravagant claims have been made as to the octane rating of some commercial gasolines. But there are several methods devised by research engineers for obtaining the octane rating and these methods do not all agree. Therefore, the only fair rating is when the fuel has been tested by the different methods and the results averaged. Aviation fuels of ten years ago had an octane rating of 73. This last year it was 92 for airlines. For military pursuit planes, 100 octane fuel is used. Experimental fuels have octane number of over 100 and up to 128.

This matter of high octane number is very important to military aviation. High octane gasoline reduces the bomber's fuel load, increases the engine power and reduces the take-off run needed by as much as 45 per cent.

One of the bottlenecks of German bomber operations would seem to be the necessity, because of long take-off runs, of large numbers of airfields. The longer a bomber must wait in the air for the squadron to assemble the less its final effectiveness. Thus, the lower octane rating of the German gasoline has cut down the number of planes which can take part in a raid on England at any one time. Some idea of the time it takes to put planes into the air may be obtained when it is realized that one of the largest airports in the United States can handle only 280 planes per day.

A few years ago crude oils which were free of gum and so useful for aviation gasoline were very scarce. However, with recent developments in refining methods and in the use of blending agents, almost any crude may be used. Some blending agents used now are iso-octane, iso-pentane and neo-hexane with a small quantity of tetra-ethyl lead. Aviation gasoline may contain as high as 40 per cent blending agent and 60 per cent gasoline with 3 cc. per gallon of tetra-ethyl lead.

Of course, advantage of high octane fuels cannot be obtained without supercharging. The whole trend seems to be towards more powerful, smaller engines with superchargers.

Up to the present time the public has been satisfied with present day highways and speeds. However, as more superhighways are built, the public will demand more powerful, more truly streamlined cars which may call forth some of the developments in aviation engines and their application to automobiles.

The meeting closed with a somewhat spirited discussion period, the subject of Mr. Scales' address being of great interest to the automotive engineers among the members.

EDMONTON BRANCH

B. W. Pitfield, Jr.E.I.C. - - *Secretary-Treasurer*
J. F. McDougall, M.E.I.C. - *Branch News Editor*

Mr. E. A. Hardy, professor of agricultural engineering at the University of Saskatchewan, addressed the fifth dinner meeting of the 1940-41 session on the evening of January 14, 1941. Professor A. R. Greig introduced the speaker. Mr. Hardy's topic was the **Development of the Combustion Chamber of the Diesel Engine.**

In his paper, which he supplemented with slides, Mr. Hardy described several types of combustion chambers which have been used by the designers of diesel engines. He stressed particularly the problem these designers have encountered in obtaining complete combustion of a low grade fuel which is not volatile, and causes smoky exhaust as the engine operates near full load.

An interesting and lengthy discussion period followed the paper, after which Mr. R. M. Dingwall moved a hearty vote of thanks to the speaker.

Twenty-four were present for dinner and an additional sixteen heard the paper. Among the guests present was Squadron-Leader Berven of the Elementary Flying Training School.

Professor R. M. Hardy acted as chairman in the absence of Branch Chairman E. Nelson.

The Engineering Students Society of the University of Alberta invited the Edmonton Branch of the Institute to be guests at their meeting on the evening of January 27th, 1941.

At this meeting was shown a United States Bureau of Mines motion picture entitled **The Making and Shaping of Steel.** The film was composed of seven reels and dealt very fully with the following topics:

Reel 1—Open pit and underground mining of iron ore. The mining of limestone. The making of coal into coke. The operation of a blast furnace was shown in detail by means of animated drawings and the reel ended with molten iron being transported to another shop for refining into steel.

Reel 2—The open-hearth and Bessemer process were shown. The closing scenes showed the removal of moulds from ingots after the steel had solidified and the transfer of the ingots to soaking pits to attain uniform temperature for rolling.

Reel 3—Flat rolled products; Reel 4—Bars and structural shapes; Reel 5—Rails, wheels and axles; Reel 6—Wire and wire products; Reel 7—Pipe and tube manufacture.

The entire film had excellent continuity and although it went into complete detail of the various phases of steel manufacture, it maintained the interest of the meeting throughout.

Immediately after the film, E. Nelson presented Charles A. Stollery, winner of the 1940 Engineering Institute of Canada Prize for the University of Alberta, with an engrossed certificate.

HALIFAX BRANCH

L. C. Young, M.E.I.C. - *Secretary-Treasurer*
G. V. Ross, M.E.I.C. - - *Branch News Editor*

On January 23rd, the members of the Halifax Branch of the Institute and of the Association of Professional Engineers of Nova Scotia, and friends gathered at the Nova Scotian Hotel for the annual joint banquet. The attendance of 240 was an increase of 43 over last year's record and included many men from outside the Halifax area.

After the toast to the King, Captain J. I. Hallett, D.S.O., R.N., delivered a strong straightforward talk encouraging Canadians to realize the dangers of the present time. "Britain needs your money for planes, guns and supplies. You are like boxers still lounging on the ropes, waiting for the bell. You should be up on your toes as they are in the Old Country." Captain Hallett was introduced by Rear Admiral S. S. Bonham Carter, C.V.O., D.S.O., R.N., Commanding 3rd Battle Squadron.

The toast to the Services, proposed by Ira P. Macnab, was responded to by Brigadier General C. E. Connolly, D.S.O., Officer Commanding Military District No. 6. Mr. F. A. Bowman, senior engineer of Nova Scotia, responded to the toast to the engineering profession proposed by Mr. E. J. Cragg, commissioner of the N.S. Power Commission.

Guests of the Institute and the Association included Commodore G. C. Jones, R.C.N., commanding officer, Atlantic Command, Air Commodore N. R. Anderson, officer commanding, Eastern Air Command R.C.A.F., Premier, A. S. MacMillan, Mayor W. E. Donovan, and American Consulate General Clinton E. MacEachran. The branch chairman, S. L. Fultz, and the Association president, J. Lorne Allan, alternated as chairman during the evening.

A splendid entertainment programme under the direction of Harry Cochrane was provided by the Canadian General Electric Company and the Northern Electric Company, K. L. Dawson, acting as master of ceremonies.

Favours were donated to everyone present by Imperial Oil Company, Moloney Electric Company, Canada Cement Company, Canadian Westinghouse Company, N.S. Power Commission, N.S. Department of Highways and Mr. Donald C. Keddy.

After the meeting, Mr. Ira Macnab conducted a sale of war savings stamps which netted about $400.00.

LAKEHEAD BRANCH

H. M. Olsson, M.E.I.C. - *Secretary-Treasurer*
W. C. Byers, Jr.E.I.C. - *Branch News Editor*

The Lakehead Branch held a Dinner Meeting at the Royal Edward Hotel, in Fort William, at 7 p.m. on January 15th. There were 37 members and guests present. The chairman, Mr. H. G. O'Leary, presided at the meeting. He mentioned how that, purely by accident, he had met the General Secretary Emeritus at the railroad depot and that he had expressed his desire to be remembered to all the members of the Branch.

The chairman then called on Mr. J. I. Carmichael, of the Canadian Car & Foundry, who spoke on the subject: **Some Problems in Aircraft Production.**

The basic problems to be coped with are: purchasing the required material; finding a suitable supply of labour, both skilled and unskilled; obtaining tools necessary for fabrication; organizing for production; marketing and financing; organizing for production being the most serious problem to the manufacturer, the remaining problems being external.

The policy of the designer is to obtain the highest possible performance. Having established the requirements, the type of structure is selected from among semi-monocoque, geodetic, welded tubular, tube and gusset or other less popular types. However, the semi-monocoque is the most common type used today. The design must maintain interchangeability of important components. The Hawker "Hurricane" is an example of mixed type of construction. The wings are of stressed skin type and the remainder bolted tube and gusset construction. On the "Hurricane" there are about 6,000 detail parts. This type of construction requires rigid material specification, special shapes, low manufacturing tolerances, large number of detail parts and critical inspection.

An embargo was placed on export of aircraft material from England, so supplies had to be located in America to meet the requirements of the British Air Commission. When the supplier had proved his ability to produce the material of the required specification he was then placed on the approved list and went into production.

Limitations in the rate of expansion of industry are set by the rate at which the necessary material can be supplied and the necessary labour can be absorbed. There is shortage of skilled labour so there is some delay while suitable labour is trained. Under good conditions it is possible to employ female labour to the extent of 30 per cent of the total staff.

The machine tool industries in both the United States and Canada have been operating to capacity, thus the manufacturer is forced to sub-contract a large portion of this machine work. The manufacturer must supply the sub-contractor with all necessary data, supervision and raw material with all possible assistance to ensure delivery in the required time.

The Inspection Department sees that only proper materials are used, standard manufacturing procedures followed, workmanship is good and drawing dimensions followed.

The Stores Department stores finished parts and is supervised by the Inspection Department.

The duties of the Shop are to maintain discipline, to train new men, and to assemble the aircraft after completing competent parts.

The Production Department sees that all necessary steps are taken to complete the programme on time with maximum efficiency.

The Planning Department is responsible for getting the required parts in the correct place at the right time. It investigates new programme feasibility.

The Material Control Department supervises the distribution of all material from external sources and its efficient operation is of vital importance.

The duties of the Control Department are to dispatch and record production orders, to route parts in the Shop and to supervise progress and to correct if necessary.

In the automobile industry, assembly proceeds without fitment with minimum skill and the assembly line operations are in units so that a continuous operation is achieved. In aircraft industry the main components are built in jigs with a large number of parts, most of which are incomplete and remain to be completed on assembly, thus producing an intermittent operation of assembly procedure.

"Thus with present design, continuous manufacturing operations cannot be used except in the case of detail parts where a saving of only ten per cent has been anticipated. Therefore, with the exception of this ten per cent saving, mass production methods will give little assistance to aircraft production."

P. E. Doncaster gave a vote of thanks to the speaker and mentioned how engineering had changed from railway construction in 1912 to aeronautical engineering in 1941.

R. B. Chandler seconded the vote of thanks and expressed interest in several statements made by the speaker.

David Boyd, Works Manager of the Aircraft Division, and E. J. Soulsby, Superintendent of Aircraft, both corroborated the statements made by the speaker and paid tribute to the work he is doing at the plant to accelerate the production of aircraft.

Several aircraft inspectors from the Canadian Car & Foundry were present at the meeting.

LETHBRIDGE BRANCH

E. A. Lawrence, s.e.i.c. - - *Secretary-Treasurer*
A. J. Branch, m.e.i.c. - - *Branch News Editor*

On Wednesday, January 15th, 1941, the Lethbridge Branch of the Institute held its regular meeting in the Marquis Hotel.

At 7.30 p.m. the corporate members of the branch met to transact the routine business and at 8 p.m. the regular meeting was opened by Wm. Meldrum, who called upon A. J. Watson, to introduce the speaker of the evening, J. H. Ross of Calgary, director of the Dominion-Provincial Youth Training for Alberta.

The speaker described the steady expansion of the youth training movement from its early stages.

The early aims of the scheme were to prepare young people physically, mentally and, if possible, vocationally for jobs. The object was to refresh minds which had been depressed by years of unemployment but, as the scheme continued trainees were fitted for work and placed in industry.

To train young people for industry efforts were made to discover inclinations of persons and then training along this line followed. Many were placed to learn the occupations with employers who generally placed trainees on their staffs when they had learned enough to be valuable.

At the request of the federal government the scheme undertook the training of mechanics in hand skills. Women are also being taught for jobs in war industry.

The training scheme is now producing many valuable men for industry who are highly developed in performing work; requiring exacting precision. This is enabling factories to continue to gear up production of war materials for the Dominion.

A question period followed the address; then Lieut.-Col. G. S. Brown, with a few well chosen remarks moved a hearty vote of thanks to the speaker in which all concurred.

The meeting closed with the singing of the National Anthem. Refreshments were then served.

LONDON BRANCH

H. G. Stead, jr.e.i.c. - - *Secretary-Treasurer*
A. L. Furanna, s.e.i.c. - *Branch News Editor*

The annual dinner meeting of the London Branch of the Institute was held on Wednesday, January 15th, 1941, at the Grange Tea Room.

The retiring chairman, Mr. H. F. Bennett, presided over a business meeting at which the auditor, Mr. F. Ball, presented the financial statement for 1940. Officers were elected for 1941.

The guest speaker of the evening was Mr. R. E. Laidlaw, K.C., assistant regional counsel for the Canadian National Railways. His subject was **The Machinery of the Law.** Mr. Laidlaw described the functions of the various courts from the daily police courts to the Dominion's last Court of Appeal, the Privy Council of England. The intricate proceedings of the law were illustrated by the speaker as he led the meeting, step by step, through the imaginary case of one charged with homicide. All through the address it was emphasized how the seemingly slow and tedious ceremony of the courts was desgined for the protection and assurance of justice to the accused. In his concluding words, Mr. Laidlaw indicated the development of justice in the courts to its present perfection, by comparing actual cases of crimes and the pronounced sentences in the days of Bonnie Prince Charlie with those of today. However, in spite of this quality of justice, those present were cautioned against any acts or circumstances which might bring the law to bear upon them.

Concluding the meeting, Mr. E. V. Buchanan proposed and Mr. J. A. Vance seconded a vote of thanks to Mr. H. F. Bennett for his services as branch chairman for the past two and a half years. Mr. Bennett was also congratulated on his work as chairman of the Committee on the Training and Welfare of the Young Engineer.

There were fifty-six members and guests in attendance at dinner.

MONCTON BRANCH

V. C. Blackett, m.e.i.c. - *Secretary-Treasurer*

A dinner meeting of Moncton Branch was held on December 19, 1940, in the Palm Room of the Brunswick Hotel. F. O. Condon, chairman of the branch, presided. During the course of the dinner the chairman introduced E. L. Miles, a member who has recently come to Moncton, J. E. Gibault, Assistant General Manager, Canadian National Railways. The guest speaker of the evening was Mr. E. C. Percy, Assistant District Airways Engineer, who read a paper prepared by Mr. J. A. Wilson, Controller of Civil Aviation, entitled **Aerodrome Construction for the British Commonwealth Air Training Plan.** The paper was illustrated with lantern slides. The speaker was called upon to answer numerous questions, and a lengthy discussion followed. A vote of thanks was extended Mr. Percy on motion of C. S. G. Rogers, seconded by Dean H. W. McKiel.

MONTREAL BRANCH

L. A. Duchastel, m.e.i.c. - *Secretary-Treasurer*

On November 21st, 1940, the Branch held its Annual Student Night. A good attendance (240) was noted and four excellent papers were presented on a competitive basis. The papers and speakers were as follows: **Manufacture of Modern Refrigerators,** by V. G. Griffin, (McGill); **Utilization and Disposal of Cannery Wastes,** by Bernard Beaupré, (Ecole Polytechnique); **Construction of Boulder Dam,** by W. C. Brown, (McGill); **Nomography,** by Roger Lessard, (Ecole Polytechnique).

All four competitors were given student memberships for the year 1941 and cash prizes were awarded to Bernard Beaupré and V. G. Griffin for the best and second best papers. While the judges were arriving at a decision a motion picture entitled **Liquid Air** was shown through the courtesy of the Canadian General Electric Company. Refreshments were served after the meeting.

The Romance of Water was the title of a paper given by Mr. Norman J. Howard, F.C.I.C. on November 28th, 1940. Mr. Howard is director of water purification for the City of Toronto, and president-elect of the American Water Works Association. The paper dealt with the progress made in water purification and analysis during the past century. The subject of taste and colour was also touched by Mr. Howard who is a specialist on the matter. The paper was illustrated with lantern slides and preceded by a courtesy dinner at the Windsor Hotel.

On December 5th, Mr. A. Van Winson gave a talk on **Metalizing** which was followed by very interesting demonstrations showing the possibilities of metal spraying. A courtesy dinner was held at the Windsor Hotel before the meeting.

Hydraulic Model Experiments was the title of an interesting talk given on December 12th by Dr. Kenneth C. Reynolds on the newer phases of hydraulic experimentation. Dr. Reynolds is a professor at the Massachusetts Institute of Technology and has made intensive studies of the flow of water in open channels. His paper was illustrated by a coloured motion picture and lantern slides and was preceded by a courtesy dinner at the Windsor Hotel.

On December 19th, Mr. J. J. Taylor gave a paper entitled **High Voltage Insulators** which was illustrated with slides and a motion picture showing dancing conductors. A courtesy dinner was held at the Windsor Hotel.

The Annual Meeting of the Branch was held on January 9th, 1941. The report of the retiring executive and the financial statement were given. The scrutineers presented their report and the results of the election were announced.

After the meeting a film on the British Navy was shown and refreshments were served.

On January 16th, Mr. George S. Mooney gave a paper entitled **Our Cities—Their Role in the National Economy,** and discussed cities as centres of industry, trade, transportation and culture.

Professor Louis E. Endsley spoke, on January 23rd, on **Diesel Electric Locomotives** and included comparisons between the diesel electric and the steam locomotive as to fuel cost and repairs. A courtesy dinner was held at the Windsor Hotel.

Prior to the Branch meeting, the Annual General Meeting of the Institute for 1941 convened for transaction of formal business and was adjourned to Hamilton on February 6th.

On January 30th, the Branch held its Annual Smoker at the Ritz Carlton Hotel. The attendance was over 500 and the entertainment was given in a gay 90's atmosphere, everyone being provided with a paper moustache. The Atterbury players provided a drama and members of the Montreal Repertory Theatre furnished several short songs and dances. A very enjoyable evening was enjoyed by everyone.

On February 3rd, a meeting was held in the Bell Telephone Auditorium to hear Dr. J. O. Perrine speak on **Energy, Frequencies and Noise Relations in Line and Amplifiers of Coaxial Cables and other Multi-channel Telephone Systems.** Members of the Institute of Radio Engineers were invited to attend the meeting which was preceded by a courtesy dinner at the Windsor Hotel.

Through the courtesy of J. L. Busfield the members of the Branch were invited to attend a luncheon of the Rotary Club of Montreal on February 11th, to hear the Hon. C. D. Howe give his first public address since his return from England. The Branch is indebted to Mr. Busfield for the opportunity afforded the membership to attend this important luncheon.

On February 13th, Mr. Gerald N. Martin gave a paper entitled **Recent Installations of Large Power Boilers in England.** The paper was a descriptive outline of recent trends in this field and an account of the visits made by the speaker to some of Britain's latest power plants.

Junior Section

On November 21st, the Annual Student Night was held as described above.

Mr. Georges L. Archambault, S.E.I.C., gave a talk, on December 2nd, on **Automatic Controls in Air Conditioning.**

On February 10th, Mr. Jacques Hurtubise, Jr.E.I.C., gave a paper on **Experimental Research on Soil Stabilization.**

MONTREAL BRANCH SMOKER

Max Sauer tells it to Lyman Playfair

From left to right: Richard L. Hearn, H. C. Fitz-James (Vancouver), A. C. D. Blanchard, Eric P. Muntz, G. E. Templeman.

Well posed by Messrs. Jamieson, Heartz, Brown and Laporte.

From left to right: D. R. Eastwood, Charles Morrison, Walter Griesbach, A. G. Sullivan.

NIAGARA PENINSULA BRANCH

Geo. E. Griffiths, m.e.i.c. - *Acting Secretary-Treasurer*
C. G. Cline, m.e.i.c. - - *Branch News Editor*

On January 24th, the Branch held a dinner meeting at the Leonard Hotel, St. Catharines, with an attendance of 45. In the absence of the branch chairman, C. H. McL. Burns, the vice-chairman, A. L. McPhail, presided.

The speaker of the evening was R. W. Angus, professor of mechanical engineering at the University of Toronto. He was introduced by J. B. McAndrew. The subject was **The History of the Development of Water Turbines and Pumps.** Professor Angus began with an interesting account of the pioneers in hydraulics. Archimedes (287-212 B.C.) developed the science of hydrostatics and also made use of the block and tackle, the screw and the lever. Vitruvius (85 B.C.) and Frontinus (35 A.D.) helped to build and operate the nine aqueducts at Rome and have left us interesting accounts of their work. Leonardo da Vinci (1452-1519 A.D.) was a versatile genius, being at once artist, sculptor and engineer. In New York city there is a display of models made from the drawings preserved in his note-books, including canals, churches, double-acting pumps, gear wheels, guns, a flying machine, parachute, air-pump and saw-mill.

This introduction was followed by a set of lantern pictures, including early examples of undershot, overshot and breast water wheels, with both straight and curved vanes; Fourneyron and Francis turbines; propeller and Kaplan type runners; and Pelton wheels. Also, there were views of a number of modern power plants in both Europe and North America which had been visited by the speaker. He showed also a shorter series of pictures illustrating in a similar manner the development of the pump.

A vote of thanks to the speaker was moved by W. R. Manock.

OTTAWA BRANCH

R. K. Odell, m.e.i.c. - *Secretary-Treasurer*

The annual meeting of the Ottawa Branch was held on Thursday evening, January 9, 1941, at the auditorium of the National Research Council building, Sussex Street. Reports for the past year were presented and officers elected for the forthcoming year. W. H. Munro, retiring chairman, presided and in his retiring address referred to the branch having had a most successful year.

W. L. Saunders reported for the membership committee.

The report of the Proceedings Committee, by W. H. Norrish, stated that twelve meetings, including the annual meeting of the branch, were held during the year. Of these, eight were luncheon meetings, one of which was held at the Ottawa Technical High School. Of the evening meetings, two were held jointly with the Ottawa Branch of the Canadian Institute of Mining and Metallurgy. The average attendance for all meetings was 107 and many outside engineers temporarily stationed in Ottawa were freely welcomed to the luncheons and other meetings.

L. A. Wright of Montreal, general secretary of the Institute, was present at the meeting and spoke briefly. He referred to the steady increase in membership of the Institute, stating it was now the highest in fifteen years.

After the business of the annual meeting proper was concluded, Dr. Charles A. Robb, professor of mechanical engineering of the University of Alberta at the time of the outbreak of the present war, and now power consultant of the Munitions Branch, Department of Munitions and Supply, gave an address on **Gauges for Mass Production.**

Through the courtesy of Dean C. J. Mackenzie, acting president of the National Research Council, the members inspected the gauge laboratory where some of the methods of testing gauges were explained.

At the close of the meeting light refreshments were served.

At the noon luncheon at the Chateau Laurier on Thursday, January 30, Alan Hay, engineer of the Ottawa Suburban Roads Commission and consulting engineer for the Federal District Commission, told of the organization so far undertaken in Ottawa and vicinity in the matter of **Air Raid Precautions.** The luncheon was under the chairmanship of W. H. Munro, immediate past chairman of the branch.

In Canada air raid precaution work is being carried on through national, provincial and local committees, mostly on a voluntary basis so as to ensure a normal or nearly normal functioning of life and services in the case of emergency. It is the aim in carrying out these precautions to maintain the morale of the public, to keep down panic, to educate the average individual how he can protect himself, and to allow certain individual volunteers to take training to fit themselves for greater service.

A national committee under the chairmanship of Dr. R. E. Wodehouse, deputy minister of the Department of Pensions and National Health, has been actively engaged in this work for the past two years, with parallel efforts undertaken by the Saint John Ambulance Association which has trained a great many people so that they may be available as instructors. Actually, two or three weeks before the war, officials from the Department travelled from coast to coast in the interests of air raid precaution work, particularly in connection with the coast cities, so that immediately war was declared some of them could have readily carried out blackout operations. Some of these cities, stated Mr. Hay, have now reached a stage of preparation quite comparable to that of most cities in the British Isles.

The organization for the Ottawa district is somewhat different from that of some of the other cities on account of the individual conditions prevailing here, including the fact that it is the seat of the federal government and also lies astride an inter-provincial boundary between two provinces. The federal location accordingly extends on both sides of the Ottawa river including Britannia, Deschenes, Hull cement works to the Gatineau Mills, Rockcliffe airport, the National Research Council location on the Montreal Road, and Billings Bridge, or 55 square miles in all. A main committee on policy for the district includes the heads of the various municipalities embraced, as well as others prominent in municipal life, with Fred Bronson, chairman of the Federal District Commission, as chairman of the committee. Working committees under this main committee look after, respectively, municipal engineering, fires, police duties, medical health, and public utilities, with a sixth committee consisting of the chairman of the other five to prevent duplication of effort and to co-ordinate the work. Mr. Hay himself is chairman of this sixth committee.

Mr. Hay detailed the duties of these various committees. The municipal engineering committee, for instance, is in charge of ordinary repair services and has to consider ways and means of restoring services that may be affected. Under the fire chief's committee, consideration is being given to the use of small type apparatus for the fighting of small fires. For instance, small fires can be fought with a pail of sand and a small shovel, and in England such equipment is practically a household necessity. Also there are pumps that can be carried by hand and used from any emergency water source, even to a bucket of water.

Regarding the efficacy of different types of shelters Mr. Hay could not speak from first hand knowledge. He felt, however, that Canada's geographical situation, the more open dispersal of population in the Canadian cities, the backyards and front lawns, and the type of construction of Canadian homes rather favoured the people of this country. Shelters naturally fell into two types of design, (1) concealment and (2) protection. Concealment may be effected by taking advantage of natural topography such as an erection against a hillside, in the shadow of trees, or by decentralizing plants so that individual units are in out-of-the-way places. Another idea here in factory construction is the "Ribbon" principle following the production line, so that if one part is hit production may be detoured. Regarding protection there has been considerable controversy on the relative merits of large and small shelters. The large shelter can be built at a lower cost per individual, and keeps up morale in affording opportunity for community efforts and singsongs. But to be safe it should be 50 feet underground or have a three-feet thick roof. For economic reasons large shelters in most Canadian cities would be far apart and so small shelters would also have to be built.

Relative danger during air raids has been worked out as follows: outside and standing up in the open, 100 per cent danger; outside and lying down in the open, 50 per cent; in a frame house, 30 per cent; in a protected brick house, 12 per cent; in a reinforced basement, 5 per cent; in an Anderson shelter, 2 per cent; and in a heavy concrete shelter, no danger.

After Mr. Hay's address was concluded, Acting Chairman W. H. Munro called on Dr. R. E. Wodehouse, who was present, to address the meeting briefly. Dr. Wodehouse referred to the plight of localities that had believed that "it can't happen here" and indicated the course of preparations in this country. Incidentally he mentioned that underground shelters should have zigzag entrances. "A direct entrance invites trouble," he stated. Also, already England has made over sixty million gas masks. Interest in gas masks over there had waned for a time but now with the threat of invasion and the possibility of gas being included, it has revived greatly.

QUEBEC BRANCH

Paul Vincent, m.e.i.c. - *Secretary-Treasurer*

Lundi soir, le 27 janvier, nous avions le plaisir d'entendre Monsieur Robert Dorion, m.e.i.c., nous parler de **L'Administration Municipale par un Ingénieur-Gérant.**

Depuis la crise économique de 1929, commença le conférencier, les principales cités et villes ouvrières de la province de Québec ont subi l'assaut du chomâge avec un déplorable résultat sur leurs finances et leur administration. Après dix ans de ce système plus ou moins néfaste, dit-il, les corps publics en sont venus à se demander quel serait le meilleur mode d'administration permettant d'éviter et de corriger si possible les abus et les excès du passé.

Monsieur Dorion nous prouva que le meilleur système administratif des cités et villes est bien celui de la gérance, surtout par un ingénieur. L'ingénieur-gérant est un officier exécutif; c'est lui qui fait exécuter les règlements passés au Conseil. Le gérant exécute et le Conseil légifère. Le gérant est aussi l'agent de liaison entre les membres du Conseil et les différents corps publics. Il s'intéresse au budget, il vérifie les dépenses et les revenus.

Dans la province de Québec, 15 villes ont adopté le système de gérance. Ce sont: Westmount, Outremont, Verdun, Mont-Royal, Lachine, Montréal-Est, St-Lambert, Arvida, La Tuque, Grand'Mère, Shawinigan Falls, Valleyfield, Val d'Or, Baie Comeau et Témiscamingue.

Il est intéressant, dit le conférencier, de noter que pas une de ces villes ayant adopté l'administration par gérant ne l'a abandonnée. Aux Etats-Unis ce système de gérance fut inauguré en 1908; aujourd'hui on compte 516 villes ainsi administrées.

L'ingénieur-gérant, dit en terminant M. Dorion, doit être un administrateur, non un dictateur.

Le conférencier répondit avec plaisir aux questions que lui posèrent quelques-uns des membres dans l'auditoire.

Monsieur Adhémar Laframboise avait presenté M. Dorion, et il fut remercié par Monsieur Lucien Trempe. Monsieur L. C. Dupuis, président de la Section de Québec, occupait le siège présidentiel.

The successful social gathering innovated last year was repeated this year in a more formal way.

The Quebec Branch held a ball at the Quebec Winter Club on Saturday evening, February 8th. At this **Fête Annuelle,** various forms of entertainment were provided throughout the evening and the guests danced to the or-

Quebec Branch annual dance, Quebec Winter Club.

chestra of Georges Amyot. For those who did not dance, there was bridge in the card room.

Through the fine collaboration of Messrs. Alex.L ariviere, Léo Roy, Gérald Molleur, Roland Lemieux, Chas. H. Boisvert and Gustave St-Jacques, the success of this formal gathering exceeded that of last year. One hundred and seventeen people kept their gay spirit all evening and they went home with reluctance.

During the buffet served in the lounge of the club, Messrs. L. C. Dupuis and E. D. Gray-Donald, respectively chairman and vice-chairman of the branch, thanked the members for their fine co-operation.

All present expressed their enchantment and their desire of making this kind of activity an annual affair.

SAULT STE. MARIE BRANCH

C. A. Evans, Jr. e.i.c. - *Secretary-Treasurer*
N. C. Cowie, Jr. e.i.c. - *Branch News Editor*

The first general meeting for the year 1941 was held in the Grill Room of the Windsor Hotel at 6.45 p.m. on Friday, January 31st, 1941, when 24 members and guests sat down to dinner. The business portion of the meeting began at 8.00 p.m. with Chairman E. M. MacQuarrie occupying the chair. The minutes of the Annual Meeting were read and adopted.

The chairman then called upon T. F. Rahilly, general manager of the Algoma Steel Corporation, to introduce the speaker of the evening, Mr. L. F. McCaffery of the Algoma Steel Corporation. Mr. Rahilly in a few words told of Mr. McCaffery's fitness to talk on the subject, **The Installation and Operation of Continuous Strip Mills,** as the speaker had charge of some of the biggest plants in America. Mr. McCaffery's address was illustrated with motion pictures.

At the conclusion of the showing of the films, the secretary was asked to write the United Engineering Company of Pittsburgh, Pennsylvania and thank them for their courtesy in supplying us with the films.

TORONTO BRANCH

J. J. Spence, m.e.i.c. - *Secretary-Treasurer*
D. Forgan, m.e.i.c. - *Branch News Editor*

Students' Night has been a successful feature on the programmes of the Toronto Branch for several years past. This year it was held during the meeting of January 16th, which took place in Hart House. As has been the case in previous Student Nights, the meeting was principally devoted to the presentation of papers by members of the student body. This one was no exception to the general run, and displayed a high level of excellence in the subject matter and in the presentation of the individual papers.

About forty members of the branch assembled to hear the six prize-winning papers which had been selected out of a much larger number of contestants by the Engineering Society. Experience has shown that more than this number cannot properly be presented in the time normally available for a Branch meeting.

The branch chairman, Nicol MacNicol, presided and introduced the speakers, whose subjects were: J. W. Ames—**Future Trend in Aircraft Design**; B. Etkin—**Estimation of Aircraft Performance**; W. D. Ramore—**A Modern Method of Placing Concrete**; P. B. Smith—**Relay Protection of Transformers**; G. M. Nixon—**The Co-Axial Cable in Telephone Transmission**; D. P. MacVannell—**Wind Tunnel Testing.**

At the conclusion of the papers and while the judges (Messrs. A. B. Cooper, J. Grieve, D. G. Geiger) were considering the relative merits of the papers, moving pictures were shown, the principal of these being a film in technicolour showing the manufacture of nylon, rayon, and similar products. Just previous to this the Institute prize awarded to the best third year man was presented by Mr. Smithers to the winner, B. K. Smith.

One outstanding feature of the programme was the large proportion of the papers devoted to aeronautical subjects, an indication perhaps of present trends and of the future direction of much engineering practice. Another was the manner in which the papers were presented by their authors. Ease, confidence and clarity characterized the delivery of each contestant, and the use of notes was practically negligible. In his concluding remarks the chairman voiced the feeling of many of the older engineers in regard to the impressions they received, comparing the present training and capabilities of students along these lines to those generally prevailing in the days when the old timers attended university.

VANCOUVER BRANCH

T. V. Berry, m.e.i.c. - *Secretary-Treasurer*
A. Peebles, m.e.i.c. - *Branch News Editor*

A programme meeting of the Vancouver Branch was held on Monday, January 20th, at the University of British Columbia. Addresses were given by two members of the university faculty, F. A. Forward, associate professor of metallurgy, and W. O. Richmond, assistant professor of mechanical engineering.

Professor Forward spoke on **The Heat Treatment of Steel.** He dealt chiefly with the structure of metals and alloys and the principles which govern heat treating techniques, rather than with the techniques themselves; pointing out that an understanding of these principles is prerequisite to the development of successful alloying or heat treating processes.

All metals are crystalline in structure, and the nature of the crystals determines the physical properties which the metal will develop. Changes take place in the size and alignment of the crystals when a metal is heated or when it is worked by rolling, and some of these changes are stable while others will revert when the metal returns to normal temperatures. The crystal structure of irons and steels is a simple one, while that of most non-ferrous metals is more complex and in the case of alloys the structure is highly intricate. Some crystals are cubic in form, that is, the atoms are arranged in a manner which builds into a cube-shaped crystal, in some cases large enough to be identified through the microscope. The atomic arrangement varies within the cube in different metals but the cubic crystal remains. Other metals may have hexagonal crystals, or still more complex shapes.

Those metals exhibiting a simple crystal form are soft and malleable, while those of a complex nature are hard and brittle.

Alloys are of three general types, a mechanical mixture, metals mutually soluble in one another, or chemical compounds. The resulting crystal formation and physical properties are determined by the type of alloy, according to this grouping. The grain size of a metal is also related to its physical properties. In general, fine-grained metals are hard and brittle. At high temperatures, the grains of metal will grow in some cases, so that grain size control is an important element in the treatment of steel. Rolling will control the grain size to a considerable extent.

The rate of cooling of a metal from high temperatures is very important in hardening and tempering processes. The effect of the cooling rate can be modified by alloying with other metals, in some instances slowing the cooling changes down to a rate which permits certain working of the metal while it is in some desirable but unstable crystalline form.

The speaker illustrated the above material with lantern slides showing typical eutectoid curves and photo-micrographs of iron and steel in some of their many forms.

Professor Richmond's subject was **The Application of Material Tests to Design.**

There are three forms of loading which are considered when designing structures and structural parts. These are the static load, the variable load, and the impact load. In testing, the tensile strength test is used for static loading. From this a stress strain curve is obtained which serves as a basis for determining design stresses. In iron and steel, a well defined yield point is apparent, but in other metals the curve will be smooth with no clearly defined point beyond which permanent deformation occurs. In such cases it is difficult to select a working stress limit. In most non-ferrous metals some permanent strain occurs as soon as load is applied, and if an unloading curve is plotted it will not be coincident with the loading curve but parallel to it. A common method of selecting the design stress is to use the point on the loading curve from which an unloading curve when projected back would show a permanent strain of 0.2 per cent of the original length of the specimen.

In testing for variable loading, rapid cycles of a reversed bending stress are used. Fatigue failure results from the development of a small crack or fissure between the grain clusters in the metal, and the gradual spread of this crack to the point where rupture occurs. Metals do not crystallize due to reversed stresses, since they are always crystalline in structure. This is an erroneous idea rather widely held.

Dean J. N. Finlayson, branch chairman, presided over the meeting, and a vote of thanks was tendered by W. O. Scott, vice-chairman. About sixty members and guests attended. Following adjournment in the lecture room, the party was conducted through the mining and metallurgical laboratories where they saw demonstrations of equipment used in studying the structure and properties of metals.

VICTORIA BRANCH

Kenneth Reid, m.e.i.c. - *Secretary-Treasurer*

The annual meeting of the Victoria Branch was held at Spencer's Dining Room, Victoria, on January 17th, 1941, with E. W. Izard presiding. The meeting was preceded by the usual dinner at 6.30 p.m.

Following the dinner the presentation of the annual reports and the financial statement were made by the chairman and the secretary. These showed the branch to be in a very healthy state with a small surplus over operating expenditure in spite of considerable increased activity in the way of branch meetings during the past year.

The election of officers for the year 1941 resulted in the election of G. M. Irwin, Victoria City engineer as chairman and A. S. G. Musgrave, engineer of the Municipality of Oak Bay, as vice-chairman. Kenneth Reid, engineer with the Victoria City Light Department, was returned as secretary-treasurer for the seventh consecutive term. Other members elected to the executive committee were J. H. Blake, Provincial Forestry Department, A. L. Ford, (retired), and B. T. O'Grady, of the Provincial Department of Mines.

Following the meeting the members of the branch were entertained by Mr. D. S. Scott with several reels of motion pictures, one on the sinking of the Graf Spee, and others depicting the nesting habits of wild fowl around Victoria and vicinity, including sea-gulls and cormorants, which proved most interesting. At the conclusion of the meeting a hearty vote of thanks was extended Mr. Scott for his very fine pictures.

WINNIPEG BRANCH

C. P. Haltalin, m.e.i.c. - *Secretary-Treasurer*

The annual meeting of the Winnipeg Branch of the Institute was held on February 6th, 1941.

After the chairman's address the various committee reports were read and approved.

Professor G. H. Herriott moved a hearty vote of thanks to the retiring chairman, Mr. H. L. Briggs, for his excellent work for the Branch during the year.

The scrutineers' report showed the following branch officers elected for the year 1941—Immediate Past Chairman: H. L. Briggs; Chairman: V. Michie; Secretary-Treasurer: C. P. Haltalin; Executive Committee: C. V. Antenbring, H. B. Brehaut, J. T. Dyment, H. W. McLeod, T. E. Storey; Chairman of the Membership Committee: Mr. E. S. Braddell; Chairman of the Programme Committee: Mr. S. G. Harknett.

At the conclusion of the business of the annual meeting a sound film entitled "There is a Difference" was shown by courtesy of Mr. L. A. Rodgers of the Winnipeg District Office of the Canadian General Electric Company.

Refreshments were served following the adjournment.

News of Other Societies

Items of interest regarding activities of other engineering societies or associations

ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO

The seventh general meeting of the Association of Professional Engineers of the Province of Ontario was held in the Roof Garden of the Royal York Hotel, Toronto, on Saturday afternoon, January 18th, 1941. The retiring president, Mr. J. W. Rawlins, occupied the chair.

In a few brief remarks the chairman welcomed not only the members of the Association, but also the members of the Dominion Council of Professional Engineers who were present. He called upon Mr. D. A. R. McCannel of Regina, president of the Dominion Council, to introduce the members of his Council to the gathering. Mr. J. C. Oliver, registrar of the British Columbia Association of Professional Engineers, was also welcomed to the meeting.

Mr. Rawlins briefly reviewed the activities of the Association during the past year, mentioning the fact that the net increase in membership for the year was 124, while the increase in recorded engineers-in-training was 133. He further stated that the Association had granted bursaries to the value of $100.00 each at the University of Toronto and at Queen's University. Detailed reports were given by the chairmen of the various committees of Council.

Mr. S. R. Frost, president-elect, reported that the Association had, after consideration by a special committee of Council, offered its assistance to the Royal Society of Canada in making a survey of the resources of our country.

In the absence of Dr. A. H. Harkness, chairman of the Committee of Consultants, his report was presented by E. A. Cross; after which Professor L. T. Rutledge presented the report of the Committee on the Recording of Engineers-in-Training. He pointed out that provisions were being made for the recording as engineers-in-training of graduates, undergraduates and students serving under articles who have insufficient experience to be granted registration.

Mr. S. R. Frost presented the report of the Finance Committee which indicated the healthy financial position of the Association.

The report of the Publicity Committee was presented by Mr. R. A. Elliott; Mr. W. C. Miller presented the report of the Legislation Committee; Mr. J. Clark Keith, the report of the Committee on By-Laws and Code of Ethics; and Mr. N. G. McDonald, the report of the Board of Examiners. Mr. D. A. R. McCannel briefly reviewed the activities of the Dominion Council during the past year.

The highlight of the meeting was the report presented by Mr. W. P. Dobson, chairman of the special committee on the remuneration of salaried engineers. In this report, the committee requested that the Association recommend the principle "Job Evaluation" as a fair criterion in determining the salaries of employees and render every assistance possible to corporations endeavouring to use this principle in their plants. Mr. J. O. Arrowsmith, explained the meaning of "Job Evaluation" and used lantern slides for illustration.

Mr. A. E. MacRae of Ottawa moved a vote of thanks to the 1940 Council for the excellent report which they gave of their activities and stated that the membership was indebted to them for the time they had devoted to the affairs of the Association. He paid particular tribute to Mr. Rawlins, the past-president who had been a member of Council since 1926.

In closing, Mr. Rawlins introduced the 1941 Council to the members.

Approximately 250 members were present at the dinner which immediately followed when Mr. George C. Bateman, president of the Canadian Institute of Mining and Metallurgy and Metals Controller of Canada spoke on the subject, **The Role of the Engineer in Peace and War.**

Mr. J. W. Rawlins, retiring president, occupied the chair. Grace was asked by Canon H. J. Cody, president of the University of Toronto. A toast to the sister professions was proposed by Mr. D. A. R. McCannel, president of the Dominion Council of Professional Engineers and replied to by Dr. A. B. Whytock, president of the Ontario Medical Association.

The speaker of the evening was introduced by the Hon. Charles McCrae, former Minister of Mines for Ontario. Others at the head table were: Mayor F. J. Conboy, representing the City of Toronto; A. J. Hazelgrove, representing the Ontario Association of Architects; Peter White, K.C., representing the Law Society of Upper Canada; J. Clark Keith, representing the Engineering Institute of Canada; G. E. Berkeley, representing the Ontario Land Surveyors; F. W. MacNeill, representing the Association of Professional Engineers of British Columbia; C. C. Kirby, representing the Association of Professional Engineers of New Brunswick; Major F. S. Milligan, District Engineering Officer, M.D. No. 2; Professor R. E. Jamieson, representing the Corporation of Professional Engineers of Quebec; E. P. Muntz, representing the National Construction Council; R. C. Poulter, representing the Affiliated Engineering & Allied Societies in Ontario; S. R. Frost, president-elect; W. C. Miller, vice-president-elect; W. P. Dobson, a past-president of the Association; and Lieut.-Col. A. D. LePan also a past-president of the Association.

Certificates were presented by the Chairman to the two students who had won the bursaries of the Association in 1940: Mr. V. M. Wallingford of the University of Toronto and Mr. Norman Grandfield of Queen's University.

Mr. J. W. Rawlins, the retiring president, installed into office Mr. Stanley R. Frost, the incoming president.

Meeting of the Dominion Council of Professional Engineers held at the Royal York Hotel, Toronto, on January 20th and 21st, 1941; From left to right—J. W. Rawlins, Past-President of the Ontario Association; Prof. H. R. Webb, representing the Alberta Association; P. Burke-Gaffney, representing the Manitoba Association; J. C. Oliver, Registrar of the British Columbia Association; F. W. MacNeill, representing the British Columbia Association; M. Barry Watson, Secretary-Treasurer; D. A. R. McCannel, representing the Saskatchewan Association; C. C. Kirby, representing the New Brunswick Association; F. W. W. Doane, representing the Nova Scotia Association; Prof. R. E. Jamieson, representing the Quebec Corporation and W. P. Dobson, representing the Ontario Association.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF NOVA SCOTIA 1941 ANNUAL MEETING

The 1941 Annual Meeting of the Association of Professional Engineers of Nova Scotia was held in the Mechanical Laboratory Building of the Nova Scotia Technical College, Halifax, N.S., on Thursday, January 23rd, 1941, commencing at 2.30 p.m.

The president, Mr. R. B. Stewart, was in the chair and about fifty members were present.

The president reported that during the year past four meetings of the Council had been held at which the usual committees had been appointed, applications for membership considered and routine business discussed.

The agreement between the two engineering bodies of the province, which had been consumated at the 1940 joint banquet had resulted in a very close co-operation of the two. Of our present membership of 232, some 199 are members of both the Institute and the Association, and some 33, of which 12 are outside of the province and not eligible for membership in the Nova Scotia branches of the Institute, are members of the Association only.

The question of bringing the graduate engineers, who are not as yet eligible for membership, more closely in touch with the activities of the Association was given a good deal of attention during the year. A by-law with this in view drafted by a special committee and approved by Council was submitted to the Association by letter ballot at the end of the year.

In conclusion, the president thanked the members of Council for their help and co-operation during the year and especially the past president, Mr. Gray, and President-Elect Allan for their valuable help on Council.

The registrar reported a total membership of 231.

Members of Association only in the province	18
Members of Association outside of the province	12
Members of Association and E.I.C.	201
	231

Of the total joint members, 14 were admitted by direct application to the Association and 36 were admitted by application through the E.I.C. branches during the year. 79 Association members took advantage of the co-operative agreement.

Professor Copp asked the opinion of the meeting regarding the appointment of a central examining board as proposed by the Dominion Council. In this connection the president read F. W. W. Doane's report of proceedings at the last Dominion Council meeting as published in the Association's 1939 Year Book, which showed that Mr. Doane did not look very favourably on the proposition. Considerable discussion ensued and the consensus of opinion expressed seemed to indicate that our Association could not see the necessity for the appointment of a central examining board.

The financial statement showed income during the year of $2,850.86. Expenditures amounted to $2,585.51 leaving a balance for the year of income over expenditure of $265.35 which included dues paid in advance of $130.00. The balance carried from 1939 amounted to $994.50 making a deposit in the bank of $1,259.85 at December 31st, 1940.

Assets including investments, accrued interest and amounts outstanding estimated collectable $6,179.00 and liabilities nil.

The scrutineers reported on amendments to by-laws as follows:

For the amendment, 97; against the amendment, 3; spoiled ballots, 1; for officers of the Association, the scrutineers reported as follows:

President, J. L. Allan; Vice-President, D. G. Dunbar; Councillors: Dr. A. E. Cameron, Professor W. P. Copp, J. R. Morrison and J. K. McKay.

President Stewart thanked the retiring councillors for their support and warmly welcomed the newly elected president and officers of the Association.

Mr. Allan then took the chair and expressed the hope that he and the newly elected officers would be able to carry on the business of the Association as successfully as the retiring president and 1940 officers had done.

The joint banquet which followed is reported in the news of the branches section of this issue, under Halifax Branch.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF ALBERTA

In accord with the by-laws, the Nominating Committee appointed following the Annual Meeting on March 30, 1940, has nominated the following slate for the vacancies to be filled on Council:

President: W. E. Cornish; Vice-Presidents: S. G. Coultis, L. C. Stevens; Civil Councillors: G. P. F. Boese, C. S. Clendening; Electrical Councillors: W. I. McFarland, R. D. Wagner; Mechanical Councillors: R. R. Couper, W. S. White; Mining Councillors: C. S. Donaldson, A. C. Dunn.

Annual Meeting

The Annual Meeting will be held on March 22, 1941, so nominations made under this clause should be in the hands of the Registrar on or before February 10, 1941.

Ballot on Classification

The Engineering Profession Act of the Province of Alberta divides the membership for voting purposes and for election of councillors, into four groups, namely: civil, electrical, mechanical and mining engineering. Modern engineering embraces so many additional branches as well as specialized subdivisions of these four main classifications, that many members felt that they were wrongly classified. A committee was appointed to study the question and the recommendation was to the effect that steps be taken to have the Act amended to abolish all such classification of members and that Council should be nominated from the membership at large.

On receipt of this report the 20th Annual Meeting, held in March, 1940, felt that it was a matter on which all members should express an opinion and that a ballot should therefore be sent out to obtain the views of all members.

The results of the ballot, canvassed last December, show that 131 members voted in favour of the abolition of the classification and 16 were against such amendment.

Library Notes

Book notes, Additions to the Library of the Engineering Institute, Reviews of New Books and Publications

ADDITIONS TO THE LIBRARY

TECHNICAL BOOKS

Analytical Mechanics for Engineers:
By Fred B. Seely and Newton E. Ensign, New York, John Wiley & Sons, 1941. 450 pp., 6 x 9¼ in. $3.75.

Experimental Electrical Engineering:
By V. Karapetoff revised by Boyd C. Dennison. 4th ed., New York, John Wiley & Sons, 1941. 814 pp., 6 x 9¼ in. $7.50.

Mastering Momentum:
By Lewis K. Sillcox, New York, Simmons-Boardman Publishing Corporation, 1941. 274 pp., 6¼ x 9¼ in. $2.50.

Metallurgy of Deep Drawing and Pressing
By J. Dudley Jevons, New York, John Wiley & Sons, 1940. 699 pp., 10 x 6 in., $10.00.

Practical Solution of Torsional Vibration Problems:
By W. Ker Wilson, New York, John Wiley & Sons, 1940. 731 pp., 8¾ x 5½ in., $8.00.

Simplified Design of Roof Trusses for Architects and Builders:
By Harry Parker, New York, John Wiley & Sons, 1941. 195 pp., 5 x 8 in. $2.75.

Storage Batteries:
By George Wood Vinal, New York, John Wiley & Sons, 1940. 464 pp., 6 x 9¼ in.

PROCEEDINGS, TRANSACTIONS

Institution of Mechanical Engineers:
Proceedings, Vol. 143, 1940.

Junior Institution of Engineers:
Journal and Transactions, Vol. 50, 1939-1940.

REPORTS

Bell Telephone System:
Co-ordination of Power and Communication Circuits for Low-frequency Induction; Feedback Amplifier Design; Crosstalk between Coaxial Conductors in Cable; Analysis of the Ionosphere; Crosstalk in Coaxial Cables; Compressed Powdered Molybdenum Permalloy; High Accuracy Heterodyne Oscillators; High-gain Amplifier for 150 Megacycles; Sound Measurement Objectives and Sound Level Meter Performance; Helium the Superfluid; Rectilinear Electron Flow in Beams; Temperature Effects in Secondary emission; X-ray Examination of Polyisobutylene; The Subjective Sharpness of Simulated Television Images; Cross-modulation in Multichannel Amplifiers; Manufacture of Quartz Crystal Filters; The Carrier Nature of Speech Radio Extension Links to the Telephone System; Results of the World's Fair Hearing Tests; Equilibrium Relations in the Solid State of iron-cobalt System; Studies in Boundary Lubrication-1; Ultra-short-wave Transmission over a 39 Mile "Optical" Path.

Canada Department of Mines and Resources—Mines and Geology Branch—Geological Survey Memoirs:
Geology of the Southern Alberta Plains by L. S. Russell and R. W. Landes, Ottawa, 1940. Memoir 221.

Canada Department of Mines and Resources—Mines and Geology Branch—Geological Survey Papers:
Preliminary Map George Creek, Alberta, Paper 40-17; Preliminary Report Natural Gas in Brantford Area, Ontario, Paper 40-22.

Canadian Engineering Standards Association:
Standard Specification for Western Red Cedar Poles, C 15 (B), 1940; Standard Specifiction for Creosote Preservative Treatment of Red, Jack and Lodgepole Pine Poles and Reinforcing Stubs by Pressure Process C 15 (D), 1940; Standard Specification for Red, Jack and Lodgepole Pine Timber for Poles and Reinforcing Stubs C 15 (C), 1940.

Electrochemical Society—Preprints:
High Temperature Metallic Resister Furnaces; The Photovoltaic Effect; The Constitution and Properties of Cyanide Plating Baths; Investigation of Lead Anodes in the Electrolysis of Zinc Sulfate Solutions; Preprints No. 79-5 to 79-8.

Metropolitan Water District of Southern California:
Annual Report for the Period July 1, 1938, to June 30, 1940.

Montreal Light Heat & Power:
Twenty-fourth Annual Report, 1940.

National University of Ireland:
Calendar for the Year 1939.

U.S.Department of Commerce—Building Materials and Structures:
Structural Properties of Two Nonreinforced Monolithic Concrete Wall Constructions, BMS 61.

U.S. Department of the Interior—Geological Survey Bulletin:
Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma, 900-E; Tungsten Deposits of the Atolia District San Bernardino and Kern Counties, California, 922-H; Antimony Deposits of a Part of the Yellow Pine District Valley County, Idaho, 922-I; Antimony Deposits of the Wildrose Canyon Area, Inyo County, California, 922-K; Tin Deposits of the Black Range Catron and Sierra Counties, New Mexico, 922-M.

U.S. Department of the Interior—Geological Survey Water Supply Paper:
Ohio River Basin, Pt. 3, Paper 853.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet the books are not in the Institute Library, but inquiries will be welcomed at headquarters, or may be sent direct to the publishers.

A.S.T.M. STANDARDS ON COAL AND COKE
Prepared by Committee D-5 on Coal and Coke, December, 1940. American Society for Testing Materials, Phila., Pa. 126 pp., illus., diagrs., charts, tables, 9 x 6 in., paper, $1.25.

The various A.S.T.M. methods of testing, definitions and specifications for coal and coke are brought together in convenient form, together with the standard specifications for the classification of coal according to rank and grade. Among the thirty-four standards given is one covering the sieves used for testing.

A.S.T.M. VISCOSITY INDEX TABLES. 31 pp., 50c.

A.S.T.M. CONVERSION TABLES FOR KINEMATIC AND SAYBOLT UNIVERSAL VISCOSITIES. 10 pp., 25c.
American Society for Testing Materials, Phila., Pa., tables, 9 x 6 in., paper.

The viscosity tables, which are based on the tentative method for calculating the viscosity index, provide a tabulation of the index, calculated from basic Saybolt universal viscosity, against Saybolt at 100 seconds under Saybolt values at 210 degrees fahrenheit for 40 seconds to 161 seconds.

The conversion tables, which are based on the standard method for the conversion of kinematic viscosity to Saybolt universal viscosity, provide a quick conversion. The tables range from 2.00 to 330.0 centistokes by increments of 0.01, 0.02, 0.10 and 0.20, depending on the range.

The two tables are particularly of interest in the field of petroleum products and lubricants.

AIRPLANE METAL WORK. Vol. 2: Airplane Sheet Metal Shop Practice.
By A. M. Robson. D. Van Nostrand Co., New York, 1940. 109 pp., illus., blueprints, tables, 10 x 7 in., paper, $1.25.

This book is intended for mechanics actively engaged in the aircraft industry and for prospective mechanics in training. Following a general discussion of work habits and conduct, the author presents practical information about specific job operations and shop practices, including questions and answers. There is also a full list of tool and miscellaneous equipment and other supplies for the airplane sheet-metal shop.

APPLIED CHEMISTRY FOR ENGINEERS
By E. S. Gyngell. Edward Arnold & Co., London; Longmans, Green & Co., New York, 1940. 328 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, $4.00.

The chemistry of materials and processes used by the engineer is dealt with in a practical manner. Major topics discussed are fuels and combustion, metallic corrosion, paints and varnishes, water treatment and sewage disposal, cements, and lubrication. Metallurgy is omitted because of its large scope and good coverage elsewhere. No details are given of methods of analysis or testing, but books covering these phases are included in the selected bibliographies.

AUDEL'S SHIPFITTER'S HANDY BOOK
By R. Newstead. Theo. Audel & Co., New York, 1940. 252 pp., illus., diagrs., charts, tables, 7 x 5 in., cloth, $2.00.

This practical treatise on steel shipbuilding and repairing is presented in simple form for the benefit of the average ship worker. All phases of ship construction are covered, including production planning and modern welding practice. There are a glossary of marine and shipbuilding terms, a list of terms and abbreviations for marking plates and templates, and many helpful illustrations.

(The) AXIAL ADJUSTMENT OF DEEP-WELL TURBINE PUMPS. (University of California Publications in Engineering, Vol. 4, No. 2, pp. 19-26)
By M. P. O'Brien and R. G. Folsom. University of California Press, Berkeley and Los Angeles, Calif., 1940. 25 pp., illus., diagrs.k charts, tables, 11 x 18 in., paper, 25 cents.

The effect of axial adjustment on deepwell turbine pumps is considered to depend upon the impeller design. Results of experimental investigations are presented showing the effect and reactions with both semi-open and closed impellers.

COFFERDAMS

By L. White and E. A. Prentis. Columbia University Press, New York, 1940. 273 pp., illus., diagrs., charts, maps, tables, 9½ x 6 ins., cloth, $7.50.

Based largely on experience gained by the authors during several years of work along the Mississippi River, this practical manual contains the essentials of scientific cofferdam construction. Hydrodynamic considerations, erosion and earth pressures are discussed as well as the construction of representative types. The book is well illustrated and contains a brief glossary and a bibliography.

(The) DESIGN OF HIGH PRESSURE PLANT AND THE PROPERTIES OF FLUIDS AT HIGH PRESSURES

By D. M. Newitt. Clarendon Press, Oxford, England; Oxford University Press, New York, 1940. 491 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, $10.00.

The first part of this book is devoted to the kinds and properties of materials used in the construction of high-pressure plant and equipment, the calculation of the stresses and strains which must be dealt with, practical design data and the measurement of high pressures. In part II the pressure-volume-temperature relationships of gases and liquids, the equation of state problem and the influence of pressure upon such properties as viscosity, solubility and refractivity are discussed. Details of experimental methods and procedure are given where necessary, and numerous illustrations and tables of data are included in the text and in appendixes.

ELECTRICAL MEASUREMENTS AND MEASURING INSTRUMENTS

By E W. Golding. 3 ed. Sir Isaac Pitman & Sons, London; Pitman Publishing Corp., New York, 1940. 828 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, $7.50.

Originally designed to cover the knowledge required for certain British examinations, this textbook has been expanded to meet the requirements of electrical engineers in general. The theory and use of all types of electrical measuring instruments and methods are comprehensively covered, including the mathematical derivations for wave-forms and transient phenomena. Refcrence bibliographies appear at the ends of the chapters, and there is a large group of examination questions with answers.

ELECTROMAGNETIC THEORY

By J. A. Stratton. McGraw-Hill Book Co., New York and London, 1941. 615 pp., diagrs., charts, tables, 9 x 6 in., cloth, $6.00.

In this advanced text the author places primary emphasis on dynamic rather than static field theory, postulating Maxwell's equations from the outset. A mathematical formulation of the general theory is followed by a comprehensive investigation of energy and stress relations. The properties of static fields are then discussed, and the rest of the book is devoted to the propagation of plane, cylindrical and spherical waves, the theory of radiation, and boundary-value problems. There are groups of illustrative problems.

ELEMENTARY ENGINEERING THERMODYNAMICS

By V. W. Young and G. A. Young. 2 ed. McGraw-Hill Book Co., New York and London, 1941. 243 pp., diagrs., charts, tables, 9½ x 6 in., cloth, $2.75.

This textbook presents the fundamental theoretical basis for an accompanying course in practical heat engineering. All important topics are covered in a simple, concise manner, with many illustrative examples. The new edition makes use of the more modern Keenan and Keyes steam tables, which were not available for the first edition.

EXPLORATION GEOPHYSICS

By J. J. Jakosky. Times-Mirror Press, Los Angeles, Calif., 1940. 786 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $8.00.

The chief object of this book is to describe the fundamental theories, equipment and field techniques of the recognized exploratory geophysical methods, and to illustrate their application to problems of economic geology. An early chapter presents the geologic and economic background, and succeeding chapters deal respectively with magnetic, gravitational, electrical, siesmic, geochemical and geothermal methods. Drill hole investigations and oil well production problems are also considered. In addition to literature references in the text there is a patent bibliography appended to each chapter.

EXTERIOR BALLISTICS, a reprint of Chapters X and XII from "Elements of Ordnance"

By T. J. Hayes. John Wiley & Sons, New York, 1940. 98 pp., illus., diagrs., charts, tables, 9 x 6 in., paper, $1.00.

This pamphlet contains two chapters of Hayes's "Elements of Ordnance", the textbook used by cadets at West Point. These chapters deal with Exterior Ballistics and Bombing from Airplanes, two subjects of direct interest in courses of study connected with the national defense programme. The reprint makes the text available at a modest price.

GEAR DESIGN SIMPLIFIED

By F. D. Jones. 2 ed. Industrial Press, New York, 1940. 139 pp., diagrs., charts, tables, 11½ x 8½ in., cloth, $3.00.

The book consists of a series of charts which illustrate, by simple diagrams and examples, the solution of practical problems of gear design. The types included arc spur, straight-tooth and spiral-bevel, helical, herringbone and worm gears. Information is also provided upon the determination of gearing ratios and speeds and on the power-transmitting capacity of gears. This second edition also contains definitions, a method for checking spur gears, and a table of steels for industrial gearing.

GEOPHYSICAL EXPLORATION

By C. A. Heiland. Prentice-Hall, New York, 1940. 1,013 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $10.00.

This book is intended as a comprehensive survey of the entire field of geophysical exploration, emphasizing the relations, differences, common features and fundamentals of geophysical methods. The elementary first part describes working principles and geological applications for those not directly concerned with field or laboratory operations. The second and major part discusses the subject from an engineering viewpoint, presenting theory, field technique, laboratory procedure and geological interpretations for gravitational magnetic, seismic and electrical methods. Consideration is also given to minor methods and to geophysical well testing.

HIGH POLYMERS. Vol. 2. PHYSICAL CHEMISTRY OF HIGH POLYMERIC SYSTEMS

By H. Mark. Interscience Publishers, New York, 1940. 345 pp., diagrs., charts, tables, 9¼ x 6 in., cloth, $6.50.

This book gives a survey of the physical and chemical methods which have proved necessary and effective in the preparation, purification, examination and elucidation of the structure of the high polymers. It shows how and with what restrictions the fundamental laws of physical chemistry can be applied to this group of chemical compounds which play such an important role in science and industry as plastics, proteins, rubber, etc. The text material is well documented.

HISTORY OF GEOMETRICAL METHODS

By J. L. Coolidge. Clarendon Press, Oxford, England; Oxford University Press, New York, 1940. 451 pp., diagrs., tables, 10 x 6 in., cloth, $10.00.

The methods which men have invented throughout the centuries to deal with geometrical questions are considered under three main headings: synthetic geometry, the earliest type which considers figures directly; algebraic geometry, including co-ordinate systems; and differential geometry. The work of the important pioneers in each field has been emphasized. There is a large bibliography.

HOISTING MACHINERY

By W. H. Atherton. Technical Press, London, 1940. 314 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, 32s. 6d.

This practical volume deals with the design, construction, maintenance and uses of the types of material handling equipment which perform intermittent short-range movements: cranes, derricks, grabs, skip hoists, stackers, telphers and transporters. There are many helpful illustrations, and literature references appear both in the text and in a brief bibliography at the end.

HOUSING FOR DEFENSE

By M. L. Colean. Twentieth Century Fund, 330 West 42nd St., New York, 1940. 198 pp., diagrs., tables, charts, maps, 9½ x 6 in., paper, $1.50.

The problems and experience with regard to housing during the last war are described, with considerable attention to the resulting government policies. The present situation is compared with the past. The relation between housing and the location of defense activities is emphasized, and community problems are discussed. The final chapters deal with the construction and financing of new housing, the relative parts to be played by private and governmental agencies, and the recommendations of the housing committee.

INTRODUCTION TO THE KINETIC THEORY OF GASES

By Sir J. Jeans. The Macmillan Co., New York; University Press, Cambridge, England, 1940. 311 pp., diagrs., charts. tables, 9 x 5½ in., cloth, $3.50.

This book provides such knowledge of the kinetic theory as is required by the serious student of physics and physical chemistry. In the discussions of pressure in a gas, molecular collisions, viscosity, heat conduction, diffusion, etc., the emphasis is on the physicist's needs although the mathematical student will find the necessary basic material from which to proceed to more specialized study.

LACQUER AND SYNTHETIC ENAMEL FINISHES

By R. C. Martin. D. Van Nostrand Co., New York, 1940. 526 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $5.20.

The subject of discussion is the cellulose nitrate and acetate basic lacquers and synthetic enamels as developed in the twentieth century. Part I deals with nitrocellulose, solvents, plasticisers, resins and synthetic compounds, and pigments. Parts II and III cover plant and equipment, requirements, types, formulation, laboratory and field tests, and faults and corrections. Part IV describes methods of application and the finishing of furniture and motor cars. There is a very large glossary of paint, varnish, lacquer and allied terms.

LOCOMOTIVES ON PARADE

By E. Hungerford. Thomas Y. Crowell Co., New York, 1940. 236 pp., illus., woodcuts, diagrs., charts, 9 x 6½ in., cloth, $2.50.

The history of one of the very important mechanical contributions of the last century, the steam locomotive, is told in layman's language. The successive types that evolved are described, including famous individual representatives and the men whose insight and mechanical genius made them possible. There are many photographs and line drawings.

(THE) METER AT WORK

By J. F. Rider. John F. Rider, Publisher, New York, 1940. 152 pp., illus., diagrs., charts, tables, 9 x 5 in., cloth, $1.25.

This practical book for servicemen and others who employ electric meters in radio and allied electronic arts describes how each type of meter works, how each is used in the field, how to increase efficiency and how to select new meters. An unusual method of book construction, which places the illustrations above and separate from the text, makes reference from one to the other more convenient.

MODERN AIR CONDITIONING, HEATING AND VENTILATING

By W. H. Carrier, R. E. Cherne and W. A. Grant. Pitman Publishing Corp., New York and Chicago, 1940. 547 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $4.50.

The whole field of interior conditioning is covered in this manual, which is designed to apply existing theory to actual practice in the industry. Basic theories are explained, but emphasis is placed on the engineering principles and design of equipment. Comfort and economic factors are also considered. Practical examples are presented and worked out in detail, and many useful tables and charts have been collected in an appendix.

MODERN ROAD EMULSIONS

By F. H. Garner, L. G. Gabriel and H. J. Prentice. 2 ed. Road Emulsion and Cold Bituminous Roads Association Ltd., 11 Bow Church Yard, London, E.C.4, 1939. 245 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, 10s.

The purpose of this book is to present the underlying principles and properties of bituminous emulsions and their behavior on the road. Some historical material, methods and plant for the transport and application of emulsions, and many tests and specifications are also included. There is a bibliography.

NATIONAL ELECTRICAL CODE HANDBOOK

By A. L. Abbott. 5 ed. McGraw-Hill Book Co., New York and London, 1940. 595 pp., illus., diagrs., charts, tables, 7½ x 4½ in., lea., $3.00.

The provisions of the National Electrical Code are discussed and their practical application is explained. These provisions are grouped into six major divisions: definitions of terms; approved types of wiring; installation of materials and apparatus; general requirements applying to all wiring systems; special cases; and construction of materials. The present edition is based on the 1940 Code.

PHYSICS OF THE AIR

By W. J. Humphreys. 3 ed. McGraw-Hill Book Co., New York, 1940. 676 pp., illus., diagrs., charts, maps, tables, 9½ x 6 in., cloth, $6.00.

This text provides a comprehensive account of the facts and theories relating to the mechanics and thermodynamics of the atmosphere, to atmospheric electricity, acoustics and optics, and to the factors that control climate. This edition has been revised to include recent information.

POWER IN TRANSITION

By E. R. Abrams. Charles Scribner's Sons, New York, 1940. 318 pp., maps, tables, 8½ x 5½ in., cloth, $3.00.

The development of the electrical utilities is briefly described up to the peak of private operation. In the succeeding chapters the growing tendency toward public control is considered. Some sixty major power projects are analyzed, their history through Congress is traced, engineering problems are discussed, and the resources, requirements and expectations of the several regions to be served are carefully detailed. Probable effects of these developments of the national power policy are briefly pointed out in a final chapter. There are chapter bibliographies.

PRACTICAL TUNNEL DRIVING

By H. W. Richardson and R. S. Mayo. McGraw-Hill Book Co., New York and London, 1941. 436 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $5.00.

This practical text and reference book for engineers and contractors covers all phases of tunneling and all kinds and classes of tunnels. All steps, from the engineering fundamentals to completion of the project, are considered, including full discussion of location, investigation and planning of the project, design, construction and economics. Attention is paid to such practical details as track layout, size of cars, timbering, explosives, etc., and there is a brief history of tunneling.

PRELIMINARY AIRPLANE DESIGN

By R. C. Wilson. Pitman Publishing Corp., New York and Chicago, 1941. 67 pp., diagrs., charts, tables, 8½ x 5 in., cloth, $1.00.

This brief, simple text is based upon the practical procedure used as a guide for instruction at the Air Corps Engineering School at Wright Field. All preliminary design factors are considered, and an appendix contains sample data sheets and weight control tables.

SEWAGE-TREATMENT WORKS

By C. E. Keefer. McGraw-Hill Book Co., New York, 1940. 673 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $6.00.

The administration and operation of sewage plants are discussed in a thorough, practical manner, with emphasis on the processes of treatment that are in wide use today. The author describes the various types of modern equipment, tells how they perform, outlines operating methods and discusses costs. The quantity and composition of sewage from institutions, municipalities and industrial plants are also given.

STEEL CASTINGS HANDBOOK

Steel Founders' Society of America, Cleveland, Ohio, 1941. 503 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $2.00.

Full of diagrams, data tables and photographs, this practical handbook covers the cast-steel industry from history to commercial applications. The physical, mechanical and engineering properties of carbon and low alloy cast steels are given in detail; production and heat-treatment methods are described; design procedure is considered; and a glossary of foundry terms is included. There are chapter references.

STORAGE BATTERIES

By G. W. Vinal. 3 ed. John Wiley & Sons, New York, 1940. 464 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $5.00.

This standard textbook is a comprehensive treatise on the theory of batteries, charging methods and equipment, the care of batteries and remedies for troubles encountered. The physical and chemical properties of storage battery materials are discussed, and manufacturing methods are described. There is a long chapter on present-day uses for storage batteries. The present edition has been considerably revised.

STRESS ANALYSIS AND DESIGN OF ELEMENTARY STRUCTURES

By J. H. Cissel. John Wiley & Sons, New York, 1940. 335 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $4.00.

Fundamental and practical material which would generally be of value to an engineer in any field is presented in this textbook, which is primarily intended for engineering students other than civil. The section on stress analysis covers external forces and loads, graphic statics, beams, trusses, masonry structures and foundations. The elementary design section covers structural fastenings and connections, timber, steel and reinforced concrete beams and columns.

TEXTILE RECORDER YEAR BOOK, 1940

Edited by W. Hubball and others. Harlequin Press, Manchester, England. Illus., diagrs., charts, tables, 7 x 5 in., cloth, 10s. 6d.

Encyclopedic in scope, this annual publication furnishes technical information upon the production, preparation, spinning, weaving, dyeing and finishing of all textile fibers. There are also sections on hosiery and knitting, microscopy and testing, and power transmission. Patent and trade mark information is given, and a classified list of recently introduced textile machines and appliances is included.

THOMAS' REGISTER OF AMERICAN MANUFACTURERS, 31st ed., Dec., 1940

Thomas Publishing Co., New York, Boston, Phila., San Francisco, Toronto, Can., 1941. 5,000 pp., illus., 14½ x 9 in., cloth, $10.00 to former subscribers, $15.00 to new subscribers.

This huge annual directory of American manufacturers has its customary three main sections: the classified directory of products (with index) in which the firms are listed, with capital ratings, geographically under each product; the alphabetical list of manufacturers, giving addresses, subsidiaries, branches, etc.; and the trade name index. The innovation, introduced in the previous edition, of assigning arbitrary numbers to advertisers, including a "key" index, has been expanded in the present volume.

TRENDS IN INDUSTRIAL PENSIONS (Industrial Relations Monograph No. 5)

By M. W. Latimer and K. Tufel. Industrial Relations Counselors, New York, 1940. 88 pp., tables, 9½ x 6 in., paper, $1.00.

The objectives of this monograph, which analyzes some 350 active company pension plans, are: first, to determine whether the characteristics and trends of pension systems have changed in the last seven years, and, if so, in what direction; second, to analyze the growth or decline and the present extent of the voluntary pension movement; and third, to consider the adaptation of private pension systems to governmental old age insurance legislation. The numerical findings of the investigation appear in a group of tables.

WELDING METALLURGY. Vols. 1 and 2

By O. H. Henry and G. E. Claussen. American Welding Society, New York, 1940. 359 pp., illus., diagrs., charts, tables, 8 x 5 in., cloth, $1.50.

Intended to familiarize members of the welding industries, including fabricators and designers, with the metallurgical aspects of the welding process, this book deals with the structure, properties and composition of welded materials. It shows how the steel is affected by varied conditions of heat and stress, explains heat treatment procedure and points out the way in which metallurgy can be used to control the welding process.

BIBLIOGRAPHY ON AIRPLANE HANGARS

Current interest in all matters connected with aviation has prompted the Engineering Societies Library to prepare a list of references on the Design and Construction of Airplane Hangars. The list includes one hundred articles selected from those published during the years 1928-1940 in the leading domestic and foreign periodicals, and contains material on both steel and reinforced concrete structures. Copies may be obtained by sending two dollars to Engineering Societies Library, 29 West 39th Street, New York.

PRELIMINARY NOTICE

of Applications for Admission and for Transfer

February 25th, 1941

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, 1941.

L. Austin Wright, General Secretary.

*The professional requirements are as follows:—

A 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 attainment 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

AGNEW—ELLIS A., of Hamilton, Ont. Born at Toronto, Ont., April 4th, 1900; Educ.: B.A.Sc., Univ. of Toronto, 1924; 1924-29, technical control of mfg., The Carborundum Co., Niagara Falls, N.Y.; 1929-32, plant supt., Lion Grinding Wheels Ltd., Brockville, Ont.; 1932 to date, vice-president i/c of engrg., design and mfg. of stokers, and ventilating and air conditioning equipment, Livingston Stoker Co. Ltd., Hamilton, Ont.

References: W. A. T. Gilmour, W. J. W. Reid, C. H. Hutton, W. L. McFaul, H. S. Philips.

BALLANTYNE—SPENCER THOMAS, of Ottawa, Ont. Born at New York, N.Y., Oct. 5th, 1914; Educ.: 1934-36, Queen's Univ. (Completed first year engrg.) 1935, rodman, Geol. Survey of Canada; 1937-38, plant design, mech. dfting, etc., and 1939 to date, asst. engr. and dftsman., The General Supply Co. of Canada Ltd., Ottawa, Ont.

References: R. E. Hayes, R. M. Prendergast, B. G. Ballard, J. L. Rannie, N. F. Ballantyne.

CRAWFORD—EARL WILLIAM, of Three Rivers, Que. Born at Port Dalhousie, Ont., Apr. 23rd, 1916; Educ.: B.Sc. (App. Sci.), Univ. of Mich., 1936; Regd. Engr., State of New York, 1940; 1932-35, student engr., divn. of highways, Dept. of Public Works, State of New York; 1936-38, special ap'tice (junior designing engr.), Ingersoll Rand; 1938 to Sept. 1940, asst. plant engr., Allied Chemical & Dye Co., New York; Sept. 1940 to date, staff mechanic, Machine Gun Training Centre, M.D. No. 4, Three Rivers (Transferring to R.C.O.C. as Ordnance Mech. Engr.).

References: R. W. Angus, T. F. Francis, H. D. Fyfe.

DANKS—CYRIL NORWOOD, of Toronto, Ont. Born at London, Ont.; May 21st, 1886; Educ.: S.P.S. Diploma, Univ. of Toronto, 1909; 1909-12, dftsman., Canadian Ingersoll-Rand, Sherbrooke, Que.; 1912-14, compressor and drill designer, Jenckes Machine Co., Sherbrooke; with the Canadian Ingersoll-Rand Co. as follows: 1914-15, shell lathe and tool designer; 1915-17, i/c dept. mfg. shell lathes and tools, and triple expansion marine engines; 1917-18, asst. supt. of munitions, 1918-21, misc. engrg. duties; 1921-24, engr. to sales dept., Montreal; 1924-40, engr. i/c of compressor div., Montreal; 1940 to date, Ontario district engr., Toronto, Ont.

References: J. B. Challies, L. A. Wright, R. W. Angus, S. R. Newton, E. Winslow-Spragge, H. L. Vercoe, G. Kearney, E. T. Harbert.

DUNCAN—WILLIAM ARCHIBALD, of 71 Jackson Ave., Toronto, Ont. Born at Sault Ste. Marie, Ont., Oct. 27th, 1900; Educ.: B.A.Sc., Univ. of Toronto, 1928. R.P.E. of Ont.; 1919-21, roadway dept., City of Toronto; 1921-26, Dept. of Provincial Highways, road and bridge bldg., etc.; 1926-27, highway resurfacing, Bituminous Spraying & Contracting Co. Ltd.; 1928-34, asst. service engr., 1934-36, service engr., and 1936 to date, manager, process service, Dominion Oxygen Co. Ltd., Toronto, Ont.

References: D. S. Lloyd, C. H. Mitchell, C. M. Pitts.

DYER—FREDERICK FRANK, of 322 Blanche St., Sarnia, Ont. Born at Toronto, Sept. 13th, 1908; Educ.: B.A.Sc., Univ. of Toronto, 1931; 1928-29 (summers), mechanic, Durant Motors, Leaside; 1929, dftsman., James Morrison Brass Co.; 1931, design and dfting., Turnbull Elevator Co., Toronto; 1932 (9 mos.), factory supt., Cutting Ltd., Toronto; 1932-34 (3 terms), demonstrator in hydraulics, Univ. of Toronto; 1936, Canadian SKF Co., Toronto (carried on duties of chief engr. during his absence of 8 mos.); 1934-35, boiler and meter tests, combustion dept., and 1937 to date, design, calculations and dfting., gen. engrg. dept., Imperial Oil Ltd., Sarnia, Ont.

References: T. Montgomery, C. E. Carson, H. E. T. Haultain, R. W. Angus, J. C. Keith.

FOLGER—COLLAMER COVERDALE, of Kingston, Ont. Born at Kingston, Oct. 16th, 1875; Educ.: Special mining course, Queen's Univ., 1898; R. P. E. of Ont.; 1898-99, elec. and gas constrn. and repair work, etc., Hammond Reef Gold Mines; 1904-12, gen. supt. of gas and elec. divns. of utilities, Kingston; 1912 to date, gen. mgr. and constrn. engr., during reconstrn. of Kingston electric, gas and meter depts.

References: T. A. McGinnis, D. S. Ellis, L. F. Grant, A. Macphail, J. B. Baty.

JOHNSON—EDWIN LEWIS, of Brownsburg, Que. Born at Plumstead, Kent, England, Dec. 22nd, 1901; Educ.: B.Sc. (Mech.), McGill Univ., 1923; 1922-23, Willys Overland, Montreal; 1924-27, American Steel Foundries, Granite City and Chicago, Ill.; 1927-28 and 1929-39, asst. to works mgr., and 1940 to date, works mgr., Dominion Ammunition Divn., Canadian Industries Ltd., Brownsburg, Que.

References: C. H. Jackson, F. S. Keith, H. C. Karn, H. B. Hanna, A. B. McEwen.

LEHEUP—CHARLES SAMUEL HENRY, of 1509 Sherbrooke St. West, Montreal. Born at Ponders End, Middlesex, England, Jan. 14th, 1910; Educ.: 1926-33, Woolwich Polytechnic, London, England (Penfold Gold Medal 1933); A. M. Inst. Mech. Engrs. (England) 1938; at the Royal Arsenal, Woolwich, England, as follows: 1926-31, engrg. ap'tice, 1931, journeyman in drawing office, 1931-33, junior dftsman., 1933-36, 2nd Class dftsman., 1936, 1st Class dftsman., 1936-40, senior dftsman., April 1940 to date, asst. mech. engr., and at present member of United Kingdom Technical Mission to Canada.

References: E. A. Ryan, F. A. Combe, G. H. Kirby, W. Griesbach, F. G. Rutley.

MICHENER—JOSEPH STANLEY, of Ucluelet, B.C. Born at Red Deer, Alta., Nov. 11th, 1915; Educ.: B.Sc., Univ. of Alta., 1938; 1938-39, dept. of physics and engrg., National Research Council, Ottawa; 1939-40, propeller divn., Canadian Car & Foundry Co. Ltd., Point St. Charles, Montreal; at present, Flying Officer, R.C.A.F., Ucluelet, B.C.

References: T. R. Loudon, R. W. Boyle, R. H. Field, W. L. Saunders, E. H. McCann.

NOONAN—WILLIAM FLEMING, of Kingston, Ont. Born at Kingston, Aug. 31st, 1890; Educ.: B.Sc. (Civil), Queen's Univ., 1914; R.P.E. of Ont.; 1911-13 (summers), chainman, C.N.R., levelman, Dept. Rlys. and Canals; 1915-18, dftsman., Dept. of Militia; 1918-19, constrn. engr., Delora Smelting & Refining Co.; 1919-24, res. engr., 1924-28, asst. engr., and 1928 to date, divn. engr., Dept. of Highways of Ontario.

References: T. A. McGinnis, D. S. Ellis, L. F. Grant, J. B. Baty, A. Macphail.

RAWLINS—JAMES WALTER, of 27 Ava Road, Toronto, Ont. Born at Manchester, England, Feb. 9th, 1878; Educ.: B.Sc., Queen's Univ., 1901; R.P.E. of Ontario; 1901-12, chief chemist, Can. Copper Co. (Int. Nickel Co.); 1912-18, asst. smelter supt., 1918-27, metallurgist, 1927-31, asst. gen. supt., Nickel refinery, and 1931-35, technical asst. to gen. mgr., International Nickel Co. Ltd.; 1935 to date, semi-retired.

References: A. D. Campbell, J. C. Keith, E. P. Muntz, W. P. Dobson, W. E Bonn.

RUSZNYAK—GEZA, of 105 Garfield Ave., Toronto, Ont. Born at Budapest, Hungary, Oct. 6th, 1891; Educ.: 1909-13, Tech. Univ. in Budapest (a) Diploma of the Royal Hungarian Tech. Univ. (b) Master of Construction, 1913; 1913-14, architect in office of O. Kaufman, Berlin; 1915-18, Tech. Officer (1st Lieut.) in the War; 1921-22, chief architect, tech. dept., of the Hungarian Town's Bank; 1922-24, mgr., Hungarian Concrete Construction Co., Budapest; 1925-39, gen. mgr., The Hungarian Company for Constructions. On constrn. of various power plants, transformer and substations, pumping stations and pumping plants, apt. houses, ammunition factories, air raid shelters, etc.; at present, vice-president of The Commercial and Construction Co., New York and Toronto.

References: R. F. Legget, C. R. Young, J. J. Spence, E. A. Allcut, S. R. Frost.

(*Continued on page 163*)

Employment Service Bureau

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party. Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted upon request after a lapse of one month. All correspondence should be addressed to THE EMPLOYMENT SERVICE BUREAU, THE ENGINEERING INSTITUTE OF CANADA, 2050 Mansfield Street, Montreal.

SITUATIONS VACANT

ENGINEER with pulp and paper experience to become Assistant Chief Engineer in a large mill. Either a man who can fit into the position immediately, or a younger man who has the training and ability to work into it gradually. The initial salary to be paid will depend upon the qualifications of the applicant. This position holds an interesting future for the right man. Send applications with full particulars to Box No. 2209-V.

REQUIRED for large gold mining organization in West Africa, several mill shiftmen, mill men and electricians. Salaries up to £40, £32 and £40 respectively per month, free living quarters. Ocean passage paid and three months' leave granted per year at half pay. Yearly renewable contracts. Defence regulations do not permit wives to accompany husbands at this time. Apply Box No. 2258-V.

STEAM ENGINEER wanted by paper mill in Ontario. Applicants should be University graduates in mechanical engineering with experience in the generation and distribution of steam. Apply stating full particulars of education and experience, and giving references to Box No. 2283-V. Applications will not be considered from persons in the employment of any firm, corporation or other employer engaged in the production of munitions, war equipment, or supplies for the armed forces unless such employee is not actually employed in his usual trade or occupation.

COMBUSTION ENGINEER preferably a mechanical graduate with some fuel oil burner and steam boiler experience. Position with large company on peace time work and steady employment. Please write giving qualifications, age, salary expected, if bilingual, etc., to Box No. 2302-V.

EMPLOYERS!

Your attention is called to Page 133 of this issue which contains a table showing the number of engineers graduating this spring from Canadian universities. Additional information on available men may be obtained from our Bureau.

SITUATIONS WANTED

CHIEF ENGINEER—twenty years industrial construction, production and operation. Structures, equipment, steam, hydro. Experienced conferences, preliminaries, organizing, preparing plans, estimates, specifications, negotiation of contracts. Apply to Box No. 36-W.

ENGINEER—M.E.I.C. Age 49. Desires change. Experience covers all types structural steel and plate work, rivetted and welded construction, as estimator. Designing, shop drawings. Available two weeks notice. Apply Box No. 2208-W.

MECHANICAL ENGINEER, Draughtsman, specification writer, supervisor, specializing in heating, ventilating, power plants and plumbing, available immediately. Will go anywhere. Apply Box No. 2285-W.

PRELIMINARY NOTICE (*Continued from page 162*)

SCHEUNERT—HANS, of 3 Manor Lodge, Fort William, Ont. Born at Novorossisk, Russia, March 17th, 1903; Educ.: 1921-25, Frankhausen Engrg. College, Mech-Engr., 1925; (Aeronautical engrg. course included in last two years of college); 1926-29, dftsman., asst. shop engr., Junkers Aircraft & Engine Works, Dessua; 1930-31, sales and service engr., Canadian Junkers Ltd., Montreal; 1931-32, project engr., Canadian Diesel Engine Corpn., Montreal; 1932-36, i/c mtce. and service, Canadian Junkers Ltd., Winnipeg; 1937-38, asst. engr., Bickle Seagrave Ltd., Woodstock, Ont.; 1938 to date, with the Canadian Car & Foundry Co. Aircraft Divn., Fort William, layout dftsman, project engr., and at present, production engr.

References: E. G. MacGill, D. Boyd, W. L. Bird.

WOOD—ELVIN MORLEY, of Toronto, Ont. Born at Houghton Twp., Norfolk Co., Ont. May 21st, 1882; Educ.: B.A.Sc., Univ. of Toronto, 1908; R.P.E. of Ont.; 1906-09, factory and test dept., Gen. Elec. Co., Pittsfield, Mass.; 1909-10, factory inspection of equipment, H.E.P.C. of Ont.; 1910-17, constrn. and complaint sections, Can. Gen. Elec. Co. Ltd.; 1917-19, operating supt. and safety engr., Cons. Mining & Smelting Co., Trail, B.C.; 1919-26, asst. engr. in station design section, 1926-39, relay engr., and 1939 to date, planning engr. (head of section), elec. engrg. dept., H.E.P.C. of Ont., Toronto, Ont.

References: T. H. Hogg, A. H. Hull, A. Holden, C. E. Sisson, P. Ackerman, S. W. Canniff, H. E. Brandon.

FOR TRANSFER FROM JUNIOR

GRAY—HARRY ALDEN, of Knowlton, Que. Born at Pierre, So. Dakota, U.S.A., July 27th, 1908; Educ.: B.Sc. (C.E.), Univ. of Man., 1935; R.P.E. of Man.; 1925-28, rodman, C.N.R.; 1929-35, rodman, engrg. and service, Wasagaming, Man.; 1935, instr'man., Dept. of Public Works, Man.; 1936, dftsman. and res. engr., Dauphin, Man.; 1937 to date, res. engr., Quebec Roads Dept., Knowlton, Que. (Jr. 1937).

References: J. N. Finlayson, G. H. Herriot, A. E. Macdonald, A. Gratton, L. Trudel.

SMITH—CARL CLIFFORD, of 167 London St. South, Hamilton, Ont. Born at Madoc, Ont., June 25th, 1907; Educ.: B.Sc., Queen's Univ., 1932; 1929-30 (summers), main tests, trans. design and test calculation, English Electric Co.; with the Canadian Westinghouse Company as follows: 1931-35, engrg. ap'tice course; 1935-36, switchboard design; 1936, oil circuit breaker design; 1936 to date, elec. engr. on design of oil filled condenser bushings. (St. 1928, Jr. 1935).

References: H. A. Cooch, D. W. Callander, G. W. Arnold, J. T. Thwaites, J. R. Dunbar.

SPRIGGS—ROBERT HAYWARD, of 552 Briar Hill Ave., Toronto 12, Ont. Born at Birmingham, England, July 31st, 1900; Educ.: B.Sc., McGill Univ., 1924; R.P.E. of Ont.; 1918 (summer), Geol. Survey; 1923 (summer), La Gabelle Power Development; with the Bell Telephone Company of Canada as follows: 1924-25, inventory asst., 1925-30, asst. engr., gen. engrg. dept., Montreal; 1930-39, exchange and budget engr., gen. engrg. dept., western area; 1939-41, dist. engr., plant dept., western divn., Jan. 1941 to date, divn. plant engr., Toronto divn., plant dept. (St. 1920, Jr. 1929).

References: J. E. McKinney, G. H. Rogers, A. M. Reid, W. G. Lloyd, D. G. Geiger.

FOR TRANSFER FROM STUDENT

ADAMS—JACK DOUGLAS, of 2293 Wilson Ave., Montreal, Que. Born at Montreal, Sept. 25th, 1911; Eudc.: B. Eng. (Civil), McGill Univ., 1939; 1936, engrg. office, Canadian Johns-Manville Co., Asbestos, Que.; 1937 (summer), timber cruiser and mapper, Canada Airways Ltd.; 1938 (summer), instr'man., La Tuque development, Shawinigan Engineering Co.; 1939, instr'man. and computer, Beauharnois Light Heat & Power Co.; 1941, examiner, British Supply Board; at present, inspr., Dominion Bridge Co. Ltd., Montreal, Que. (St. 1939).

References: R. DeL. French, G. J. Dodd, J. Weir, C. G. Kingsmill, L. C. Nesham, R. E. Jamieson.

BALDRY—GEORGE S., of 810 Wolseley Ave., Winnipeg, Man. Born at Winnipeg, June 24th, 1913; Educ.: B.Sc. (Chem.), Univ. of North Dakota, 1935; 1931 (5 mos.), ice machine installn., Arctic Ice Co., Winnipeg; 1932 (4 mos.), gen. contracting; 1936-38 (intermittent), supt., Baldry Engrg. and Constrn. Co. Ltd., Winnipeg; at present interning at St. Boniface Hospital, and expects to graduate in medicine from Univ. of Man. in May, 1941. (Planning to specialize in industrial medicine and hygiene). (St. 1931).

References: D. L. McLean, C. P. Haltalin, A. E. Macdonald, E. S. Kent, C. V. Antenbring.

BROOKS—JOSEPH WARREN, of 120 Division St., Kingston, Ont. Born at London, Ont., June 30th, 1917; Educ.: B.Sc. (Civil), Queen's Univ., 1939. R.P.E. of Ont.; 1937-38 (summers), London Structural Steel Co., and A. W. Robertson Constrn. Co., Montreal; 1939-40, demonstrator, and 1940-41, lecturer, in civil engrg., Queen's University. 1940 (summer), civil engr., Beauharnois Light Heat & Power Co. (St. 1939).

References: A. Macphail, D. S. Ellis, C. H. Pigot, C. G. Kingsmill, J. B. Baty, H. A. McKay, W. L. Malcolm, B. K. Boulton.

HOWE—HAROLD BERTRAM, of 4163 Western Ave., Westmount, Que. Born at Inverness, Que., March 29th, 1915; Eudc.: B.Sc. (Mech.), Queen's Univ., 1936; 1936-37, dftsman., 1937-39, asst. mech. engr., Canadian Johns-Manville Co. Ltd., Asbestos, Que.; 1939-40, plant engr., at Montreal East, i/c of all constrn., and Oct., 1940 to date, engr. dftsman., head office, Canada Cement Co. Ltd., Montreal. (St. 1935).

References: L. Trudel, L. M. Arkley, L. T. Rutledge, D. Giles, K. L. MacMillan.

McINTOSH—WILLIAM GARDNER, of 240 Cooper St., Ottawa, Ont. Born at Winnipeg, Man., Aug. 19th, 1913; Educ.: B.Sc. (Elec.), Univ. of Man., 1937; 1936-37, airline technician course, and 1937 (July-Nov.), dfting. and stress work, Boeing School of Aeronautics, Oakland, Calif.; 1937-38, dftsman., Trans-Canada Air Lines; 1938-40, production office, Boeing Aircraft of Canada Ltd.; 1940, engrg. branch, R.C.A.F., and Dec. 1940 to date, Flight Lieut., Air Force Headquarters, Ottawa, Ont. (St. 1935).

References: E. P. Fetherstonhaugh, N. M. Hall, J. N. Finlayson, J. T. Dyment, G. M. Minard.

OLIVER—JAMES, of Arvida, Que. Born at Calgary, Alta., Nov. 23rd, 1913; Educ.: B.Sc. (Civil), Univ. of Alta., 1937; 1937-38, i/c surface and underground surveying, Melba Gold Mines Ltd., Bourkes, Ont.; 1938, instr'man., E. G. M. Cape Co. Ltd., Montreal; 1939, layout engr., Anglin-Norcross Ltd., Montreal; 1939-40, layout engr., J. L. E. Price & Co. Ltd., Montreal, and June 1940 to date, constrn. engr. for same company on new filtration plant at Arvida, Que. (St. 1936).

References: J. L. E. Price, J. R. Scanlan, J. B. Stirling, H. R. Webb, A. S. Rutherford, A. I. Cunningham, R. S. L. Wilson.

WARDROP—WILLIAM LESLIE, of 21 Edmonton St., Winnipeg, Man. Born at Whitemouth, Man., Dec. 18th, 1915; Educ.: B.Sc. (Elec.), Univ. of Man., 1939; 1938, plant inspr., Manitoba Good Roads; 1939, instr'man., reclam. br., Manitoba Govt.; 1940, brick industry at Whitemouth; Oct. 1940 to date, instructing at Univ. of Manitoba. (St. 1939).

References: A. E. Macdonald, E. P. Fetherstonhaugh, W. F. Riddell, G. H. Herriot, S. H. DeJong, C. H. Blanchard.

Industrial News

Industrial development — new products — changes in personnel — special events — trade literature

MONORAIL

The principal uses of the Beatty Monorail Systems installed in stores, warehouses, sidings, foundries, factories and shops are illustrated and described in the new 4-page bulletin issued by Beatty Bros. Ltd., Fergus, Ont.

SPIRAL WELDED PIPE

In their recently issued 6-page booklet, Canada Ingot Iron Co. Ltd., Guelph, Ont., give facts, advantages and uses of Armco spiral welded pipe in the oil and gas industry, together with data for designing pipe lines and car loading data.

STEELSTRAP

Acme Steel Co., Montreal, Que., have issued an 8-page house organ which illustrates applications of steelstrap to shipments. Includes articles on strapping practices employed by shippers of trucks, sugar, airplanes, nut meats, boats, sucker rods, salmon and mining equipment.

INSULATING VARNISH

In a 4-page folder, Irvington Varnish & Insulator Co. of Canada Ltd., Hamilton, Ont., announce Harvel 612C—a recently developed, internal drying, synthetic resinous phenol-aldehyde type varnish which solidifies throughout by heat-induced chemical polymerization. Illustrations, and technical and application data are also included.

VALVES

An interesting handbook, No. 740 of 38 pages issued by Saunders Valve & Supply Co. Ltd., Montreal, Que., describes the Saunders standard diaphragm valve, non-standard diaphragm and straightway valve. Gives details of applications, technical data and maintenance. This book is thoroughly illustrated and is tab-indexed to facilitate reference.

STEEL PRODUCTS

The Steel Co. of Canada Ltd., Montreal, Que., have issued a 32-page alphabetically arranged list of the company's products revised to September 15th, 1940, showing the works in which each is manufactured, the location of the warehouse where each is stocked and the principal sales office.

MASONRY DRILLS

Canadian General Electric Co. Ltd., Toronto, Ont., have recently issued a bulletin CGT-103C which gives instructions for the use of Canadian-made carboloy drills for drilling holes in slate, concrete, tile, plaster and other non-metallic substances. Lists of new prices are also included.

MATERIALS HANDLING EQUIPMENT

Catalogue No. 2140 of 184 pages, issued by Richardson Scale Co. of Canada Ltd., Fort Erie North, Ont., fully describes and illustrates automatic scales, Convey-O-Weigh, weighing, proportioning and feeding equipment for glass manufacture and automatic feeder weighers.

BOILER BLOWOFF EQUIPMENT

The Permutit Co. of Canada Ltd., Montreal, Que., have issued a bulletin, No. 2391, of 8-pages which discusses typical arrangements of continuous blowoff systems based on flash or non-flash, high or low heat level, single or group control operating characteristics. Indicated Permutit equipment is described.

DRAINAGE PRODUCTS

The 46-page catalogue No. 12 of Canada Ingot Iron Co. Ltd., Guelph, Ont., is a quick reference to Armco drainage products, completely illustrated with photographs of installations of Armco drainage pipes of various sizes and types to meet a wide range of conditions and requirements.

FLAME-CLEANING

Entitled "3 New Processes," an 8-page booklet issued by Canadian Liquid Air Co. Ltd., Montreal, Que., describes flame-cleaning and dehydrating of old and new structural steel by paint burning and surface conditioning and the descaling of billets, castings and forgings.

INSTRUMENTS FOR INDUSTRIAL APPLICATIONS

A number of scientific, optical, indicating and measuring instruments for a wide range of industrial uses are described and illustrated in the 20-page catalogue issued by Frederick C. Baker & Co., Toronto, Ont.

DRILL AND TAPPERS

The "Buffalo" No. 15 heavy duty production drill; the No. 15 manufacturing type drill; the No. 15 tapping machine; and accessories are featured in an 8-page bulletin No. 2963-C which was just recently made available by Canadian Blower & Forge Co. Ltd., Kitchener, Ont. This bulletin is completely illustrated with photographs and sectional drawings and contains full specifications.

OXYGEN RECORDER

Mine Safety Appliances Co. of Canada Ltd., Montreal, Que., have issued a bulletin of 2 pages which describes the M.S.A. oxygen recorder which is now available completely assembled on a steel panel thus simplifying installation and permitting easy maintenance. The instrument measures oxygen concentrations from 0 to 20.8 per cent and can be calibrated for any range desired within these limits.

TRANSFORMERS

Typical examples of the many types of Moloney transformers and installations are featured in the 36-page booklet issued recently by Moloney Electric Co. of Canada Ltd., Toronto, Ont. This attractively prepared booklet also describes and illustrates the company's plant and manufacturing facilities.

BALL BEARING UNITS

A 32-page catalogue, No. 840, issued by Stephens-Adamson Mfg. Co. of Canada Ltd., Belleville, Ont., includes complete line of "Sealmaster" ball bearing units. These units are pre-lubricated, self-aligning and feature the "Sealmaster Centrifugal Labyrinth Seal." Each type of unit is illustrated and described and tables of capacity and dimensions are also given.

WELDING EQUIPMENT

A detailed description of the many products of this company used in arc welding is contained in the 56-page bulletin No. 402, an issue of Lincoln Electric Co. of Canada Ltd., Toronto, Ont. All products are well illustrated and valuable reference information is given in each case.

INDUSTRIAL ADVERTISERS SELECT TORONTO FOR 1941 CONFERENCE

Toronto has been chosen by the National Industrial Advertisers Association as the city in which its nineteenth annual conference, to take place in September, will be held, according to a statement just released by Richard P. Dodds, president of the Association, and advertising manager of Truscon Steel Co., Youngstown, Ohio.

The Conference will be sponsored by the Industrial Advertisers Association of Ontario, the Toronto Chapter of N.I.A.A. This chapter has a membership of 50, headed by John A. M. Galilee, assistant advertising manager, Canadian Westinghouse Co. Ltd., of Hamilton, Ontario. The Montreal chapter of N.I.A.A. will co-operate in putting on the conference.

The Royal York Hotel, Toronto, will be headquarters for the thousand or more members and guests of N.I.A.A. who are expected to attend the conference from the 20 chapters throughout the United States and Canada. Total membership of the Association is now over 1,500.

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

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"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public."

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CANADIAN ENGINEERS AND THE WAR

DR. THOMAS H. HOGG, M.E.I.C.

Chairman and Chief Engineer, The Hydro-Electric Power Commission of Ontario, Toronto, Ont.

This address was delivered by Dr. Hogg on the occasion of the joint banquet at Calgary celebrating the signing of a co-operative agreement between the Association of Professional Engineers and the Institute, on December 14th, 1940.

(ABRIDGED)

When Mr. Churchill said, "Never in the field of human conflict was so much owed by so many to so few," he was speaking of the Royal Air Force and its magnificent defence of Great Britain. But this fine tribute of the British Prime Minister has also been earned by those engineers and scientists, both of the fighting services and in civil life, who have, during the past twenty years or more, laboured so that in the day of trial Britain's sword can strike so effectively. For years these men, aided by the staff officers of the naval and military forces, have been quietly developing British machines and equipment that have proved superior to those of our enemies.

It is thus fitting to discuss Canada's war effort and the problems which are facing Canadian engineers in this, the most important business of today.

Canada's Resources

Although a nation of only 11½ million people, Canada's capacity to help is probably at least twice as great as that of an equal European population. This is due mainly to two things: first, Canada's immense natural resources; and second, the up-to-date character of our equipment for utilizing these resources effectively.

The fundamental measure of a nation's scientific and industrial status is the degree to which mechanical power has replaced human labour. One of the principal items of Canada's equipment today is the ample supply of low-cost hydro-electric power available in all provinces, as evidenced by statistics of the power used per capita in Canada, which, in some measure, is a gauge of the nation's industrial capacity. In 1914 the hydraulic turbine power installed in Canada was less than two million horsepower. By 1918 this had risen to 2⅓ million horsepower. There is now available in Canada more than four times the amount of electric power that was available in 1918 at the end of the last war, and of this nearly 7¾ million horsepower is utilized in central electric station industry.

Much of the increase in power utilization has been devoted to the production of raw materials of industry, many of which are of primary importance in war. This increased production is particularly noticeable in non-ferrous metals. Since 1914 copper production has risen from 76 to 607 million pounds per year—a nine-fold increase. Zinc production was quite small in 1914, but it is now nearly 400 million pounds—a sixty-fold increase making Canada the third largest world producer. Nickel production has risen from 47 to 227 million pounds—a five-fold increase. All these metals are of great significance in munitions production.

Canada has no known commercial deposits of aluminum ore, bauxite, but its water powers situated near tidewater have been put to good use in developing, from ore imported from British sources, a large aluminum industry. Since 1914, the production of aluminum in Canada has increased immensely, and to-day our entire production of this vital war metal is under contract to the British Government.

There is no need to continue a catalogue of advances in mineral production. Other war minerals being produced in useful quantities in Canada include lead, now ten times the average output of the 1915-18 war years, as well as platinum, cobalt, molybdenum, asbestos, magnesite and mica.

In 1914, Canada was only just beginning to feel its strength in industrial and manufacturing facilities. Since then we have not only trebled our manufacturing facilities but we have immensely improved their efficiency. Thus Canada is in a far better position than in 1914 to lend effective aid to the Empire cause.

It is important to note, however, that this rapidly-developed productive capacity was intended almost exclusively for peaceful purposes. In 1914 the situation was similar but on a smaller scale, yet we were then able to divert our material and mechanical resources into the channels of war production in an effective way. The same effort is being made to-day.

Personnel Problems

Another impediment to the acceleration of our industrial war effort may be the difficulty of securing suitable personnel for the new armament plants and for the operation of existing industrial plants now being adapted to munitions manufacture.

There are several ways in which the shortage of the highly skilled workers can be made up. First, with the willing co-operation of the union organizations of the skilled workers, industrial management will be able to organize production so as to employ the maximum of partly-skilled labour under the minimum of fully-skilled supervision. Again, in many operations involved in manufacturing light mechanical equipment and instruments, Canadian women will probably play an important part, as indeed they did in the last war. Further, the ranks of the skilled workers may well be filled by the best of the students training at the technical and vocational schools and by the re-training of men who have had some industrial experience but have abandoned manual work for other employment.

Research Work

Since the last war, Canada has been farsighted in supporting scientific and industrial research. During this period the problems which engaged the National Research Council were naturally concerned with peacetime activities, but to-day the efforts of a staff, doubled in number, are devoted almost exclusively to war problems. It is gratifying to note that there is close co-operation between Government war departments, such as the Department of National Defence and the Department of Munitions and Supply, and the various organizations carrying on research work.

Adequate Power Resources Available

Some concern has recently been expressed as to whether the power now available in Canada will be sufficient to service our war activities. Speaking for Ontario—and I think this applies to most, if not all, of the other provinces —I have previously expressed the belief that for the immediate future sufficient power was available in all districts to enable Ontario's war effort to be speeded up and maintained at this higher level. Up to the present although the demand for power has increased, it has been met without undue difficulty.

The development of war industries, however, is inevitably accompanied by a more rapid tempo in other activities, which again produces an increased demand for power all along the line. It follows, therefore, as I have pointed out before, that Canada cannot play her full part unless there can be made available large additional quantities of power. It is obvious that in such a case we cannot wait until the demand actually arises. We must plan and move well in advance.

Now there has never been a time when future needs for power have been more difficult to estimate. Thus it is in a maze of uncertainty that weighty decisions respecting new developments have to be made. The electric supply industry of Canada is now preparing itself to meet the demands that may be made upon it, no matter what they may be.

Canada Prepares

In Ontario, even before the war started, we had planned, and have since carried out, a strengthening of our transmission and distribution networks to enable us to transfer power with greater facility from one part of the province to another; we also constructed one additional power development. At the present time we have under construction two others.

Diversions of Water to Great Lakes

We have also been able, in co-operation with the Dominion authorities, to arrange for the use of more water at Niagara by undertaking to make permanent diversions to the Great Lakes of a substantial flow of water from certain rivers in northern Ontario. These are known as the Ogoki river and Long Lake diversions, and their immediate value depends upon the co-operation extended by the United States. There is now an understanding (confirmed by formal interchange of notes between the Canadian Minister to the United States and the United States Secretary of State) whereby Canada is enabled to utilize immediately, for increasing power output at Niagara for war purposes, an additional flow of water equivalent to that which will be added to the Great Lakes when the diversion works are completed; Canada undertaking to start immediately the construction of the necessary dams, channels, etc., for the Ogoki diversion and to divert to Lake Superior immediately the 1,000 cubic feet of water per second from Long Lake, for which the physical works have already been completed. The ultimate result will be a beneficial diversion of water from one watershed to another by taking stream flow from the upper portion of two tributaries of the Albany river—the Ogoki and Kenogami, and transferring that water to the Great Lakes system.

The physical conditions permit the diversion of the flow from an area of about 5,800 square miles of the upper watershed of the Ogoki river to lake Nipigon and thence to lake Superior; and from about 1,500 square miles of the watershed of Long lake, at the head of the Kenogami river, directly to lake Superior down a short stream.

At present the water from these watersheds flows down the Ogoki and Kenogami rivers to their junctions with the Albany and thence down the Albany river to James bay.

These diversions will work no injury to any future industries or settlements in the watershed of the Albany river, as there is ample power at other sites in the vicinity of the Ogoki area.

Turning to the province of Quebec, large additions have recently been made to generating equipment at the Beauharnois power development on the St. Lawrence river and at the new La Tuque plant of the St. Maurice Power Corporation.

St. Lawrence River Improvement

The improvement of the St. Lawrence river for navigation and for power development is a subject that is again receiving attention. As a project it is now linked up with the joint steps being taken by the United States and Canada for the defence of the Americas. Time will not permit any discussion of the proposed further development of this great waterway, but it is evident that changing world conditions must profoundly modify many of the views previously held respecting this great undertaking.

Regulation by Dominion Power Controller

Certain economies in power consumption can be effected by restricting the less essential uses of electricity. Great care, however, must be exercised in doing so, because it is quite possible to save electricity at the cost of imposing other burdens which would diminish rather than increase our total war effort. These matters are receiving the careful attention of the Dominion Power Controller, in co-operation with the various provincial authorities.

One ruling by the Dominion Power Controller has already effected a substantial saving in power demand—namely the extension of daylight saving time in Ontario and Quebec in those communities which adopted it during the summer. This regulation has unfortunately resulted in some confusion in the mind of the general public. It has even been suggested that electric power could be conserved by cutting off street and highway lighting, and electric signs; some people are trying to conserve electricity in their homes. Such efforts, while being commendable because they are sincere, are not very helpful unless you happen to reduce peak load by switching off lights when your generating stations are operating at their maximum capacity—which is usually late in the afternoon when all factories are in full production.

Thus it is desirable that everybody should continue to use electricity as fully as needed until they receive advice from the Dominion Power Controller, or their local electric utility, otherwise they may interfere with their own war effort. Engineers will understand that the effect of introducing a staggered form of Daylight Saving Time (as has been done in Ontario and Quebec) creates a better diversity in the time of peak demands from various classes of consumers.

Conclusion

This brief review of Canada's war effort has, I hope, indicated to some extent the important part that is being played by Canadian engineers.

To-day, notwithstanding the temporary superiority enjoyed by Germany in numbers and masses of military weapons and supplies, it may be stated with some assurance that in scientific and technical matters the British Empire is superior to Germany. This is to be expected, because the highest achievement in these things can only be attained where the utmost freedom of thought and action are permitted. While dictatorships may have some advantages over democracies in the regimentation of a nation for controlling its political and economical life, the same control cannot successfully be applied to its scientific development.

In addition to its natural resources and its up-to-date equipment for their utilization, Canada enjoys for the time being a freedom from direct enemy action against her territory. This is both an advantage and a danger. It leaves us free to devote our energies to our assigned task of training personnel for the great air armada in the making, and to develop our raw materials, and manufacture and assemble them for shipment. But the danger lies in the possibility that we may become complacent and fail to mobilize every ounce of our strength.

Relatively speaking, Canada has more to lose, should the Empire fail to achieve victory, than even Britain herself. Just before the war Germany had many accredited agents travelling through Canada making an inventory of our assets. Asked what they were particularly interested in, one of these agents replied, "In your natural resources." Canada, therefore, has a very definite and important part in the struggle. We must develop and use our natural resources to the utmost to prevent the enemy from taking them from us.

As Canadian engineers we may be proud that those to whom the call has come have been found both willing and able to render effective help. We cannot all apply our engineering knowledge in active service overseas. But in our appointed tasks we can each employ our talents, our engineering experience and whatever specialized knowledge we may possess to the solution of the problems with which we have to deal—to the end that, by the efficient mobilization of the great resources of this Dominion, a continuous stream of munitions and supplies of all kinds may flow through unimpeded channels to their appointed destination.

EARTH'S CRUST RESISTANCE AND LIGHTNING

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It has been a pleasant experience to review the past ten years' work on the reduction of lightning outages. This has led to the realization that our knowledge of the earth's crust is not all one should expect in these enlightened days.

During the summer of 1940 we were given the opportunity of measuring the footing resistance of the steel grillage tower foundations which were being installed for a new 220 kv. steel tower transmission line (No. 35) between the cities of Three Rivers and Quebec. A field party was sent out with earth resistance measuring apparatus described later. The data obtained were plotted so that comparisons could be made along the right-of-way to determine what sections should be specially treated to obtain the lowest overall resistance to earth for the least money spent.

Low resistance to earth along a steel tower line has been found to be a very important factor in reducing, (and on several high voltage lines, eliminating) power arc-overs caused by lightning.

A study of the graph of resistance per tower base vs the line plan and profile (see Fig. 1) yields some curious information. The largest river crossed, the St. Maurice, has high resistance banks. The reason for this is, probably, the sandy soil from which all of the soluble conducting materials have been washed or leached into the river by the infiltration of surface water and rains. Such high resistance was specially noted where slopes are steep, as at Towers 55-70.

This high resistance was found to a lesser degree at other, but not all, rivers along the line. It seems reasonable to suppose that most soils through which water can pass even slowly should be poor conductors. Water itself is not a good conductor except when salts or acids are present in solution.

This condition of high resistance tower footings near rivers was so intriguing that other old ground resistance measurement data were investigated and a typical case on line No. 33 is offered for reflection, in Fig. 2.

For the No. 35 line tests, a box with metal end plates was used, containing approximately one cubic foot of earth

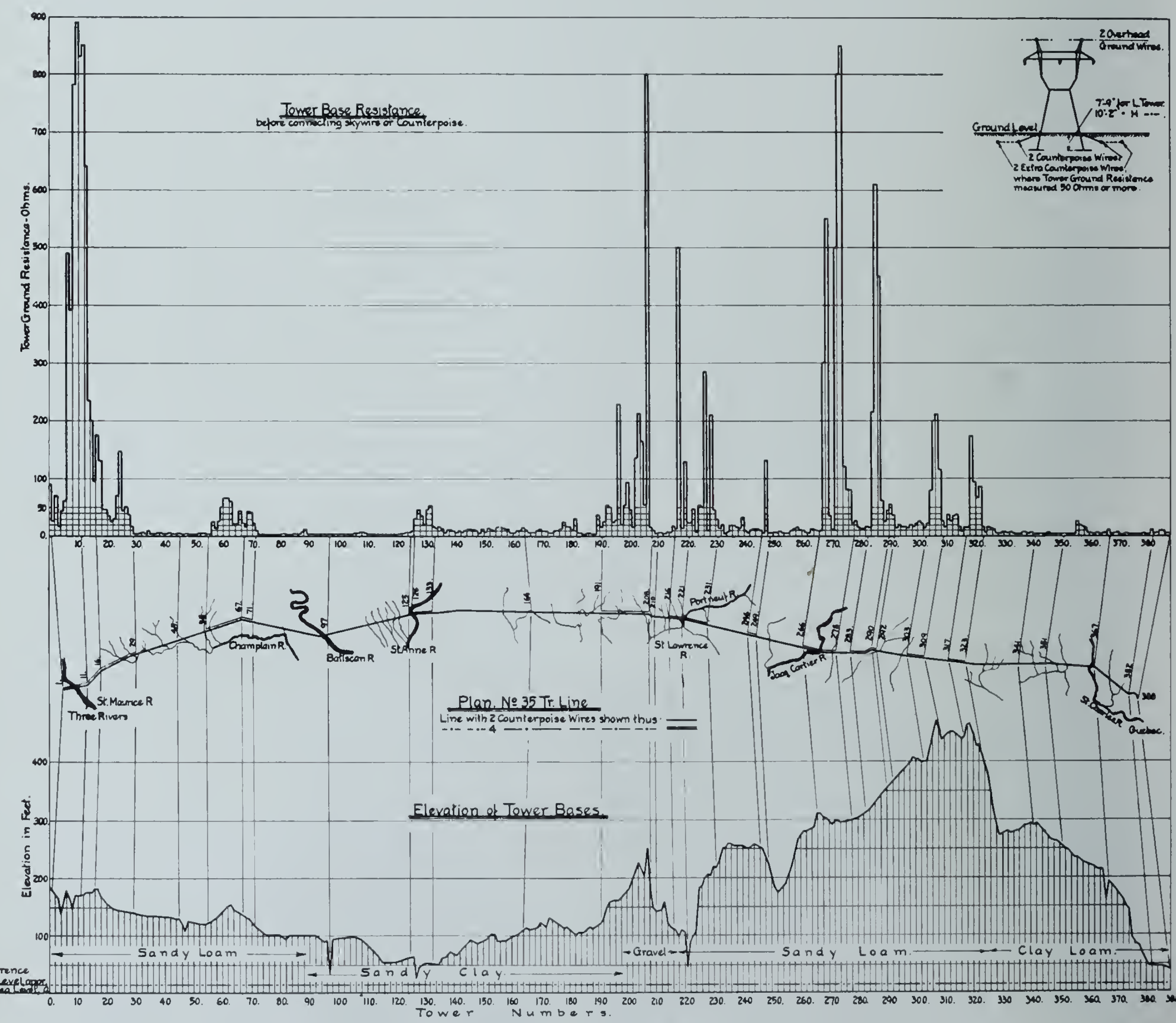

Fig. 1—Diagram showing ground resistance along transmission line No. 35.

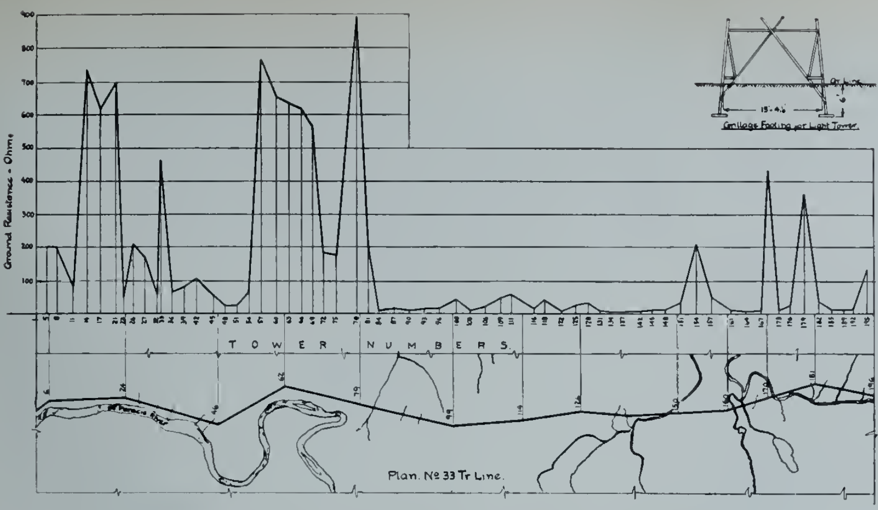

Fig. 2—Diagram showing the high resistance of tower footings near rivers.

The resistance of earth samples measured in this box ranged from 253 to 3,000 ohms. Such high resistances showed that the earth contained few conducting impurities. If such impurities were present, the galvanized steel footings would soon be damaged by rust action.

In connection with Figs. 3 and 4, it should be explained that the ground resistance measuring gang, consisting of four men equipped with an Evershed & Vignoles earth tester, wires, probes, etc., followed the base setting gang, well ahead of the wire gang. Thus they had buried steel bases to measure without the effects of other man-made grounds.

The method of testing was the probe or potential. This was checked by a loop resistance measurement of the tower base under test in series with a long lead, usually 1,100 ft. in length, and the nearest measured tower base. The two methods checked closely so that a fair idea of the base resistance at each tower was obtained.

This method of testing isolated grounds involves reversed or alternating currents passed into the earth. (See Fig. 5). The potential drop P_1 to P_2 in the earth between the two current points C_1 and C_2, when combined with the current, can be read on the instrument as earth resistance of the point C_1, which is the tower base under investigation. This method gives a measure of local resistance which, from a lightning protection standpoint, is the resistance value in which we are interested.

Just why are we interested in resistance of tower footings and the earth's crust?

The sketch in Fig. 6 has been made up in an attempt to show what may happen when a stroke of lightning contacts a transmission line. An instrument such as a photographic cathode ray oscillograph could be used as a recorder or voltmeter.

It will be noted from Fig. 6 that in this case we have a potentiometer. At the point where the stroke contacts the line, current is carried to ground via the tower steel, and the potential between the instrument and the flashover is recorded on the view plate and photographed.

A shunt path in parallel with r will by-pass the flow and, if this shunt is of sufficiently low resistance, the IR drop will not be high enough to flash the insulators.

The shunt path may be a sky wire or a counterpoise or deep driven ground rods, or all three.

Before proceeding further, a study of the phenomenon of lightning might be helpful. Our electricity is carried on what we call electrons, and we choose to call these electrons negative in polarity. When these electrons accumulate in a cloud, they repel each other by virtue of their similar negative properties. They are held together by atmospheric insulation because they cannot get away until they develop sufficient potential difference to some other collection (a cloud) or perhaps the earth. Now let us consider the earth or its crust: we have been led to believe that some strange opposite charge follows around a negatively charged cloud. This is easier to visualize if we consider the repulsion effect of the negatively charged cloud repelling the electrons out of the area below. We know (from data collected by communication companies) that potential differences exist between points or grounds on the earth's crust. These potential differences do not assume very large values unless something special happens. One case of something special happening, is when a cloud loaded with electricity (negative electrons) in an insulating atmosphere finally develops such a potential difference to earth that it dumps the charge down a path made luminous by the ionization and heat of the electron flow, or the I^2R power as we say.

Why so much negative current flows down this single path can be explained if we remember that flowing electrons are always accompanied by counter-clockwise whorls of magnetic lines, and that parallel current paths magnetically attract each other, finally becoming one path.

The graph shown in Fig. 7 is a reproduction of a flash record taken by the General Electric Company in New

Fig. 3—Steel underground in grillage tower base.

Fig. 4—Steel above ground in grillage tower base.

York of a lightning stroke on the Empire State building. This diagram is important in that it settles, we hope finally, the nature of the lightning discharge.

We have a cloud dumping a large flow of electrons or electricity down a flash to earth, the normal container for all of our earthbound electricity. The flow varies in quantity but not in direction. In a few records the flow at the end of the discharge has been found to reverse, but unless you are interested in the theory of low resistance oscillating circuits it is just as well to ignore these few rare cases.

If some of the mystery of the discharge has been dispersed, suppose we consider what happens to the electrons when they arrive at the earth. Of course, the spot struck receives a huge quantity of electrons which must be distributed to the rest of the earth's crust.

We now have a fascinating study for a mathematician who likes dealing in circles and hemispheres. The nature of the material in these circles and hemispheres, of course, must be variable just to make it interesting. However, we should not go too deeply into this angle of the question because it has been worked out for us by a record of our flashovers on our transmission lines.

We know from records of damage to wood poles caused by lightning, and found by patrolmen on 60 kv. power lines, that potential differences of 600 kv. and more may exist between poles approximately 200 ft. apart. These high potential differences which exist up to 2,000 ft. from the point struck are shown by our records to have reached values as high as 2,000 kv. in some instances. That these potential differences exist we are sure. The exact mechanics of each case is not so easily understood. This fact leads to a study of probabilities and chances based on our meagre set of rules to cover mass movement of electrons at widely varying rates of flow.

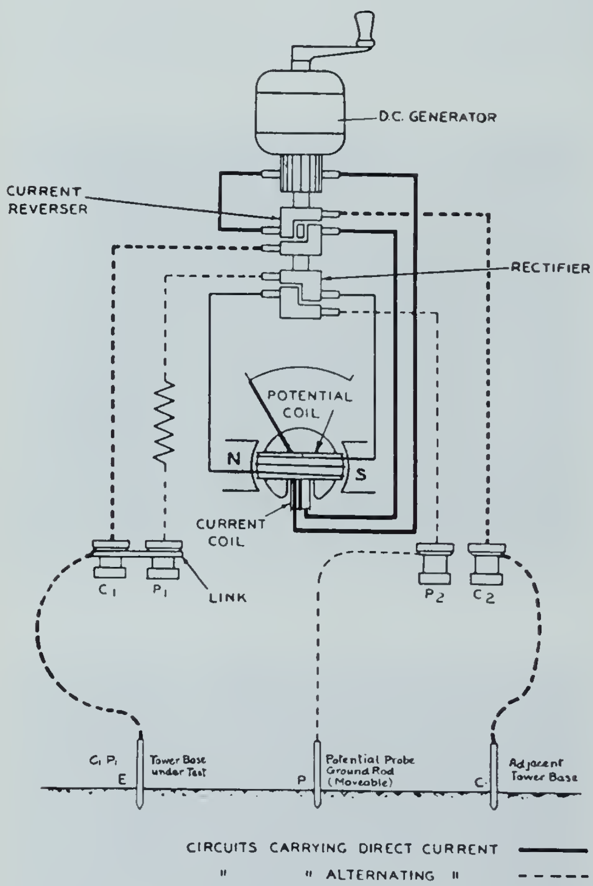

Fig. 5—Diagram showing the principle of operation of a Megger earth tester.

Figures 8 and 9 show the conditions found on lines Nos. 18 and 38 due to lightning storms on July 8 and June 11, 1939, respectively.

The tubes noted on the poles (Fig. 10) are similar to a fuse holder. The lightning flashes through the tube and builds up pressure which at times explodes the tube. No other damage is experienced and when the line trips out, as it does if the relaying is fast, the line closes back. Other than the tube loss, there is no permanent damage even to insulators.

So far as this paper is concerned, the tube acts as an indication of a flashover caused by high lightning potential.

If our municipal engineers care to think of a heavy rain storm or cloudburst on roofs equipped with eave troughs (sky wires) and conductor pipes (steel towers or pole ground leads), some idea of the effect may be visualized.

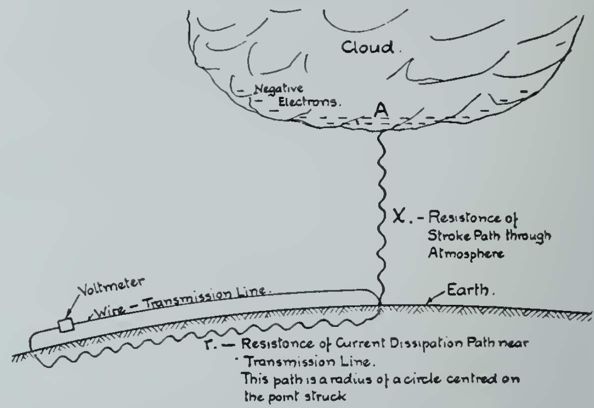

Fig. 6—Diagram showing the method of measuring the potential drop during distribution of electrons following lightning flash.

If the run off sewer (counterpoise or other equally good continuous grounding) be adequate, no spill over will occur.

Lightning is in the same category as a cloudburst; it must be got rid of and quickly by properly designed run off equipment.

We have ten years' records to show that short-circuiting the bases of steel towers reduced materially the flashovers. On a number of lines the lightning outages have been reduced to zero. Some of the results of the preventive work are shown in Figs. 11, 12, 13, 14.

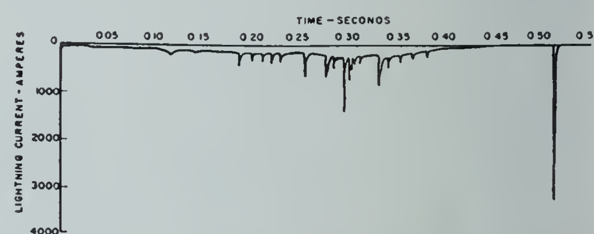

Fig. 7—Crater lamp oscillogram of lightning stroke on Empire State Building, New York. (Reproduced from *Electrical World*, February 10, 1940, Wave Shapes of Successive Lightning Current Peaks, by K. B. McEachron.)

Fig. 11 is an eleven year record of the line outages caused by lightning on the Shawinigan system between Shawinigan Falls and Montreal.

The top graph is the result of a count made each year of the days on which lightning was recorded and conveys some idea of the severity of lightning for the different years.

The second graph from top shows the percentage of tower line right of way which has the bases of the towers bonded together by counterpoise wire buried approximately 18 inches.

The third graph is a plot of the outages caused by lightning each year; note the downward slope as the percentage of continuous counterpoise increases in the graph above.

The fourth graph is the same as the third, but in terms of outages per 100 miles of circuit for easy comparison with other companies' records.

The voltage on these circuits (Fig. 11) is 110 kv. insulated by seven standard suspension insulators. One of the tower lines has two overhead sky wires and the other tower line has no sky wire. This point is discussed later with Fig. 14.

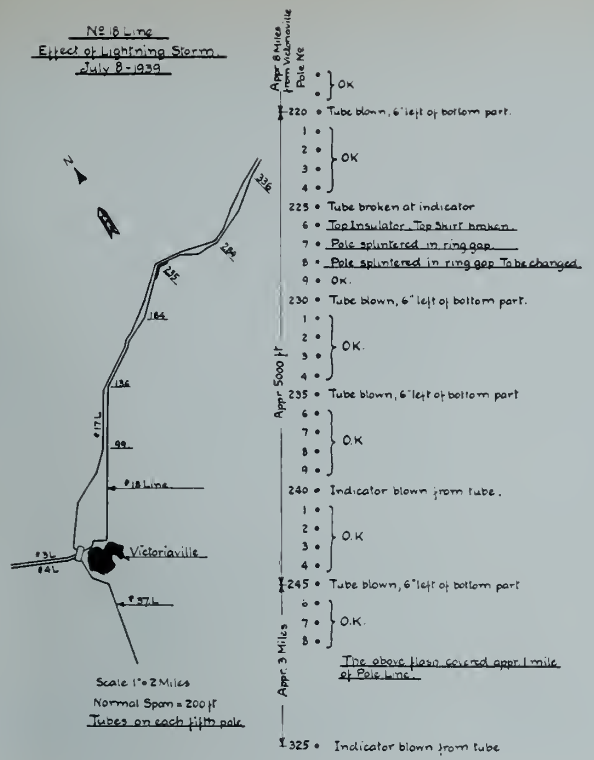

Fig. 8—Plan of line No. 18 indicating damage done by lightning storm.

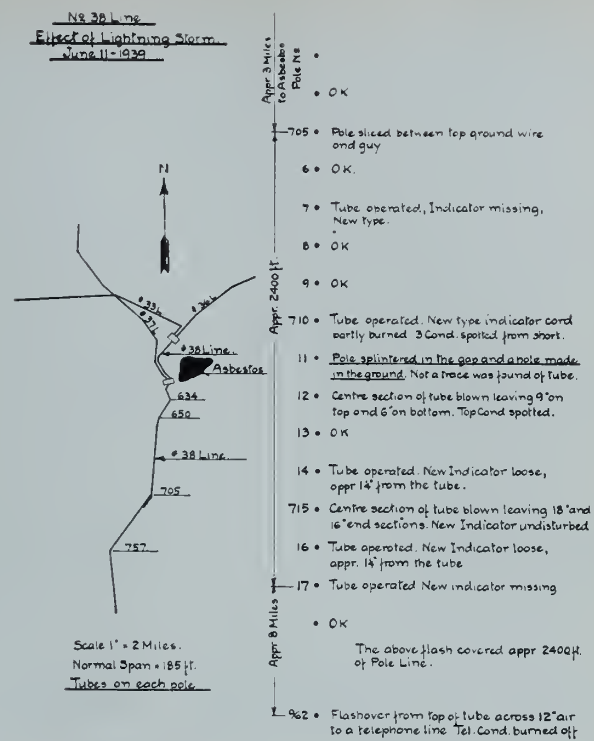

Fig. 9—Plan of line No. 38 indicating damage done by lightning storm.

It will be noted by the dotted lines in the side sketch of the tower and counterpoise arrangement on each graph, that the towers are cross connected together underground wherever counterpoise has been installed on right of way used by more than one line of towers.

In another case where 100 per cent counterpoising of three important circuits operating at 60 and 110 kv. was carried out, the outages were completely eliminated. The insulation is seven standard suspension units. It has been found by comparing the records of 110 kv. and 60 kv. lines operating on the same construction and insulation that no difference in outages is apparent. This suggests future studies on how low insulation can be reduced on a well protected high voltage line.

Fig. 12 is a record showing a reduction in outages of which we are justly proud. This line is operating at 220 kv. and insulated by 16 units of the standard five inch suspension type. The improvement after counterpoising was definite.

We would not be surprised if an outage should occur in future years. Such an occurrence would be studied and further grounding measures taken, as is being done in the case shown in Fig. 13.

The tower lines referred to in Fig. 13 were counterpoised and also two sky wires added in the case of Nos. 19-21 section. The record showed reduction to zero for one year but not the second or third years. Here we found that the flashed towers were on very high resistance earth in the St. Maurice river valley. Tests were made by driving deep rods. Resistances as follows, were found:—

Tower No.	Depth of Rod.	Ohms to the Tower & Sky Wire
84	64 ft.	50 ohms
85	88 "	30 "
98	112 "	40 "
118	48 "	70 "
119	48 "	75 "
123	56 "	75 "
134	40 "	700 "
171	56 "	20 " (in a swamp).

The earth resistance of this section is so high that more than the usual counterpoise grounding is necessary. Two extra wires in the ground or more deep driven rods are indicated before the next lightning season.

The purpose of the so-called "counterpoise" wire, which is buried 18 inches deep and connected to the tower bases, is to provide a conducting path through the poorly conducting earth's crust immediately below the transmission line, so that any mass distribution of electrons can flow away in the earth, and not force the streams of electrons to jump insulators into the transmission conductors to get

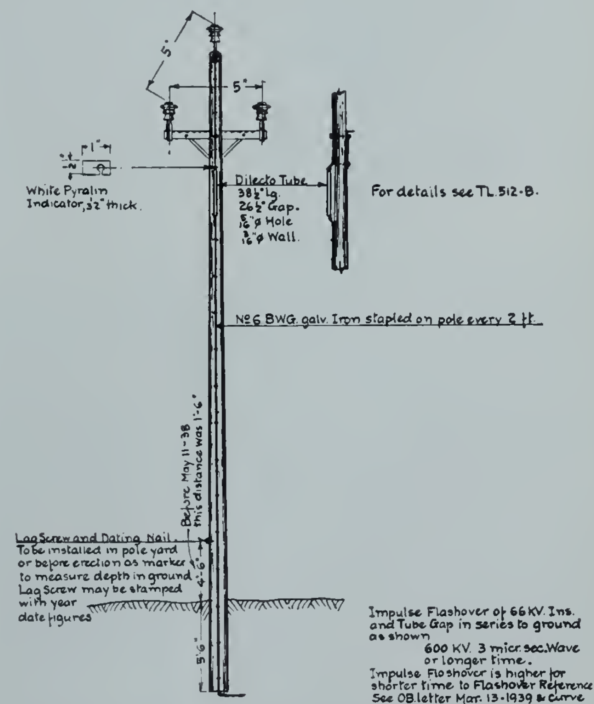

Fig. 10—Wood pole for 60 kv. line with tube gap connection.

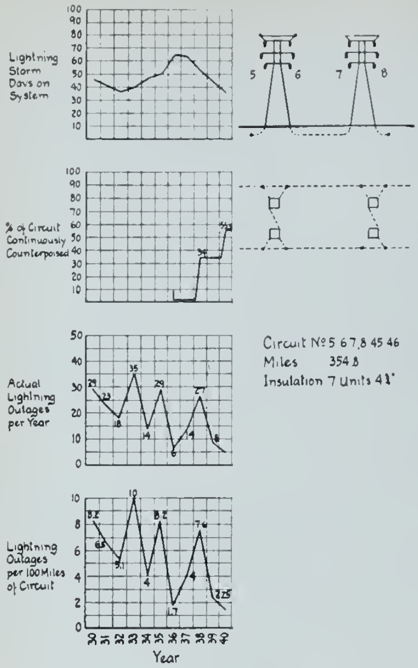

Fig. 11—110 kv. lines 55.3% counterpoised. Outages reduced 75%.

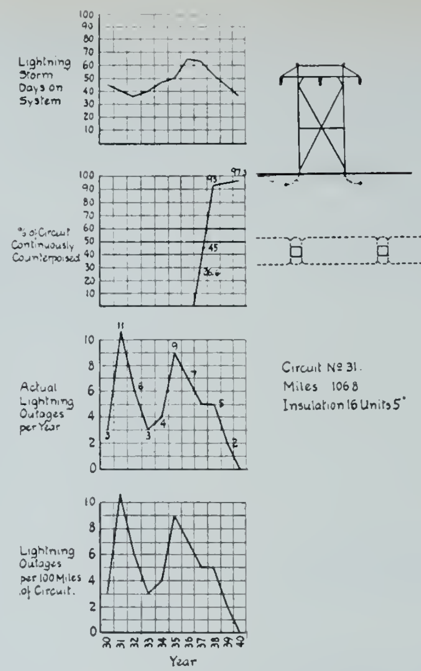

Fig. 12—220 kv. line 100% counterpoised. Outages reduced 100%.

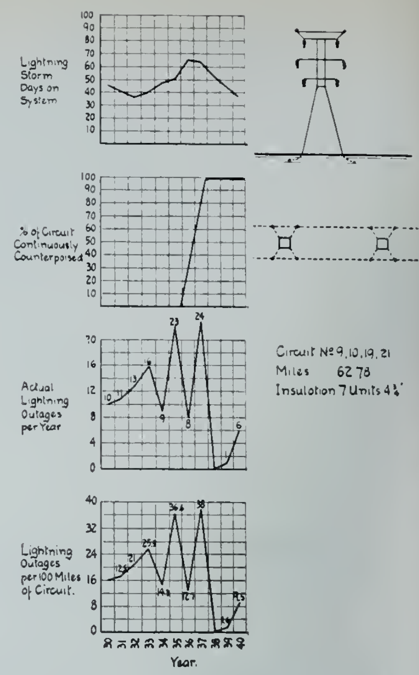

Fig. 13—110 kv. lines operating at 110 kv. and 60 kv. Counterpoised 100%. Outages reduced to zero, one year only.

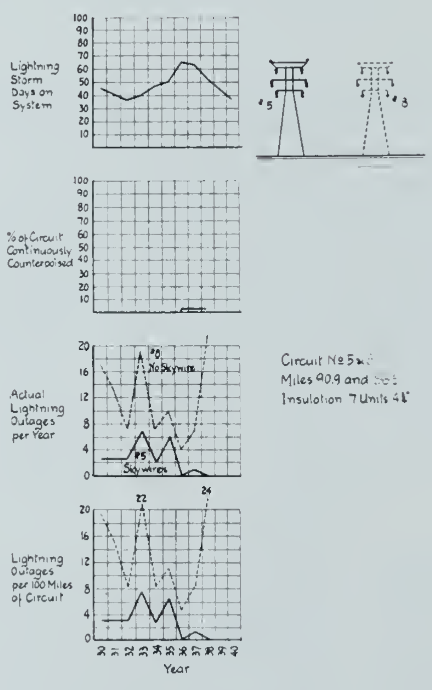

Fig. 14—Comparison of 110 kv. lines with (No. 5) and without (No. 8) sky wire.

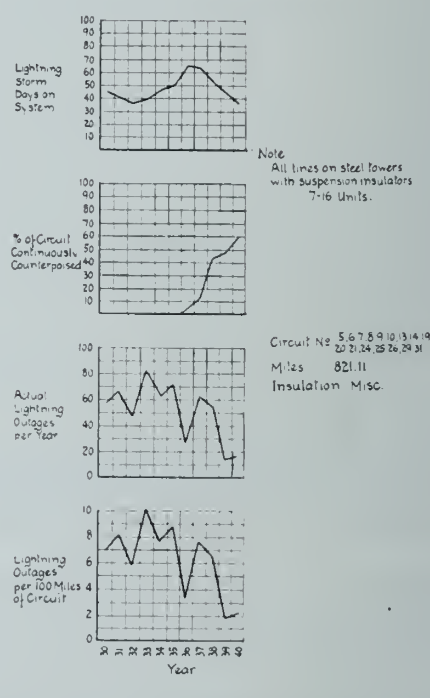

Fig. 15—Graphs for all 60, 110, 185 and 220 kv. lines with partially continuous counterpoise showing that with 60% of circuits continuously counterpoised outages have been reduced 75% that is, from 8 to 2 outages per 100 miles of circuit per annum.

where they are going by virtue of their concentration or potential difference.

The sky wire functions as a collector of lightning, also it acts as part of the shunt or bonding circuit between the towers. Thus it supplements the conduction of the earth's crust and other ground connections, continuous counterpoise, etc.

Before anything definite can be decided in reference to height of sky wires or lightning rods, it is believed essential that adequate continuous counterpoise grounding be provided to run off, without dangerous rise of potential, the very high lightning currents.

Fig. 14 has been included to show that a tower line equipped with sky wires has a better record than a tower line with no sky wire. Tower lines No. 5 and No. 8 are 50 ft. apart on the same right of way for a distance of 90 miles and present a fair comparison of the case. It should be noted that a small amount of counterpoise was installed in 1936.

There are volumes of records to show the protecting value of the sky wire, and recent records combine the sky wire and the buried counterpoise or the deep driven ground rod. I do not believe any engineer would claim for sky wire 100 per cent protection in these enlightened days, but many records have been published in the last year or two which indicate a tendency to complete protection when the grounding is thoroughly carried out. Our own records are most conclusive.

TABLE I

LIGHTNING OUTAGES ON S.W. & P. CO. LINES (OPER. DEPT.)

Line Number or Name	Line Mileage as in 1939	Construction Type as in 1939	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941
1/42	81.20	Wood Pole, 60 Kv.	10	21	13	9	14	7	5	10	2	15	24	3	5	—
2/34	80.56	Wood Pole, 60 Kv.	10	21	28	9	5	12	4	13	4	17	18	6	6	—
3	46.03	Wood Pole, 60 Kv.	10	12	8	3	3	8	4	6	9	16	18	16	5	—
4	33.40	Wood Pole, 60 Kv.	10	11	4	4	8	16	9	12	0	0	0	—	—	—
5/45/46	90.90	110 Kv. Steel, 2 Cir. 2 Sky Wire	0	3	3	3	3	7	2	6	0	1	0	2	0	—
6	86.50	110 Kv. Steel, 2 Cir. 2 Sky Wire	1	3	3	4	3	6	2	7	0	3	0	2	1	—
7/45/46	90.90	110 Kv. Steel, 2 Cir.	2	8	6	5	5	3	3	6	2	3	6	1	1	—
8	86.50	110 Kv. Steel, 2 Cir.	6	17	17	13	7	19	7	10	4	7	21	3	3	—
9	15.63	110 Kv. Steel, 2 Cir. 2 Sky Wire	2	2	3	2	4	6	3	4	—	1	0	0	0	—
10	17.64	110 Kv. Steel, 2 Cir. 2 Sky Wire	0	3	2	2	4	3	1	5	1	3	0	0	0	—
11/43	159.97	60 Kv. Steel, 2 Cir. 1 Sky Wire	13	16	4	11	2	10	16	11	4	40	32	10	4	—
12/43	159.97	60 Kv. Steel, 2 Cir. 1 Sky Wire	7	12	6	7	2	9	14	8	4	40	32	10	4	—
13	8.10	110 Kv. Steel, 2 Cir. 2 Sky Wire	0	1	0	0	0	4	0	1	0	0	2	0	0	—
14	8.45	110 Kv. Steel, 2 Cir. 2 Sky Wire	1	3	0	0	0	2	0	3	0	1	2	0	0	—
15	2.05	60 Kv. Steel, 2 Cir. 1 Sky Wire	—	—	—	—	—	—	—	—	—	—	1	1	0	—
16	2.27	60 Kv. Steel, 2 Cir. 1 Sky Wire	—	—	—	—	—	—	—	—	—	—	0	2	0	—
17	37.11	Wood Pole, 60 Kv.	5	9	12	6	4	5	7	5	1	10	10	7	1	—
18	37.35	Wood Pole, 60 Kv.	4	10	4	8	2	0	3	9	0	8	9	10	3	—
19	17.72	110 Kv. Steel, 2 Cir. 2 Sky Wire	1	0	1	0	0	0	0	3	0	2	0	0	3	—
20	—	110 Kv. Steel, 2 Cir. 2 Sky Wire	3	1	1	0	1	2	0	5	5	3	—	0	—	—
21	11.79	110 Kv. Steel, 2 Cir. 2 Sky Wire	0	5	2	5	3	2	5	2	1	7	0	0	3	—
22	12.87	Wood Pole, 60 Kv.	0	3	1	2	1	3	0	4	1	8	2	0	4	—
23	32.27	Wood Pole, 60 Kv.	8	13	2	5	6	12	9	7	6	10	10	10	4	—
24/1 Tie	18.07	110 Kv. Steel, 1 Cir. 2 Sky Wire	0	4	0	0	2	3	1	0	0	2	1	1	0	—
25	135.23	187 Kv. Steel, 2 Cir. 2 Sky Wire	1	2	6	10	5	8	17	3	3	5	7	3	3	—
26	135.23	187 Kv. Steel, 2 Cir. 2 Sky Wire	2	3	10	11	5	10	16	4	3	8	8	1	3	—
27	57.58	110 Kv. Steel, 1 Cir. 2 Sky Wire	1	3	4	1	4	1	7	4	0	3	2	3	2	—
28	.86	110 Kv. Steel, 2 Cir. 2 Sky Wire	—	—	—	—	—	0	0	1	0	—	1	0	0	—
29	6.27	110 Kv. Steel, 1 Cir. 2 Sky Wire	—	—	0	1	0	2	2	1	1	4	2	0	0	—
30	11.31	60 Kv. Steel, 2 Cir.	—	—	2	1	0	5	3	3	3	7	6	3	3	—
31	106.80	220 Kv. Steel, 1 Cir. 2 Sky Wire	—	—	3	11	6	3	4	9	7	5	5	2	0	—
32	35.40	110 Kv. Steel, 1 Cir. 1 Sky Wire	—	—	3	2	3	3	1	3	1	5	2	4	1	—
33/36/38	49.30	110 Kv. Steel and Wood Pole	—	—	—	5	6	11	12	13	4	14	7	11	4	—
34	6.58	Wood Pole, 60 Kv.	—	—	—	See	above	—	—	—	See	above	—	—	—	—
35	—	——	—	—	—	—	—	—	—	—	—	—	—	—	—	—
36	6.31	Wood Pole, 60 Kv.	See	above	—	—	—	—	—	—	—See	above	—	—	—	—
37	22.35	Wood Pole, 60 Kv.	7	12	20	6	5	8	7	4	3	7	5	2	0	—
38	16.53	Wood Pole, 60 Kv.	See	above	—	—	—	—	—	—	—See	above	—	—	—	—
39/E.A.	21.34	Wood Pole, 60 Kv.	5	4	1	6	10	5	5	2	5	4	7	8	2	—
40	7.04	Wood Pole, 60 Kv.	2	6	0	1	2	0	2	3	3	2	3	3	1	—
41	16.94	Wood Pole, 60 Kv.	3	5	0	3	1	2	1	9	1	0	1	5	2	—
42	9.10	Wood Pole, 60 Kv.	—	—	—	—	—	—	—	—	—See	above	—	—	—	—
43	1.98	Wood Pole, 60 Kv.	—	—	—	—	—	—	—	—	—See	above	—	—	—	—
44	6.85	Wood Pole, 60 Kv.	—	—	—	—	—	—	—	—	1	1	0	2	2	—
45	2.20	110 Kv. Steel, 2 Cir. 2 Sky Wire	—	—	—	—	—	—	—	—	—See	above	—	—	—	—
46	2.20	110 Kv. Steel, 2 Cir. 2 Sky Wire	—	—	—	—	—	—	—	—	—See	above	—	—	—	—
47	6.81	Wood Pole, 60 Kv.	—	—	—	—	—	—	—	—	—	—	1	1	2	—
48	2.63	Wood Pole, 30 Kv.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
No. 1 Tie	2.19	60 Kv. Steel, 1 Sky Wire	—	—	See	above	—	—	—	—	—	—	—	—	—	—
2	3.09	60 Kv. Steel, 1 Sky Wire	0	0	3	0	3	2	2	0	0	0	1	0	0	—
3	.51	60 Kv. Steel, 1 Sky Wire	0	0	0	0	0	0	1	0	0	0	0	0	0	—
4	—	——	0	0	1	0	1	0	1	0	1	2	—	—	—	—
5	3.26	110 Kv. Steel, 2 Cir. 2 Sky Wire	—	—	—	—	—	—	—	—	—	—	0	0	0	—
6	3.65	110 Kv. Steel, 2 Cir. 2 Sky Wire	—	—	—	—	—	—	—	—	—	—	0	0	0	—
7	3.65	110 Kv. Steel, 2 Cir. 2 Sky Wire	—	—	—	—	—	—	—	—	—	—	1	0	0	—
1 Anglo	3.60	187 Kv. Steel, 2 Cir. 2 Sky Wire	1	1	1	0	0	0	0	0	0	0	0	0	0	—
2 Anglo	3.60	187 Kv. Steel, 2 Cir. 2 Sky Wire	1	1	1	0	0	0	1	0	1	0	0	0	0	—
1 Laurentian	7.20	60 Kv. Steel, 2 Cir. 2 Sky Wire	1	2	2	0	1	1	0	0	0	2	0	1	0	—
2 Laurentian	31.50	60 Kv. Steel, 2 Cir. 2 Sky Wire	1	4	4	3	0	2	2	4	0	2	0	2	0	—
3 Laurentian	24.67	60 Kv. Steel, 2 Cir. 2 Sky Wire	7	7	1	1	0	3	1	5	1	4	1	3	1	—
1 Queen	4.44	Wood Pole, 60 Kv.	0	8	1	0	1	0	0	2	1	2	1	0	0	—
2 Queen	3.59	60 Kv. Steel, 2 Cir. 2 Sky Wire	0	8	1	0	0	0	1	1	0	0	1	0	0	—
Murray Bay	53.07	Wood Pole, 60 Kv.	0	7	16	16	4	11	9	0	3	14	20	8	7	—
Belgo Tie	.55	60 Kv. Steel, 2 Cir.	—	—	—	0	0	2	0	0	0	0	1	0	0	—
Can. P. Co.	.44	Wood Pole, 60 Kv.	0	3	3	2	0	0	0	3	1	1	1	2	1	—
			124	245	199	178	136	218	190	211	83	249	240	148	81	—

At the end of 1940 the Shawinigan Water & Power Company had 613.64 circuit miles of power lines, 60 to 220 kv., protected by counterpoise. This corresponds to 332 miles of tower line.

In percentage figures for the entire 60, 110, 185 and 220 kv. steel tower line system, 51.6 per cent of our circuit miles or 45.7 per cent of our tower line miles are now continuously counterpoised. In addition to this, we have the new 220 kv. line No. 35 continuously counterpoised with two wires and four wires where the resistance per tower base was measured as 50 ohms or more.

Fig. 15 is a composite graph for all the lines on which any serious counterpoising has been carried out. The total miles of circuit from which outage records are compiled is 821.11. Only 60 per cent of the total milage is protected by continuous counterpoise to the end of 1940. The graph indicates that the outages have dropped to the low figure of 2 per 100 miles of circuit. The downward slope of the outages corresponds to the upward rise in the curve indicating the percentage of circuits continuously counterpoised. With the exception of one case indicated in Fig. 13, no lightning flashovers have occurred on any lines continuously counterpoised and insulated with seven or more units in suspension at a distance greater than 1,000 ft. from the end of the counterpoise. Flashovers have occurred on the tower at the end of the counterpoise in several cases.

Tables I and II are tabulations covering complete line outages caused by lightning, and line outages on circuits under special study with reference to counterpoise, respectively.

What we now lack is two or three years' data on a transmission line protected by counterpoise alone in order to evaluate the relative protection afforded by the buried counterpoise and the sky wire. With such data on record, the actual value of the sky wire would be better understood.

Various conductors have been used for counterpoise. We use No. 5 BWG electro-galvanized steel, resistance 9.8 ohms per mile, weight 625 lbs. per mile, 0.8 ounce zinc per sq. ft. This wire is placed 18 inches underground by a specially

TABLE II

YEARLY LIGHTNING OUTAGES REFERRED TO CONTINUOUS COUNTERPOISE INSTALLATION ON STEEL TOWER LINE 60-220 KV.

Line Designation	Circuit Miles	1930		1931		1932		1933		1934		1935		1936		1937		1938		1939		1940	
		% Prot. by D.C.C*	Line Outages.	% Prot. by D.C.C*	Line Outages.	% Prot. by D.C.C*	Line Outages.	% Prot. by D.C.C*	Line Outages.	% Prot. by D.C.C*	Line Outages.	% Prot. by D.C.C*	Line Outages.	% Prot. by D.C.C*	Line Outages.	% Prot. by D.C.C*	Line Outages.	% Prot. by D.C.C*	Line Outages.	% Prot. by D.C.C*	Line Outages.	% Prot- by D.C.C*	Line Outages.
No. 5, 6, 7, and 8	346.0	—	29	—	25	—	18	—	35	—	14	—	29	.96	6	.96	14	34.0	27	34.0	8	55.3	5
No. 9, 10, 19 20, 21, 22	60.68	—	10	—	11	—	13	—	16	—	9	—	23	24.6	8	98.0	24	98.0	0	98.0	1	98.0	6
No. 13 & 14	16.2	—	0	—	0	—	0	—	6	—	0	—	4	—	0	—	1	—	4	100	0	100	0
No. 24	15.54	—	0	—	0	—	2	—	3	—	1	—	0	6.1	0	6.1	2	6.1	1	6.1	1	6.1	0
No. 25 & 26	270.46	—	16	—	21	—	10	—	18	—	33	—	7	—	6	—	13	22.9	15	22.9	4	31.3	6
No. 29	5.43	—	0	—	1	—	0	—	2	—	2	—	1	—	1	—	4	—	2	100	0	100	0
No. 31	106.8	—	3	—	11	—	6	—	3	—	4	—	9	—	7	45.0	5	92.8	5	92.8	2	97.6	0
Totals	821.11	—	58	—	69	—	49	—	83	—	63	—	73	2.3	28	13.7	63	41.5	54	47.6	16	60.0	17
Outages per 100 Circuit Miles	—	—	7.05	—	8.4	—	5.96	—	10.1	—	7.68	—	8.9	—	3.4	—	7.68	—	6.56	—	1.95	—	2.07
Circuit Miles Counter-poised	—	—	—	—	—	—	—	—	—	—	—	—	—	19.23	—	112.09	—	339.33	—	391.05	—	492.61	—

*D.C.C. is the abbreviation for Double Continuous Counterpoise.

constructed plough drawn by one or two tractors. The cost of installation, exclusive of any property arrangements, is approximately $100.00 per wire-mile. Figure 16 shows the relative location of the wires.

Conclusions

1. The earth near rivers is usually washed clear of conducting salts and acids and has high ohmic resistance.

2. Buried counterpoise continuous tower to tower, from powerhouse to substation, is giving excellent operating records through lightning storms.

3. The cost of such protection from lightning flashover is comparatively low.

4. There is need for data on the protecting value of the continuous buried counterpoise without sky wires. Such data may lead to reduced cost of high voltage lines.

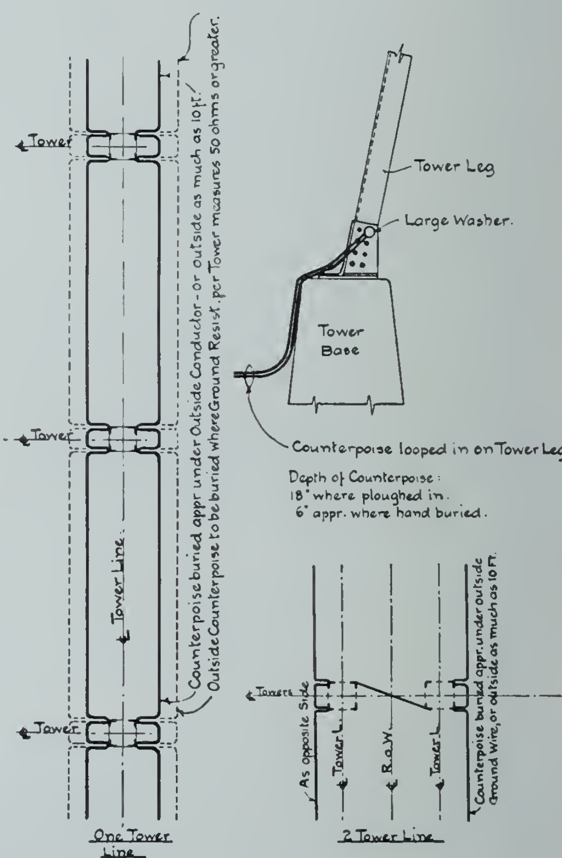

Fig. 16—Diagram showing a counterpoise installation.

DISCUSSION

W. B. Buchanan[1]

The author has presented data of a type which is important to those interested in the grounding of electrical circuits and, particularly, with respect to the protection of power lines against flashovers due to lightning. He mentions the possibility of such a study justifying the use of a lesser amount of line insulation. This may not be permissible however for other reasons—liberal factors of safety will be demanded and while insulator life is doubtless better than formerly, some allowance should be made for faulty insulators.

The writer was intrigued by the use of the term "Earth's Crust" and, after reading the paper carefully, wondered if Mr. Runciman had really reached the earth's crust as some of us have had reason to consider it. This remark is not by way of criticism, as we are quite in agreement with the author's exposition of principles and practice, but is intended as a caution that still greater variations may occur in practice than appear in the paper.

As a member of the staff of the Hydro-Electric Power Commission of Ontario, the writer has been concerned in several extensive studies in earth resistance measurements. Some of the information obtained is of interest in comparison with corresponding data in the paper.

Some years ago an extensive series of tests were made of the resistances of driven-rod or service grounds as used on distribution systems. Compilation of the data appeared to justify a division into three classes, defined as regards the character of the soil. Those in the group having low resistances were in heavy clay loam and could very well have been represented by a chart like that of Fig. 1 of the paper, considering those below 50 ohms. The second group, classed as sandy or gravelly loam, varied considerably but few exceeded 300 ohms. Dry sand or gravel, however, might give much higher values, up to thousands of ohms. It is under such conditions as these that the earthed counterpoise becomes helpful, or even necessary, if troubles due to lightning are to be minimized.

During the installation of the first 220 kv. line built by the Hydro-Electric Power Commission, from Toronto to the Quebec border, a complete series of tower footing resistance tests were made. The method of measurement was different from that mentioned by the author as extra leads and probes were not required. Two overhead ground wires were already installed and furnished an effective tie with many other lower grounds in parallel. Raising and insulating these at one tower enabled an instrument to be inserted by which the resistance of a composite loop could be measured in which the footing under test would be much the greater component.

Here again, the values were shown to depend on the nature of the soil. Throughout a clay-loam belt of thirty miles or more, resistances from four to twenty ohms were obtained and the writer believes that no lightning flashovers have occurred in this district. Real difficulty, however, became evident throughout the rocky district. Many miles of line pass through country where there is very little earth of any kind over the rock; here tower footing resistances were measured exceeding one thousand ohms and even these values were not very dependable. Some efforts were made to reduce them by connecting the footings to adjacent lakes, pockets of earth, etc., but this could not be done in all cases.

A very unusual case of lightning damage occurred in this district. The stroke passed down through a group of basswood trees about fifty feet outside of the right of way, travelled along the surface of the ground to the tower footing, up the tower and tripped out the line. The evidence was observed by many persons and this story may be regarded as authentic.

Under such circumstances reluctance on the part of engineers to guarantee 100 per cent protection against lightning is quite understandable.

Usually the possibilities of protection against lightning depend, more or less, upon economic considerations. The following example illustrates what may be regarded as an extreme but very effective use of the counterpoise.

During the construction of the Chats Falls generating plant, the writer was requested to make an earth survey with a view to establishing satisfactory grounds for all equipment and considering all possible uses of such grounds. The terrain was almost altogether rock with very little earth even as overburden. The initial problem of locating probes for measuring resistance was very conveniently solved by nature providing pools of water in pockets on the surface. The resistivity is roughly indicated by the value of 1,800 ohms obtained as the resistance between two pools each of approximately one hundred square feet area and not more than fifty feet apart.

The net results of such tests led to the installation of two heavy copper cables between the remote ends of generating and switching stations, supplemented by additional leads to various pockets of earth in the vicinity that might have value. This constituted really an artificial earth of large dimensions and seemed to be the only practical solution of the grounding problem.

The overhead ground-wire network was also given careful study and an extensive screen was installed. The fact that the station, so far as we have been able to learn, has been immune to any harmful effects from lightning, speaks well for the soundness of the design.

In view of the last conclusion stated in the paper, the writer would suggest that overhead ground-wire and counterpoise should be regarded as supplementary rather than competitive in their effects. Available data tend to indicate that a sky-line may be so placed as to shield the power conductors almost 100 per cent from direct strokes, that the induced surge on the power conductor with a satisfactory ground plane such as should result from the use of counterpoise would be only one-half (or less) than the potential in the sky-line in case of direct stroke and that such induced charge would contain only a small fraction of the amount of energy of the main stroke and be dissipated much more quickly. If lightning could be persuaded to confine its attention to the towers only, the path of the current being at right angles to the power conductors, there would probably be very little induced charge on the latter, but with long span construction, particularly, the chances of doing this seems very remote.

In connection with the data submitted, I would like to ask:

1. Re Fig. 8. Are the poles which are noted as O.K. after the storm, equipped with down wires and ground rods, or have the poles on which the detectors were mounted been required to drain the most of the discharge?
2. What means are used to install rods to depths of from 40 to 112 feet as noted in the table, Page 173?

I must confess inability to absorb all the information contained in this paper within the time available, or appraise its value. However, we shall doubtless have occasion to refer to it in future studies.

Lachlan Gilchrist[2]

The following comments are offered on Mr. Runciman's paper:—

I. With reference to the character of the ground and the tower base resistances.

It is a little difficult to understand the great differences in tower resistances from tower positions 0 to 90 in Fig. 1,

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which seem to occur at rather slight but sharp rises in elevation. Possibly these are due to the use of the three-point method of measuring the resistance as shown in Fig. 5. In this method even a narrow section of very dry sand close in at the tower footings—dry because of a slight increase in elevation—would cause a high resistance reading which would hardly give a true indication of the average resistivity of the ground at some distance from the tower footings. An occasional check at some of these places could be made by making a four-point reading, i.e. separating C_1 and P_1 and grounding P_1 at least halfway from the tower footings to the potential probe ground rod P. To make a fair comparison the specific resistance or resistivity should be calculated for each of the resistance readings on the "Megger" earth tester.

II. With reference to the theory associated with Fig. 6 there is this added theory.

The negative electrons on the cloud draw to the top of the towers positive charge from the earth which gathers at the top of the towers and perhaps also on the sky lines in considerable density, σ. This positive charge acts with an outward force on itself of $2\pi\sigma$ dynes per sq. cm. and this outward force depends on the value of σ, which is greater the sharper the tops of the towers. There is also the pulling force of the negative electrons on the cloud on the positive charge on the top of the tower. The result is a silent discharge from the towers to the cloud which tends to neutralize the negative charge on the cloud and consequently lowers the potential drop between the cloud and the tower to a value below that which is necessary for a lightning discharge, thus avoiding the ionization of the air about the insulators and the consequent spill-over. This is similar to the ordinary lightning-rod effect and it would appear that the towers act as lightning-rods, perhaps slightly inefficient if not supplied with points at the top and not thoroughly counterpoised to as low a ground resistance as possible. According to this theory the towers on the peak elevations of ground are the best lightning-rods, but probably are the most difficult to provide with the lowest possible ground resistance. Hence it is evident that a special effort should be made to obtain this low ground resistance for the elevated towers.

III. It is interesting to note that Mr. Runciman's experiments indicate considerable advantages in the continuously counterpoised towers over those with sky lines. The conclusion seems to be that the lightning-rod effect of producing a silent discharge is largely due to the towers and very little due to the sky lines. In any case it might improve the efficiency in decreasing outages by making the towers more lightning-rod-like in character with projecting points, and lowering the ground resistance of those towers on high elevations. Further, the continuous underground line between towers might be attached to counterpoise plates at several well chosen places between the tower positions, in order to make the grounding resistance as low as possible. This should be of considerable assistance in diminishing the number of spillovers.

Claude Gliddon, m.e.i.c.[3]

I am glad to offer the following comments on Mr. Runciman's paper:—

1. The phenomenon of high ground resistance near rivers as observed by Mr. Runciman is new to us. It should be possible, however, to compare observations of ground resistance made in the vicinity of many rivers by other observers and thus determine whether this phenomenon applied generally to all rivers. Gatineau Power Company's observations so far have indicated that ground resistance depends largely on the nature of the soil (clay being low resistance and sand being high resistance) and moisture content.

2. The advantages of counterpoise for reducing lightning outages, as observed by Mr. Runciman, bear out the experience of other observers. A considerably longer period of record will be required to determine quantitative results.

3. The suggestion made in the paper that improvement in line performance may sometimes be more economically obtained by other means than simply adding more insulators, is a very good one, and is an important consideration in transmission line design.

Edwin Hansson[4]

Mr. Runciman's paper presents a most convincing case for the value of sky wires and low footing resistances combined with ample insulation as a means of lightning protection for high tension lines.

The author comments on the poor soil conductivity near some of the rivers. It is a well known fact that the conductivity varies with the composition of the soil, and clean sand is practically non conductive. What surprises me is the high conductivity with which Mr. Runciman is blessed in his territory. On our system, soil resistance varies from 3,000 to 10,000 ohms per cubic foot, as determined during a partial survey by A.T. & T.

I do not think it is necessary to wait for records from a line equipped with counterpoise but no sky wires. In a paper by Edgar Bell (*AIEE Transactions* 1940, Vol. 59, p. 822) he states that "three out of every four strokes to an overhead-ground-wire section of this line occurred to such wires between structures." It seems reasonable to assume that a large number, if not practically all, of these strokes would have caused flashovers if permitted to contact the conductors.

On page 175 the author mentions the lack of two or three years' experience with a counterpoised line without sky wires. I want to say a word of caution against putting any reliance on short time records in connection with this subject. The factors are so many and so varied that even ten years is none too long to get valid evidence. The number of strokes per 100 miles of line varies greatly from year to year and, in addition, there is a great variation in severity of strokes. In comparing the four-year record of two different lines we find that the number of strokes per 100 miles per year varies from 54 to 129 for the one line and from 85 to 232 for the other, and the minimum for the one occurs the same year as the maximum for the other.

The author deserves to be congratulated on having kept and published such careful records. Every such contribution goes a long way to clear up a subject of which we know none too much.

K. B. McEachron[5]

There is little question in my mind but that flashovers on transmission lines are caused, in some cases, by lightning strokes to points so located with respect to transmission lines that currents flow from the point of contact on the earth's surface to the transmission line tower, up the tower, and may well cause flashover of the transmission line conductors.

It would be expected that such a phenomenon would occur most frequently in places where the soil is of poor conductivity, so that when flashover occurs, the transmission line tower, and its conductors present an appreciably better chance to secure connections to earth.

Although I have no factual data with respect to transmission lines, I have known several cases in which the following conditions were typical: lightning struck a tall pine tree leaving its characteristic mark over the surface of most of the tree, which was about 60 ft. in height. From that point it travelled over the surface of the ground horizontally, leaving a characteristic furrow in the earth's surface. This furrow terminated at the base of a telephone

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[4]Pennsylvania Water & Power Company, Baltimore, Md., U.S.A.

[5]Research Engineer, General Electric Company, Pittsfield, Mass., U.S.A.

pole, which was split on the outside up to the point of attachment of a pair of telephone wires. Considerable damage was noted on the telephone circuit, in a cable on one side and in the subscribers' station on the other side of the split pole. There was no damage observable to the pole above the point of attachment of the wires. This indicates the phenomenon very clearly.

In the case of a steel tower line, or a wood pole line with down wires, using overhead ground wires in either case, such a stroke of lightning would find its way to earth down a considerable number of towers in parallel, due to the presence of the overhead ground wire. If tower footing resistance were high, flashover still might ensue, particularly on the structure or structures over which the lightning current originally flowed from the earth, presumably nearest the point struck.

I would expect that a buried counterpoise at the base of such structures would assist materially in those cases where strokes did not make contact with the transmission line, but did occur close enough to it so that considerable volumes of current must be dissipated. In this case, the buried earth counterpoise would act to distribute these charges over sufficiently wide areas so that flashover would not occur. This perhaps is a partial explanation of the phenomenon indicated by Mr. Runciman, particularly in paragraph 4 of his conclusion. It is to be noted in this regard that overhead ground wires with frequent down connections to earth are not only helpful in this way but they are also advantageous in connection with strokes which are to be diverted from the transmission line through the protective tent offered by the overhead ground wires.

On the other hand, a buried counterpoise without the overhead ground wires will be useful only in those cases where lightning occurs nearby and does not strike the transmission line. It is probable with the lower ground resistance resulting from the use of the counterpoise, that for strokes to the transmission line conductors, flashover is somewhat more likely, because of the presence of the counterpoise. This naturally leads one to the general conclusion that counterpoise plus the overhead ground wire results in the most satisfactory combination, taking care of both strokes to the line and strokes nearby, provided the ground resistance and the insulation on the structure are suitable.

It is interesting to observe that a negative stroke to a point near a transmission line, travelling to the base of a tower, and up a tower, would be registered as a positive stroke on a magnetic link connected to that tower for the purpose of measuring lightning currents flowing through the tower structure. This may explain some of the positive records which have been obtained in the past.

THE AUTHOR

It is interesting to note that both Mr. McEachron and Mr. Buchanan mention cases of lightning hitting nearby and travelling to conductors on pole lines. Mr. McEachron's case was a telephone line and Mr. Buchanan's a power line. No doubt there are many such cases but it is not easy to obtain the evidence. This type of lightning stroke is taken care of readily by the use of a buried counterpoise, which is assisted in many cases by the parallel sky wire. The point which is not at all clear as yet, is the reason for advocating trials without sky wires. This theory is based on the fact that the lightning stroke path is an expansion of a smaller current flow through the lowest resistance path. Some idea of the theory may be obtained by studying pictures, which were incorporated in a paper by Mr. Goodlet in the Journal of the Institution of Electrical Engineers, dated July, 1937.

In the discussion following the paper, page 46, Mr. F. J. Miranda produces these pictures, giving credit to Stekolnikov for making the original experiment. The experiment consisted of a buried metal sphere and two sand cones. Overvoltage discharges flashed both to the cones and to the metal ball buried below the surface of the sand. The voltage was considerably higher than that required to just flash to the cones and, therefore, built itself a path of low conductivity through the longer gap to the buried sphere. A careful study of these pictures indicates that this is correct and, in the case of a well counterpoised steel tower transmission line, the lightning would be expected to strike one or more steel towers, on account of the fact that this path would be the lowest resistance circuit; that it would have lower resistance than another circuit involving the conductor.

Mr. Hansson's reference to Edgar Bell's paper citing a case where three out of four strokes contacted the overhead sky wire does not prove that the conductors would be struck if the overhead sky wire were not present. It rather tends to prove that the sky wire circuit is a good path to ground and that height is not the sole factor in the establishment of the lightning stroke circuit. The author's opinion is that if the sky wire were absent, the lightning stroke would contact the best ground, which would be the top of the tower.

Mr. Hansson's question re the relative resistance of earth in Quebec and Maryland requires the explanation that we were using an earth tester, whose top limit was 3,000 ohms. No doubt the resistances were higher than could be read. It is probable that Quebec and Maryland and other soils elsewhere read up to his figure of 10,000 ohms per cubic foot.

The author does not disagree in the use of sky wire, but believes that when the above phenomenon is better understood, engineers will feel more satisfied to design transmission lines well counterpoised and possibly omitting the sky wires.

To quote from a letter received from A. E. Silver, consulting Electrical Engineer, Ebasco Services Inc.: "It is the opinion of those who have been observing the performance of this line that substantial benefit has resulted from the continuous counterpoise in the way of reduction of the number of single phase tripouts and apparent elimination, during the period in use, of three-phase faults, occasionally being experienced before the counterpoise was installed."

This statement refers to a 35-mile section of the Wallenpaupack-Siegfried 220 kv. line, which was equipped with counterpoise and no sky wire.

To answer Mr. Buchanan's point, in reference to reduced insulation, it should be pointed out that the minimum insulation for a 220 kv. line in wet weather would be about six suspension units, and some other companies, eighteen to twenty-four units. The extra units are there because of our fear of lightning flash over and the occasional defective unit.

Replying to Mr. Buchanan's other questions:

1. The poles were equipped with ground wires in which some sort of gap is inserted to increase the insulation to lighting from 200 kv. to 600 kv.

2. The gasoline driven Barco hammer drives rods to any required depth.

GAUGES FOR MASS PRODUCTION

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Paper presented at the Annual Meeting of the Ottawa Branch of The Engineering Institute of Canada, Ottawa, 9th January, 1941.

SUMMARY—This paper deals with gauges which are among the most essential tools for quantity production of duplicate and interchangeable parts. The subject is treated with particular reference to developments in recent years and to current practice in Canada.

Gauges are essential tools for the quantity production of duplicate and interchangeable machine parts. They are used to measure and control the size and accuracy of the manufactured pieces, and should be on hand before actual production begins. The critical task in manufacture is to know when and where to stop the removal of material. When only a small quantity of parts of mechanisms are required, standard shop measuring instruments are adequate. However, when large scale or mass production is involved, the use of such instruments is slow, expensive, and presents many chances of error.

Mass Production of Interchangeable Parts

In mass production no two pieces of a series coming from a machinery process can have exactly the same size or form. To ensure satisfactory assembly of the complete machine, limits must therefore be specified for each part, within which the dimensions and shape of all acceptable parts must lie. The closer these limits are, the more expense is incurred in manufacture, and in inspecting the pieces for acceptability.

Thus, for example, in a pair of parts, involving a cylindrical plug which has to fit a cylindrical hole, gauges must be provided which will make sure that the smallest hole and the largest plug will fit properly and, similarly, that the largest hole and the smallest plug will be satisfactory. It is also necessary to ascertain that both the hole and the plug are reasonably cylindrical and that the parts are everywhere within the dimensional limits or tolerance required by the designer. The plug must not be larger than a given dimension; a snap or caliper gauge, of that size, which fits over the plug provides this assurance and is known as the "high," or "high limit" gauge, or the "go" gauge. Similarly, the plug must not be too small, and if a gauge of the same type, but of the smaller dimension required (the low limit),

Fig. 1—Ring and plug gauge.

will *not* fit over the part at any point, it follows that the plug is within the specified limits—the high limit and the low limit.

It will be noted that, because the "go" gauge has accepted the plug, wear of this gauge will result from repeated use. However, if the low or "not go" gauge has been too small to receive the part or plug, then wear of this gauge, except possibly at the point of entrance, has not occurred. Here we have a simple example of limit gauges. All plugs, which are received by the "go" gauge and are not received by the "not-go" gauge, are considered to be within the required limits and are acceptable. While both gauges can be made in one piece and, in certain cases this design is convenient from the standpoint of inspection, the usual practice is to make a separate gauge for the high limit and another gauge for the low limit. It is noted that since the "go" gauges wear, a large number of them will be required, while a relatively small number of "not-go" gauges will be needed.

Gauges are commonly made of tool steel and require for their manufacture the services of skilled tool makers. They are produced by successive operations of roughing, hardening, grinding, and lapping. They are expensive, ranging in price per unit from a dollar to many hundreds of dollars. However, the total cost for gauges may be only a small fraction of the cost of the finished product. In making the gauges themselves, the permissible tolerances are of course

Fig. 2—Snap gauges.

much smaller than for the parts whose sizes they control. In typical cases, the gauges are within .0001 in. or .0005 in. of the nominal size, with .0003 in. as a common value. This tolerance is, when possible, allowed in the direction of wear.

We have seen that gauges are necessary to provide speed, economy, and accuracy in mass production. While they may be required during the tooling-up process, their normal application is for the inspection of the finished product. This inspection usually occurs at the establishment where the mechanisms or parts are made. Gauges must be handled with care, protected against excessive shocks or extremes of temperature, must be kept under competent supervision, and replaced as soon as worn beyond the permissible allowance.

Classification of Gauges

Various types of gauges may be classified in the order of difficulty of their manufacture, as thread, profile, fixture, ring, snap and plug gauges. Shop gauges are often provided for preliminary shop inspection. In this case the gauge tolerance may be the same as for inspection gauges but the limits are reduced to insure acceptance of the parts upon final inspection.

Manufacturing Technique

Plug gauges (as shown in Fig. 1) may be roughed out in a common engine lathe, but when any considerable quantity is required, turret lathes are used. In order to economize material and to facilitate renewals, separable handles are often provided. A limited number of different-sized handles serves a large variety of plug gauges. The gauge may be pinned to the handle. Naturally, the weight of the handle must be properly related to the gauge. A handle which is too heavy introduces a risk of damage to the gauging surface or breakage in handling.

The tool steel gauging portion may be manufactured in a turret lathe and, after hardening, be ground to approximately the required dimensions, from .0001 in. to .0003 in. of material being left on for the final lapping or polishing operation. This lapping may be done in a lapping machine, or by hand.

Snap gauges may be made from drop-forged blanks, be forged from material approximating the dimensions required, or be cut from the plate (see Fig. 2). In the latter case, the gauges are roughed out, ground on the faces and then finished in gangs, as many as twenty being handled in this manner. The economy of the method is obvious, when it is realized that, for example, if a gang of only three were finished at one time, the two end gauges of the gang are sometimes scrapped, due to the behaviour of the wheel at the entering and leaving points of the gang. Certain types of gauges require a minimum of two in the set-up. Flat grinding is done by a surface grinder on which the rotating wheel is mounted. The gauge, commonly held in position by a magnetic chuck, is moved back and forth in front of the wheel, which has been dressed, usually with a diamond pointed tool, to provide the necessary flatness of surface.

In the lapping machine, the gauge itself, if it is a plug gauge, may be rotated and is embraced by a cylindrical nut provided with an adjustment to permit closing in as required, and held from turning, usually by hand. The lap may be of cast iron, steel, or other suitable material, impregnated with an abrasive—diamond dust, carborundum, or the like.

The Gauging Surface

Finishing the gauging surface is an expensive process. Three classes of gauging surface are in use. Of these, the finest is described as a mirror finish, and is the most costly. The cheapest, or commercial finish is less polished and some of the marks left by the grinder may remain. Plug gauges are ground on a cylindrical grinder in which the gauge is rotated. The wheel is mounted in a similar manner to the tool post of a lathe, but at the back. The external cylindrical grinder is usually provided with a cooling liquid to control the temperature of the gauge being ground. The wheels of most modern grinders are motor driven. Internal grinders are available for diameters as low as ¾ in.

Fig. 3—Male and female screw gauges

Thread Gauges

Thread gauges are difficult to make, require thread grinding machines—which are expensive—and are the first concern of the gauge production man. Typical forms are shown in Fig. 3. Thread-grinding machines, hereafter referred to as thread grinders, must provide the necessary accuracy in pitch and with it, a suitable form of thread. These machines are of two kinds; the universal type in which any desired pitch or number of threads per inch may be obtained by the use of a suitable gear train which actuates the lead screw of the machine, and a second type which requires a lead screw and nut for each desired pitch. The former tends to have a higher first cost. The cost of the latter is dependent upon the variety of pitches required. Very substantial progress has been made in the art of thread grinding in recent years. The requirements of a thread grinder are an accurate lead screw, accurate ways, carriage, satisfactory wheel dressing devices, and a suitable non-rusting, non-inflammable cooling fluid. The switch control board of a modern thread-grinding machine is quite elaborate. The tendency has been to provide the operator with devices which will permit control of measurements and inspection of the gauge as the operation proceeds. The value of the thread grinder will be appreciated, because with the earlier method the hardening process, which followed the final machining operation, tended to change the dimensions of the piece, thus altering the pitch. Attempts to correct this inaccuracy in pitch by further lapping usually resulted in an unsatisfactory form of thread.

Fig. 4—Fixture gauges.

While thread gauges for well casings having a V-form had been ground previously, it was not until 1917 that thread grinders were developed for Whitworth threads. Machines of each type described above, but in crude form, were tried out at that time. The most successful thread grinder of this early period consisted of an old Norton cylindrical grinder, which was adapted for this service, and had the added advantage of the cooling fluid. Thread grinders made it possible for tool steel to supersede the pack-hardened machinery steel previously used. This contributed to a reduction in the price of a 2-inch threaded gauge about one inch long from \$100.00 per unit to about \$10.00 in a few months.

Due to a tendency of thread gauges to chip and to wear rapidly, it is usual to leave a softer gauging surface than is the case in other types. The feather edge which results at the end of the gauge is ground back until the entering thread has full form. In order to provide for the removal of debris which tends to collect in the parts to be measured, it is usual to cut a slot axially across the threads; this provides a tapping action, the groove serving to collect the chips and dirt.

During the current year at least one manufacturer has adopted the thread grinder to grind commercial threads for optical instruments.

Details of British Standard screw threads are given in the publications of the British Engineering Standards Association, London, those of American Standard screw threads, by the American Standards Association, New York.

In most thread grinders production is limited to the plug form, that is to say, they are simply external grinders. In the case of ring thread gauges, it is usual to grind the taps and laps in the thread grinder. These may be made in sets of two or three each.

In order to guard against an erroneous impression that thread gauge production to-day is a simple matter and without hazard, it may be mentioned that recently one manufacturer lost 35 thread gauges out of a total lot of 50. This occurred due to cracking during the grinding process. In this case the onus was placed on the tool steel.

Optical Projection Apparatus

Among the devices which have contributed to the successful production of modern thread gauges, optical projection apparatus is the most outstanding. This aid to the inspection of thread gauges was developed in 1916, at the gauge laboratory of the Imperial Ministry of Munitions at Ottawa. In this early design, a direct current arc was used to project the shadow of the thread form on a screen placed at a distance of from 15 to 30 feet. On this screen the image was compared with a diagram having the correct form. It was necessary, of course, to rake either the beam or the gauge in order to secure the clearest possible definition, and the device was of great value in assisting the manufacturer to get a clear picture of his gauge production troubles. It must be remembered that even when the above precaution has been taken, the image is not the shadow of a straight line element, but rather that of two curved surfaces. Some tendency to error is due to parallax and to the differences which exist between the actual image and the image which would be obtained from a thin longitudinal section or lamina cut by planes passing through the axis of the thread.

Special Machines

Another machine, the jig borer, developed in recent years, is used in the production of fixture and profile gauges (see Figs. 4 and 5). This machine, in which the movable table can be set to bear on Johansson blocks, makes it possible for a hole to be located within .0002 in. or less.

Certain of these machines, utilizing the principle of the pantograph, are adapted for the manufacture of profile gauges.

Some types of profile gauges are made by special fixtures in which either the gauge or the grinding wheel is carried at the end of a radius arm of adjustable length to suit the particular gauges concerned.

Gauge Inspection Equipment

Comparing the position to-day with that in 1916, it is recalled that at that time only two sets of Johannsson blocks and two Rivett lathes, having a very accurate lead screw, were available in Canada. A Pratt and Whitney

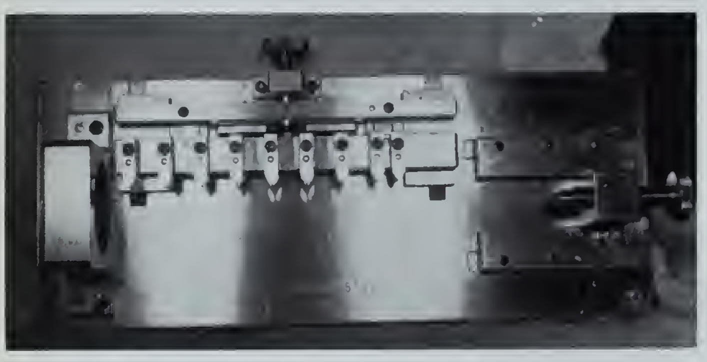

Fig. 5—Fixture gauge.

measuring machine was obtained to facilitate precision measurement of gauges. Johannsson blocks are now to be found in most of the better tool shops. A set of them is shown in Fig. 6. These, originally developed in Sweden, are small steel blocks of which two faces are plane and parallel within an accuracy of one-hundred–thousandth of an inch—an amount three hundred times less than the diameter of a human hair. In the gauge shops, such blocks provide the standard for measurement, and are in use wherever gauges are to be verified. Johannson blocks are now manufactured in the United States, as are the somewhat similar Hoke gauges. The latter are an interesting development of 1917, and are stated to have comparable accuracy. These reference blocks are checked by interferometer measurements, utilizing the interference of light waves.

Plug thread gauges are measured as follows: the full, effective and core diameters are found by means of a micrometer or measuring machine in conjunction with accurate cylindrical wires; the form of thread is checked by the same means in conjunction with the projection apparatus; the pitch by means of a pitch measuring machine of which the Pitter is an example. This is used in conjunction with the projection apparatus and it is usual, as a final precaution, to have a threaded ring gauge or check into which the plug thread gauge must fit. Plaster casts of the threads of ring thread gauges may be used to assist in checking the form of thread; certain kinds of dental plasters can be used for this purpose.

The accuracy of a surface as regards roughness may be measured in microns by means of an electrical device, the profilometer. Chips, cracks or internal fractures in precision parts, which are difficult or impossible to discover by ordinary methods are detected by means of the X-ray, magnaflux or other devices.

Dial indicators with plain, partially jewelled, and fully jewelled bearings are used for production, shop and gauge inspection, as is also a companion device, the comparator. The latter consists of an accurate anvil surmounted by a dial indicator and suitable lighting devices which permit a quick comparison between, for example, a Johannsson block and a part or gauge which is to be measured.

The Solex system of gauging, which depends for its operation on an air blast, is especially adaptable for measuring long cylindrical parts of which internal measurements are required.

Space will not permit the discussion in this paper of the various forms of pitch measuring devices, plain and thread micrometers, height and depth gauges, surface plates and straight edges, which are essential for gauge inspection.

Hardness

Devices for measuring hardness include the Rockwell, Vickers, Brinell and the Shore scleroscopes.

The Rockwell method is most commonly employed in Canadian shops, and for commercial gauges, a hardness ranging from sixty-two to sixty-four Rockwell has been found acceptable.

All of these devices have the disability that they cannot be applied directly to the gauging surface without causing damage. When the gauge is made of tool steel, satisfactory results may be obtained with a hardness tester. However, there is a wide-spread disposition to employ a fine Swiss file to test the actual gauging surface, which, if it is scratched by the file, is considered to be too soft. Some manufacturers regularly draw the hardness from the gauge at other than the gauging parts, in order to reduce internal strains, the risk of breakage, and to give added strength. A stabilizing process is applied to most of the more accurate gauges.

Temperature Control

Gauges and measuring equipment should be at approximately the same temperature for routine inspection. Certain firms install a temperature-control standards room with a range of precise measuring equipment, to give an immediate ruling on all questions of accuracy and to keep a rigid check on their gauges.

Wear of Gauges

The wear of gauges, the durability of different types of steel and the effect of different heat treatments, are questions which have received a good deal of attention in recent years, more particularly in connection with screw gauges, the life of which is short as compared with that of gauges of other types. This is due to the greater length of travel of the screw gauge for each gauging operation. For example, the two-inch thread gauge already referred to, when applied to the part to be measured, travels a distance of about twelve feet in gauging one part. A plain gauge of similar dimensions would travel only about two inches in one gauging operation. Experience has shown that a hard lapped steel gauge of these dimensions can only be depended upon for about 6,000 inspections before becoming worn beyond allowable limits. An overall length gauge, on the other hand, may serve for about 300,000 parts. Wear of gauges also depends upon the material and the quality of the surfaces to be measured. Thus, a gauge used in inspecting steel parts may have only about one-quarter the life of a similar gauge used for inspecting brass parts. A short pilot may be provided at the tip of thread gauges to reduce trouble experienced from progressive chipping away of the first threads in ordinary use. It has already been stated that the specified standard of hardness for screw gauges is definitely lower than that for other gauges.

Re-inspection for Wear

Various methods are employed for the re-inspection of gauges for wear. Some gauges can be examined from time to time simply by the application of a suitable check which will ensure that the gauge has not worn beyond allowable limits. However, when the allowable life of a gauge is not known, and future requirements have to be estimated well in advance of production, it is usual to report the measurement of each re-inspection, serial numbers being assigned to each individual gauge. One Canadian manufacturer regularly inspects and reports on all shop gauges every 48 hours. When gauges are placed in service, wear begins at once and provision must be made for the replacement of

Fig. 6—Johannsson gauge blocks.

worn gauges or parts thereof as the case may be. Having this in mind, the designer should provide as far as possible for salvaging by the replacement of relatively inexpensive parts, such as pins, ball points, and the like. For example, in the pin type snap gauge, the gauging surfaces consist of pins, commonly screwed into the body of the snap gauge and provided with suitable locking and sealing devices. Similarly, threaded roller type gap gauges are used for the measurement of threaded parts; these are amenable to adjustments as to the diameter of the part and may be designed in such a way that the threaded ring can be rotated from time to time, so as to present a new gauging surface.

Cylinder gauges may be provided with a hardened ring set at the entering edge of the gauge, which can be cheaply replaced.

Caliper gauges are usually designed with an adjustable ball point, which is replaceable.

Certain adjustable threaded ring shop gauges are reclaimed by closing in the gauge and relapping. When very accurate inspection is required, and especially when the gauge takes the form of a threaded concentricity gauge, the solid type is preferred and indeed may be required. This type does not lend itself to this method of salvage.

Chrome Plating

Hard chrome deposited by electrolysis is used for the rectification and repair of gauges. This material when

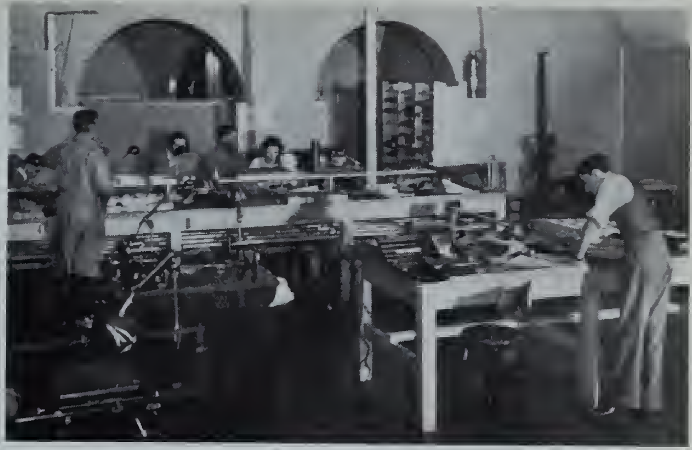

Fig. 7—Corner in National Research Council gauge laboratory.

ground and polished provides an excellent mirror gauging surface, having approximately five times the wear of a polished hardened steel gauge.

For snap, plug, ring and cylinder gauges, the cost of reclamation ranges from one-quarter to one-half the cost of the original gauge. In repairing old gauges, it is usual to grind off from .002 to .003 in. from each gauging surface. The chrome is then deposited, ground and finally polished. It is claimed that a hard surface is required for the deposition of the chrome. In some cases, the hardness of the steel is drawn back to 42 Rockwell. This practice is not general. However, experience has shown that gauges, in which the chrome surface has been scratched, have failed, owing to cracking of the steel. It may be that when the concentration of stress occurs in the hard chrome, the steel does not have sufficient resilience to resist the beginning of a crack. The result follows the conventional picture of such failures. The author, while admitting the need for a hard base for chrome, is of the opinion that there are limits for the resilience of the base metal and that hardness is a factor in a successful technique. Reclamation of Whitworth plug-thread gauges by chrome plating has been successfully carried out on this continent. In this case, the tendency for the chrome to heap at the crest of the thread has been overcome by placing an electrode at the foot of the thread. This is a significant development.

Tungsten carbide is being used successfully on gauges which are subject to exceptional wear.

Nitriding

Nitrided steel has a very hard surface, but unless the material has a special heat treatment after the process of nitriding, it tends to chip away at the very hard skin. The fact that the process of nitriding causes an increase in the dimensions of a steel gauge makes it necessary to grind after the nitriding process. This is quite possible, but care has to be used to avoid grinding through the hard outer casing. Although one manufacturer abroad specializes in this type of gauge, nitrided gauges are not extensively used in this country, and the process may be considered to be in the laboratory stage in Canada.

Gauge Production

While steam engine manufacturers regularly produced interchangeable parts before the turn of the century, motor-car manufacturers have given the lead in precision work in recent years. Twenty-five years ago, they required an accuracy of .0001 in. for master gauges.

To-day, one manufacturer requires that four classes of parts be measureable within .0002 in., including intervening surfaces as shown by the profilometer.

The smaller shops which supply taps, jigs, fixtures, etc. and production parts for the motor car manufacturers, provide a natural source of supply for gauges. For the last year in which statistics are available, no gauges as such were exported from Canada and about $290,000 worth were imported annually. Only one manufacturer included gauges in his list of advertised products. To-day more than fifty manufacturers are engaged in this task.

As the production of gauges develops, the tendency is towards a substantial reduction of unit cost for any particular gauge.

Standards of Measurements

The National Research Council is the repository of standards for measurements in Canada, the National Physical Laboratory for the United Kingdom and the Bureau of Standards for the United States.

The Research Council, in collaboration with the Ontario Research Foundation, has made a very substantial contribution in the present emergency.

THE BURMA ROAD AND INDUSTRIAL DEVELOPMENT IN CHINA

Dr. C. A. MIDDLETON SMITH, M.Sc., M.I. Mech E., L.L.D.

Reproduced from *The Engineer*, London, November 22, 1940.

No triumph of the civil engineer has attracted such world-wide attention as the new road that connects the Burma and China frontier with the large inland provinces of Yunnan and Szechwan in Western China. The interest of millions of newspaper readers has been aroused because of the effect of the road upon the China-Japan War and with our own struggle for survival. "To-day the fortunes of Western civilization have become inseparable from the eternal Chinese." Those words were written recently by a renowned English journalist; it is well to remember them.

Newspapers have recently explained that the Burma Road is an astounding affair, running over high mountains, down precipitous cuttings, crossing famous gorges over dizzy bridges, and that it was built in an incredibly short time by hand labour of a patient and industrious people, with no other mechanism than a stone boulder hauled by a bullock!

They have not mentioned that there were also Chinese engineers at work on the road, engineers who had had a sound technical training in well-equipped universities. They used modern materials, such as steel and concrete, for the many bridges, culverts, etc. There was no more mechanism than was in use centuries ago, when the Chinese built the Great Wall and the Grand Canal. Yet it was their knowledge of applied science, as well as the efficient manual labour of the workers, that made it possible for the Chinese to build the road over this difficult country.

Some time ago the writer described in this journal* in detail, the engineering problems solved by the Chinese who built the road. It is now proposed to discuss "the imponderable forces" that are at work in Asia and that are rapidly changing the industrial and social systems of a large number of people in that continent. Since the spread of a knowledge of applied science has been the chief cause of these changes it may be of interest to engineers to consider them and their probable developments.

The building of the Burma Road has demonstrated what can be done by an almost unlimited supply of Chinese man power. In Malaya, Hong Kong, in China, and in other parts of the world, Chinese and British have worked together to their mutual advantage. The Chinese have supplied the man power needed for engineering and industrial schemes and the British the technical knowledge and administrative experience. It is not improbable that the present conflict will result in closer co-operation between the two nations.

Although it is my conviction that British engineers will, when peace returns, take an active part in the inevitable transformation of large areas in Asia, yet an increasing number of native engineers will be employed. The greater the number of these native engineers at work in their own countries, the more rapid will be the development of natural resources and the greater the demand for imported machinery. Foreign advice for large engineering schemes will be needed. There are now a considerable number of Chinese and Indian engineers who have a sound knowledge of applied science. My experience with Chinese engineers makes me believe that they have the patience, industry, and ability that is a sure foundation for successful work.

Moreover, the Chinese artisan is a great aid to any engineer. No more industrious and good tempered workman can be found. More than one engineer-captain, in charge of a large number of Chinese artisans in the important R.N. Dockyard in Hong Kong has expressed to me his great appreciation, and indeed admiration, for the Chinese, who so quickly learned how to use new types of machinery. Many thousands of them are in the big private dockyards in the colony, where they are building and repairing ocean-going ships of big tonnage. Many other Chinese artisans are at work in Malaya, Siam, and other parts of the Far East.

Mining and Mechanization

The Japanese invasion of China has stimulated mechanization and mining developments to an extent that seemed impossible three years ago. The Chinese intellectuals always held the Japanese in contempt, but the terrible behaviour of the Japanese soldiers in China has created an intense hatred amongst all classes, and it will live for many years. Like the people in Britain, the Chinese "can take it," and their engineers and artisans will work on until the enemy is defeated. Their tenacity of purpose has enabled China to make a steady advance in developing her internal resources; that is much more important than a spectacular military victory.

Before the Burma Road was built the two largest provinces in China, Yunnan and Szechwan, respectively 150,000 and 220,000 square miles in area, were isolated (England is 50,874 square miles in area). It is true that of late years the railway from the coast in Indo-China has connected Kunming (the capital of Yunnan province) with the sea—the railway that "cost a human life for every sleeper laid for miles along the dreaded Nanti valley." There was also difficult water transport up to Chungking, in Szechwan, 1,350 miles above Shanghai. It was exciting to make a trip in a British vessel of about 1,200 tons register, driven by oil engines of 3,500 hp., through the famous gorges, where the rapids make navigation perilous and where the difference between high and low water each year is about 180 ft. There are no British ships operating on the Yangtse to-day; most of them are laid up, and it is probable that the loss is about £250,000 per annum.

These two provinces are on a lofty plateau; Kunming is at a height of 6,400 ft. In Yunnan there are four arsenals, several power-driven factories—there are 18,000 spindles in operation—and immense mineral wealth—tin, coal, gold, etc. Kunming is 2,000 miles from the old centre of government, now called Peiping; the Imperial express took 100 days for the journey. From Chungking to Rangoon is 1,500 miles. The journey now takes about eight days by road and rail; this will be improved upon.

Kunming is 600 miles from Chungking. The total length

**The Engineer*, December 23rd and 30th, 1938.

of the road to Laschio, the railhead in Burma, is 772 miles. The Burmese Government built the 124 miles of road in their territory, and at the other end the Chinese Government had completed the 281 miles of road from Kunming to Hsiakuan two years before the outbreak of war. Since the outbreak of war more than 5,700 kiloms. of highways have been built in the interior of China, and the Minister for Communications, Mr. Chang Kiang An, recently stated that the vastness of the interior of China necessitates a huge fleet of trucks to carry on international trade.

From Hsiakuan to the frontier, 367 miles, the road was built over mountains, 8,000 ft. high. It passes over two mighty rivers (the Salwen and the Mekong) and countless valleys that make the country look like a toast rack. The gradients are appalling. There are hairpin bends where the road is only 8 ft. wide, with a drop of 2,000 ft. for any vehicle that slips over. A Chinese engineer told me, in a casual manner, "We lose on the average two lorries and three or four men every day on the road, but that is nothing in war." He reminded me that in Yunnan province alone, 10,000,000 lives were lost in the sixteen years of the Moslem rebellion (A.D. 1856-72). There were many more casualties during the Taiping rebellion in the middle of last century, but which did not affect Yunnan.

Of their present affliction, the Chinese say, "This too, will pass." In a land where flood and famine have periodically taken a toll of millions of lives, and where rebellions have decimated the inhabitants of large districts, calamities are accepted with a stolidity that astounds the English. It is a characteristic due, to a great extent, to a social code which has been observed by the race through many generations, and which insists that the family is of more importance than the individual. Brave and cheerful, industrious and intelligent, but pledged to parentage, the Chinese in his home formerly asked nothing from the outside world, and felt no "national" obligations to that outside. That social system was not likely to throw up natural leaders for a nation, such as the *samurai* in Japan. That is why this intelligent and industrious race seem to be unable to organize any large undertakings. The war and the new methods of communication have, however, unified the nation as never before. It has always been an axiom in China that the people have not only the right, but the duty, to rebel against oppression, and often have they done so. Any Chinese Government must guarantee personal freedom, but to-day it is accepted that it can not only guide but compel.

The Province of Szechwan

Their social system made the Chinese weak in organization, and so American experts were engaged to organize traffic on the Burma Road. They have effected great improvements. No doubt it is well camouflaged in the difficult country through which it runs. The Japanese will bomb it, but my inspection of craters in South China showed me they are poor marksmen. And the Chinese have huge labour battalions ready to make repairs.

Szechwan, now the home of the Chinese Government, is about twice the size of Britain and has a population at least equal to that of Japan. A tremendous influx of refugees from the Yangtse Valley has enormously increased the numbers. Many of the refugees are skilled artisans and engineers. A great amount of machinery was carried up into the province in advance of the Japanese tide up the Yangtse River. With abundance of cheap labour, it is being used, not only for military purposes, but to utilize the great variety of raw materials in the province. For Szechwan is rich in many things—foodstuffs, such as rice, wheat, maize, sugar, and oranges; minerals, such as iron, copper, salt, coal, and gold; textile materials, such as silk, wool, and hemp. A great quantity of wood oil was exported; much of it was carried in bulk in ships down the river to Shanghai. Some of the immense wealth of metal in Yunnan province —gold-bearing copper, the zinc of the Kungshan coalfield, and silver-bearing lead—was carried by coolies and animals, and later by motor trucks, to markets in Szechwan.

As long ago as 200 B.C., Chinese engineers provided a remarkable irrigation and flood-prevention scheme in Szechwan. It transformed the Chengtu Plain from waste into fertility, an area equal to that of Middlesex. Ten years ago the population on the plain was ten times as great as that of the English county, but the great influx of refugees has added to the numbers there.

Transport in South-East Asia

Last year it was my good fortune to travel some thousands of miles by motor through French Indo-China, Siam, and

The Burma Road

Malaya. Visits were also made to Manilla and Java. It was surprising to find such excellent motor roads in all these places, and to be told of the recent advances in modern methods of transport. Public vehicles were crowded.

The French engineers had done good work in Indo-China. One of them told me of a large reclamation scheme on the coast which had been recently completed. He stated that the land reclaimed had provided work, mostly on ricefields, for so many people that 3,000,000 human beings were living on an area which previously was entirely uninhabited.

French scientists had also been at work and had done a great deal to make the country a centre of interest to Europeans and a more prosperous home for the natives. No engineer could visit the famous city of Angkor without feeling immense admiration for the constructive ability of the builders of the temples and palaces of ten centuries ago. For about 300 years a million people lived in the City of Angkor, and then it was suddenly deserted; no one lived within a hundred miles of it, and no one knows why it was deserted. Europeans had never heard of it until at the end of last century the French discovered it, buried in the jungle, which has reduced to ruins many of the huge stone buildings. But the French have restored the vast temple called Angkor Vat, certainly the most fascinating building it has been my lot to inspect. When, after a 300-mile motor ride from Saigon, over excellent roads, but under the heat and glare of a tropical sun, we reached Angkor, we met an acquaintance, a shrewd Scotch banker who had travelled all over the world. He had just returned from a visit to Angkor Vat. "Let me come with you to see it again," he said. "You are an engineer, so you ought to be able to explain to me how they erected a building higher than Notre Dame, built only of huge stone blocks, and standing through nearly eleven centuries, without any mortar or cement to hold it together." Then, after a pause, he said: "Well, I have been disappointed when seeing many of the sights of the world, after reading about them in the tourist books, but, believe me, there is no baloney about Angkor —it beats any description!"

The building is now in a good state of restoration. It was probably saved from the encroachment of the jungle, which ruined so many other fine works, because it was surrounded by a moat. It is rectangular in shape, and on the ground floor is a wide corridor, with walls built up of large stone blocks placed one on top of the other. You can walk round the four sides of the rectangle, along this corridor, the total length of which is 2.2 miles! And you can climb up the many stone steps to the *sanctum sanctorum* on the third storey of the temple. "Tell me how they got that huge coping stone, that forms the roof, up here," said the banker. The answer was that an enormous earth ramp must have been provided for the purpose. The quarries whence came the large rectangular stones that, piled one on top of another, make up this amazing temple, were several miles away, and the stone must have been floated on rafts down the river. It is strange that few Europeans in the Far East have heard of Angkor, and on my return to England it was noticeable that none of my friends had heard of it. Indo-China is but a name to most people in this country, but it meant much to the many French people there, amongst whom were engineers and scientists, pushing forward the new type of peaceful civilisation into Asia. We cannot believe that their work has been in vain. The Japanese have obtained possession of the railway from Hanoi, on the coast, to the Chinese frontier. A few months ago they bombed the end of one of the tunnels, and a train, containing amongst the many passengers several Europeans, was wrecked and everyone on the train was killed. Chinese engineers, with as many coolies as they wanted, made a new tunnel and had the line running again within a month.

Water and Road Transport

Between the great mountain system in Asia and the seas to the south and east—the Indian and Pacific oceans—there is an immense granary, whose economic strength has not yet been fully developed, and that is awaiting the spread of knowledge concerning applied science in order to yield its tribute to mankind. And in that area 48 per cent of the world's total population is concentrated on barely 5 per cent of the land surface of the earth!

To the north and north-west of the high mountain ranges is the background of the vast Arctic-Atlantic hinterland, with its endless leagues of steppes flanked by a huge area of primeval forests. Centuries ago some 200,000 horsemen, intent on looting the rich plains to the south of China, found their path blocked by that marvellous structure, the Great Wall. The horsemen recoiled, like the waves of the sea stopped by a cliff, and they dashed across the many thousands of miles of Asia, right up to the walls of Vienna. Thus did the Chinese engineers who built the wall bring the Turks into Europe. The reaction came with the development of applied science, and especially since the invention of the steam engine, accelerated the rise of ocean power and enabled engineers to make travel by rail easy, rapid, and safe. Calais and Hong Kong in South China were connected by rails that run through the tropics, Siberian forests, across Asia and Europe, connecting the Pacific Ocean with the English Channel. Many thousands of miles of railways and motor roads were built. The old single-file caravan tracks, with their tens of thousands of human and animal bearers, slowly carrying goods between trade centres, have been converted into modern highways. By air, passengers and mails have been carried from Hong Kong to London, from Hong Kong to Chungking and other remote cities in China, and from Hong Kong across the Pacific to San Francisco.

In Asia Nature has developed certain features on a gigantic scale, but there is room for them. There are abrupt contrasts between the comparatively small swarms of raiders of great mobility in the north and the remarkable concentration of humanity, 48 per cent of the world's population, between the ramparts of the great mid-world mountain system and the Indo-Pacific Ocean. On the one side, virility; on the other, there seemed to be deceptive immobility, brooding over Hinduism and Buddhism, creeds of calm and contemplation.

India was the first part of Asia to be affected by the work of the engineer, and, whatever may be the political and social changes in that land, there will always remain many monuments to commemorate the devotion of British engineers to a sense of duty.

Burma and Siam presented greater obstacles to engineers than India; obstacles of a political type rather than technical difficulties. But there has been progress. In recent years the Japanese have put forward a scheme which at first sight seems attractive, but which presents enormous engineering difficulties. It is to cut a canal across the Kra Isthmus in Siam. It would save 600 miles of sea travel between Calcutta and Canton, and at least 1,200 miles between Rangoon and Bangkok.

My tour in Malaya last year made me realize that the notable economic progress in that country had been very largely due to the work of engineers. Everywhere there was evidence of the determination of the Government to do everything possible, so that the country should benefit by improved methods of communications and engineering schemes of all types. It was typical of the enterprise of Government officials in Malaya that we travelled in air-conditioned railway carriages—a very great relief in a tropical country. Malaya supplies plenty of evidence, as do Hong Kong and Shanghai, of co-operation between Chinese and British.

Chinese Engineers and Scientists

Mechanised transport, ships, motor-cars, trains, and aeroplanes enabled us to travel thousands of miles along the coast line, through cities, villages, rice fields, rubber plantations, and jungle in this fascinating part of the earth. In the evening we listened to the B.B.C. news relayed from the Hong Kong wireless station, and we knew that they could hear it in many parts of China. We found that the English language could be understood in nearly all the places we visited. It seems inevitable that the vast experience that Angle-Saxon engineers have gained in tropical lands (India, Africa, and America) will be applied in this part of the world.

About thirty years ago a number of us listened to Dr. Diesel at a meeting of the Institution of Mechanical Engineers, when he outlined his belief that the British would utilize tropical soil for the production of vegetable oil suitable for the production of power. When we saw the rather crude mechanism installed on the palm oil plantations in Malaya, where they obtain quite large quantities of oil for human consumption, the vision of Dr. Diesel came to my mind, and it often returned as we rode in comfort through the jungle. Under the tropic sun Nature accelerates the reproduction of vegetable, insect, and animal life in a manner that at first bewilders the native of the temperate zone. It seems that the earth and the fulness thereof have been placed at the disposal of man, but that *homo sapiens* has, so far, miserably failed to make good use of the good earth and the sun.

The contrast between many of the natives of South-east Asia and the Chinese who had emigrated to the south made me realise that Nature abhors indolence even in a land where a man can exist on a few handfuls of rice and the fruits dropped from the trees. Starvation is easily defeated, but malaria, enteric, and other preventable diseases each year claim millions of victims. Indolence leads to decadence. Many of the natives, and some Europeans, live as if "there aint no Ten Commandments," and pay the inevitable penalty, for which the climate is too often blamed. The poverty-stricken Chinese emigrants, on the other hand, are the most active workers, pulling through hardships that would kill the average European, demonstrating that work will win and that the meek—and energetic—accumulate wealth. These Chinese ex-coolies are the millionaires and ideal citizens in Malaya, Siam, and Indo-China. They were taught from infancy the Confucian code that man is capable of great development provided that he follows the moral code taught by his elders and betters.

An Englishwoman who travelled over the Burma Road in a lorry wrote: "I sat down to consider my revolutionized ideas of the Chinese. True, my knowledge of them was extremely slight, gleaned from hearsay, books, and casual acquaintance with members of the race in other parts of the world; but nothing I had learned had prepared me for their amazing kindliness, their attention to practical detail, their strong sense of humour." My own experience makes me re-echo those words.

The wealthy Chinese emigrants remain loyal to the Confucian code. They train their sons to respect their elders, their teachers, and to remember the old axiom that of all men the scholar stands highest in social status. They accept another ancient axiom from their classics, viz., that people should be governed by moral and intellectual agencies rather than by physical force.

There are many young Chinese men and women who are seeking the new knowledge in European and American universities, but they know the Confucian code. You see the results in the struggle made by the Chinese graduates to build roads and communications of all types. They have installed power plants and opened up mines. They are at work on the new hospitals—my friend, Dr. Ling, was running a hospital on the Burma Road when last we heard of him. They are teaching the laws of hygiene; they are trying to improve agriculture, and to urge the importance of scientific research. Perhaps some are attracted by certain Western political and economic theories, much of which will not fit into the Chinese social system. But make no mistake, there is the same dynamic urge to do useful work that brought wealth to their fathers in a land waiting for development. The Japanese military caste fear the results of scientific knowledge and methods in China and have made great efforts to bomb the modern universities. They have not succeeded in preventing instruction in applied science subjects in China, and even if they did there are the millions of overseas Chinese, many of them wealthy, who are urging their sons to qualify as engineers, doctors, etc., so that they may return to China or work in South-east Asia.

Mention must be made of the Malay islands—Java, larger than England; Sumatra and Borneo, much larger; Celebes, and numerous other islands—these are the lands for which the English and Dutch fought each other so bitterly in the seventeenth century, and where it seems probable they will closely co-operate for the development of their natural resources at no distant date. What opportunities for the engineer and scientist are offered by these fertile areas: Already the ubiquitous Chinese have done much of the commercial development. Some of our Hong Kong engineering graduates returned to Java, Sumatra, or Borneo, and we heard of them installing power plants for sawmills, cold storage, etc., or engaged in surveys of the jungle. There are schools in this area where the Chinese are trained in English up to matriculation standard.

It can be claimed that the British were the pioneers of engineering works in China, and, indeed, in the Indo-Pacific areas. Not only did they build railways, docks, and industrial power-driven factories, but they were responsible for great improvements in harbours and inland waterways. For many years there was blind opposition to Western science in China, but that no longer exists. On the contrary, there is a demand for any machinery or other equipment that will aid the war effort or develop the resources of the country. Recently an officer of the Hong Kong University flew to consult the Chinese Government in Chungking, as to how the University could best help China. A reliable correspondent in Hong Kong has informed me that the reply was: "Send us as many trained engineers as you can; hundreds of them." They were not interested in anything else! My experience in Hong Kong was that the Chinese did not oppose the instruction in science of their own nationals, but that a number of English residents, particularly graduates of Oxford or Cambridge, who had studied classics, did their utmost to prevent any extension of the engineering departments. They did not hesitate to inform me that engineering was not a fit subject to be included in a university course. There should be, they said, a technical school unconnected with any institution that confers degrees. During my service in the universities of Birmingham and London in the early part of this century, my colleagues in the Faculty of Arts often expressed those views—in a very pleasant manner—but which left the impression that they believed that engineers were out of place in the academic cloisters, which, they said, should be preserved for those concerned with ideas which do not affect things material. It was useless to talk to them about the ideals of engineers; all of the evils of the industrial system were attributed to the inventors of machinery. That spirit still exists in England. Only a few days ago an Oxford professor solemnly stated in my hearing, in the course of an address, that the war was caused by wireless, because Hitler would never have attained to such power without the aid of that invention! There are perhaps men of the Mandarin type of mind in Britain, as well as a few in China. It is significant, however, that the Chinese Government, in this crisis, is doing everything possible to encourage engineering developments.

It is not only the Burma Road that is of interest to those British engineers whose thoughts are turned to the Far East. We see in the conference at Delhi evidence of co-operation between India and the rich tropical countries in the Pacific. We can be sanguine that at no distant date there will also be co-operation with the Chinese. In the last war the Chinese labour battalions in France did splendid work. It is not improbable that in this war we may seek the aid of Chinese labour and co-operate much more closely with the Chinese Government. It is my firm conviction that the Chinese work more harmoniously with British people than with any other nationals. It has been stated that there are 3,000,000 Chinese who have British nationality and who reside in Malaya, Hong Kong, and other parts of the British Empire. In the days of reconstruction it will be to the mutual advantage of both nations if they can co-operate in the economic development of South-east Asia.

THE DESIGN OF BEAMS IN STEEL FRAME BUILDINGS

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SUMMARY—Methods are given for the design of beams in steel frame buildings in which allowance is made for partial or complete restraint of the ends. For secondary beams the design method assumes that a high degree of restraint is present and it is shown that this may be ensured by the use of a comparatively small amount of special steel in the form of reinforcing bars placed in the concrete floor slab, if present, or by plates attached to the top flanges of the beams. In the case of beams connected to columns, curves are derived by which allowance may be made for the restraint produced by simple connections using clip angles. The design method is based on the work of the Steel Structures Research Committee (Great Britain) but is considered to be simpler to use and more accurate than the method recommended by that committee. A number of examples are given showing the application of the proposed methods and the possible saving in weight of steel. The recommended methods of design form Appendix E of Part 3 of the National Building Code.

The National Building Code is a model building code for use by Canadian municipalities which is being prepared under the joint sponsorship of the National Research Council and the Department of Finance of Canada. The complete Code is not yet available but Part 3, Engineering Requirements, has been issued separately and it is reviewed on Page 214 of this issue. The author of this paper was Secretary of the Subcommittee on Steel Construction.

Introduction

In the recent report of the Joint Committee on Concrete and Reinforced Concrete* the following words occur:

"In the design of buildings it has been for many years common practice to design columns and beams as isolated members, the columns as compression members axially loaded, and the floor system by prescribed coefficients for moments at the ends and in the centre of the span. In some cases prescribed moment coefficients have also been used to evaluate the bending in columns induced by unbalanced loadings from the floor system.

"Although such practice has apparently resulted in safe design in the case of buildings with uniform column spacings, it has become increasingly clear with the advent of newer methods of analysis that the degree of safety was neither uniform throughout the structure nor in some cases equal to that intended in the design. In the rather frequent cases of unequal spacing of columns or story heights, the design based on the usual moment coefficients often leads to improper design, and quite generally to wide departure from uniformity of factor of safety in the various members of the structure.

"The committee recognizes that more exact methods of analysis are now available for general use in the design of buildings and other framed structures, also that they may be simplified without undue sacrifice of accuracy. These methods will result in better provision for the effects due to continuity and should thereby secure a more uniform degree of safety. The need for such improvement in design becomes more important with the introduction of higher strengths and lighter weights of concrete and the accompanying higher working stresses. The consideration of continuity is especially important in cases of unequal spans alternately loaded where the ratio of live to dead load is large."

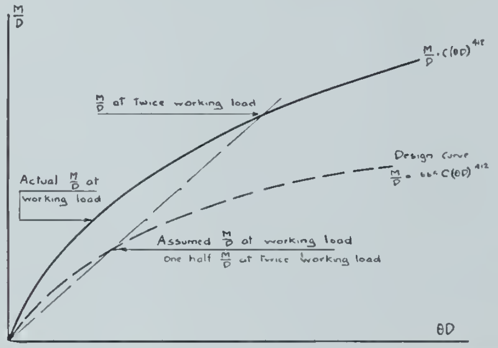

Fig. 1—Derivation of design curves for semi-rigid connections.

It has become increasingly evident in recent years that a somewhat similar state of affairs exists in connection with steel frame construction. This realization must be attributed largely to the work carried out from 1929 to 1935 by the Steel Structures Research Committee in Great Britain. The following extract from the Journal of the Institution of Civil Engineers[1] will show the importance attached to the work of the Committee by the Chairman, Sir Clement Hindley:

"Sir Clement considered that the investigation was of outstanding importance to the engineering profession, and he did not think that in the last 40 or 50 years there had been one of more importance, or one which might affect more definitely the work of engineers engaged in design; if the more rational method of design could be brought into practice the work would be of the very greatest importance and value."

The work of the Steel Structures Research Committee clearly established, both by measurements in the field and by laboratory tests, that, in the average steel frame building, the factor of safety for columns is considerably less than the factor of safety for beams. In such circumstances appreciable economies may be made in the weight of beams without reducing the overall factor of safety of the structure of which they are a part.

In this paper it is proposed to consider the possible economies that can result from making allowance for the complete or partial restraint of beams. Two types of beams will be considered, beams which frame into other beams and beams which frame into columns. For convenience, beams of the first type will be referred to as secondary beams and those of the second type as girders. The treatment of girders is based upon the work of the Steel Structures Research Committee, but the proposed design method is believed to be considerably simpler and somewhat more accurate than the method recommended by the Committee. The design of secondary beams was not considered by the Committee. The recommended methods of design form Appendix E of Part 3 of the National Building Code.

Secondary Beams

The restraint at the end of a secondary beam depends partly upon the torsional rigidity of the girder to which it is connected and partly upon the stiffness of the end connection of the beam. In general, the torsional rigidity of beams of I section is small, but it is greatly increased if the girder is solidly encased in concrete. Standard beam connections are comparatively flexible but a high degree of restraint may be developed by the use of a small amount of additional steel. For example, MacKay[2] showed by a number of tests made at McGill University in 1924 that the additional steel could take the form of reinforcing rods placed in a concrete floor slab. There is no doubt also that plates suitably connected to the beams could be used for this purpose.

If it is assumed that torsional rotation of the girder may be neglected, either as a result of the stiffening effect of concrete encasement, or because the moments on either side of the girder are equal in magnitude and opposite in direction, then it is possible by a simple calculation to determine

*This Committee consists of representatives of the American Society of Civil Engineers, the American Society for Testing Materials, the Portland Cement Association, the American Concrete Institute, the American Railway Engineers Association, the American Institute of Architects.

the amount of supplementary steel needed to ensure an adequate degree of restraint. Alternatively, it would be possible to estimate the degree of restraint produced by any given quantity of supplementary steel. The former method appears to be more satisfactory since it leads to an exceedingly simple method of design.

Consider first, a beam carrying a uniform load. If the ends are fixed, the maximum moment will be $\frac{WL}{12}$ which will occur at the ends. If a restraining moment of $\frac{WL}{24}$, i.e. 50 per cent of the fixed end moment, is applied the maximum moment will also be $\frac{WL}{12}$ but will occur at mid-span. Thus 50 per cent restraint is sufficient to justify a reduction of one-third in the maximum bending moment of a freely supported beam. In the case of a beam carrying a single load at mid-span, 50 per cent restraint is sufficient to justify a reduction of one-quarter in the maximum bending moment in the beam, and with 60 per cent restraint a reduction of 30 per cent in the maximum bending moment will result.

On the basis of the above figures it appears to be reasonable to provide sufficient supplementary steel for 60 per cent restraint and to assume that the maximum bending moment will be reduced by one-third, whatever the loading. The reduction in moment must be ensured not only at working loads but at overload also. In this connection it is convenient to use the term 'load factor' as meaning the ratio of the maximum useful load that can be placed on a structure to the working load. This term is used in preference to 'factor of safety' which is defined in most text books as the ratio of the ultimate strength of a material (usually in tension) to the unit working stress. It will be assumed that a load factor of two is sufficient, this being somewhat greater than that usually found in columns and somewhat less than the common value for beams.

The required area of supplementary steel may be determined in the following manner:

Let A_S be the area of the cross section of the beam,
A'_S the area of cross section of supplementary steel in tension,
D the depth of beam,
D' the lever arm of the force in the supplementary steel,
f_s the allowable flexural working stress in the steel,
f_y the stress at yield,
k the radius of gyration of the area of cross section of the beam,
M_F the fixed end moment,
and S the section modulus of the beam.

Many modern codes, including the National Building Code, permit the load on a beam to be increased if it is encased in concrete. Such increase is equivalent to an increase of working stress and on this basis it will be assumed that the working stress has been increased from f_s to f_s $(1+P)$.

Then

$$C_1 M_F = f_s(1+P)S \qquad (1)$$

where C_1 is a constant greater than one.

If the supplementary steel yields at twice the working load, its moment of resistance will be $f_y A'_S D'$ which may be written $C_2 f_y A'_S D$ where C_2 is a constant.

Thus, if the restraint at twice the working load is to be six-tenths of the fixed end moment,

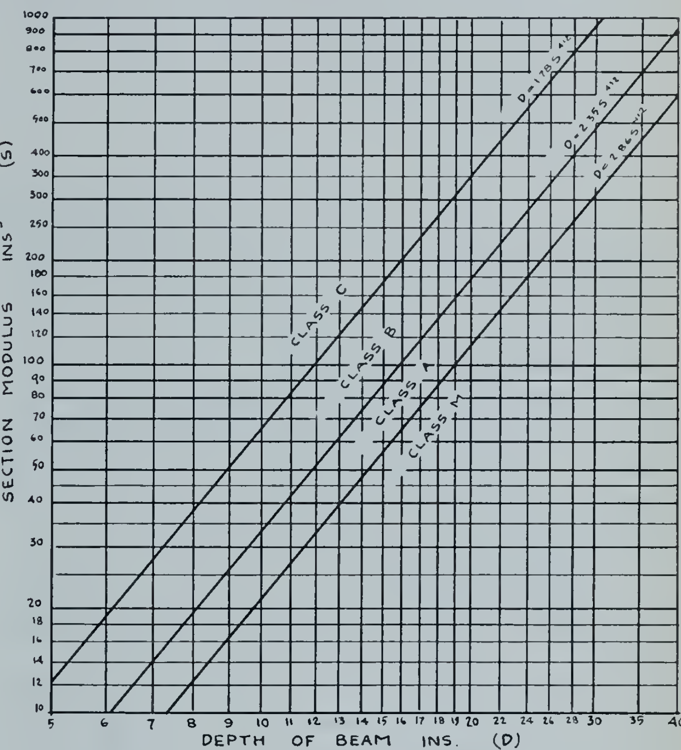

Fig. 2—Classification of beams.

$$\frac{C_1(C_2 f_y A'_S D)}{2 f_s(1+P)S} = 0.6 \qquad (2)$$

and substituting $S = \frac{2I}{D} = \frac{2A_S k^2}{D}$,

$$\frac{A'_S}{A_S} = \frac{0.6(1+P)}{C_1 C_2}\left(\frac{f_s}{f_y}\right)\frac{4k^2}{D^2} \qquad (3)$$

$\frac{A'_S}{A_S}$ will be a maximum when P, $\frac{f_s}{f_y}$ and $\frac{4k^2}{D^2}$ have maximum values and when C_1 and C_2 have minimum values. Studies on the properties of encased beams suggest 0.16 as a reason-

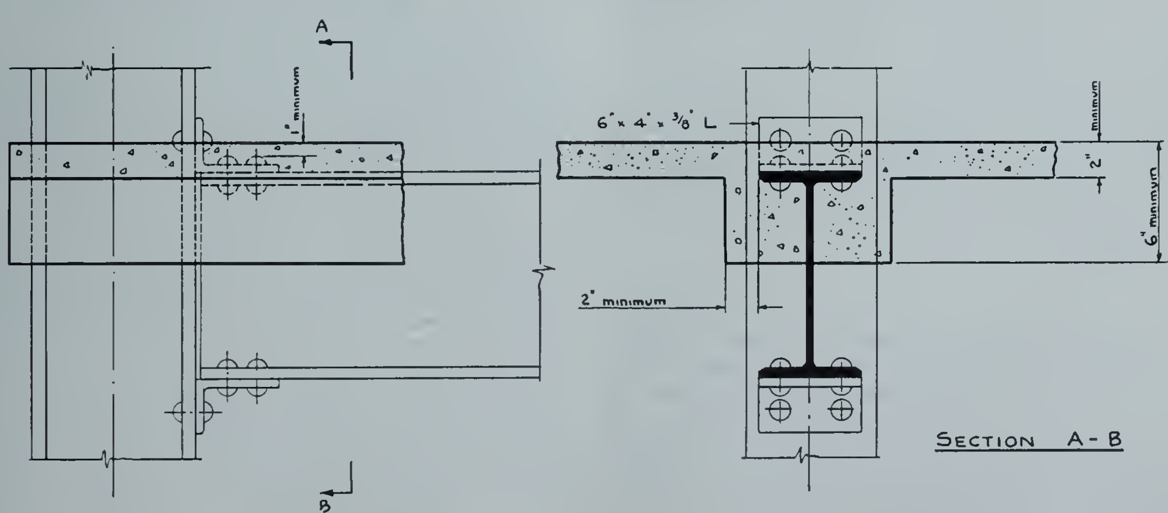

Fig. 3—Minimum concrete encasement required for Class B connections using 3/8-in. clip angles.

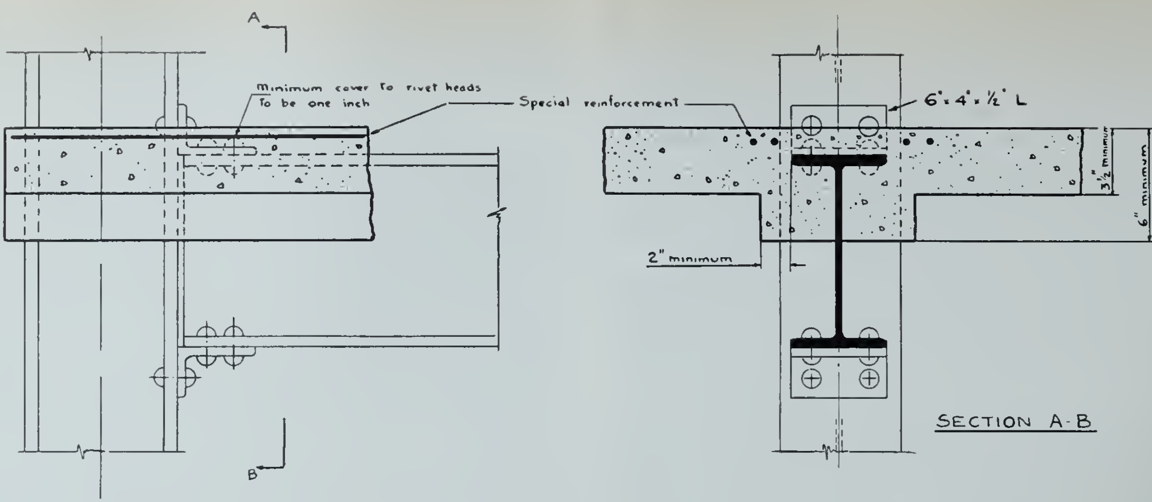

Fig. 4—Minimum encasement required for Class C connections using ½-in. clip angles.

able maximum value for P; the minimum value of C_1 is one and it is unlikely that C_2 will be appreciably less than one. If f_y is assumed to be the specified yield point stress, $\frac{f_s}{f_y}$ will be approximately 0.6. Tests on beams have shown, however, that yield will occur at an apparent stress somewhat in excess of the tensile yield point and it therefore appears to be reasonable to assume $\frac{f_s}{f_y}$ to be equal to one-half.

With these assumptions, equation (3) reduces to

$$\frac{A_S'}{A_S} = 0.348\,\frac{4k^2}{D^2} \qquad (4)$$

The value of $\frac{4k^2}{D^2}$ depends only upon the properties of the beam sections. Obviously k can never exceed $D/2$ and hence $\frac{4k^2}{D^2}$ can never exceed one. Examination of tables of properties of sections leads to the conclusion that $\frac{4k^2}{D^2}$ will not exceed 0.66 in the case of standard beams and 0.76 in the case of wide flange beams. It appears to be reasonable therefore to assume 0.76 as a maximum value for $\frac{4k^2}{D^2}$; substituting this value in equation (4) the value of $\frac{A_S'}{A_S}$ is found to be 0.264. Thus, if supplementary reinforcement having an area equal to 0.264 times the area of cross section of the beam is provided, the beam may be designed to resist only two-thirds of the static moment; and the load factor will in no case be less than two. It is possible, but not probable, that if twice the working load were applied, the supplementary reinforcement would yield. This, however, would not affect the safety of the beam in any way, and is not in itself undesirable.

In practice, the coefficient 0.264 may be assumed as one-quarter without serious error, and since the allowable stress in the supplementary steel may not be the same as that in the beam, the requirement may be expressed in a more general way by requiring the supplementary steel to be capable of resisting a tensile force

$$T' = \frac{f_s A_S}{4} \qquad (5)$$

The preceding discussion has been concerned only with the method of resisting tension. It will, of course, be necessary also to transmit compression from the girder to the lower flange of the beam. If the girder is solidly encased in concrete it may be assumed that the concrete is capable of resisting the compressive stresses. Alternately, certain types of end connection may be used; for example, a seat angle connected to the lower flange of the beam with four rivets will be adequate in many cases.

Girders

The moments present at the end of a girder depend upon the following variables:

(1) The magnitude of the load
(2) The distribution of the load
(3) The stiffness of the end connections
(4) The stiffness of the members to which the girder is attached
(5) The moment of inertia of the girder
(6) The depth of the girder
(7) The length of the girder.

Of these variables, the stiffness of the end connections has proved to be the most difficult one to estimate. Semi-rigid types of end connections are indeterminate structures in which certain portions are stressed beyond yield. Attempts to predict the behaviour of such connections by calculation have proved to be particularly unsuccessful and it is necessary therefore to refer to the results of tests. Such tests have been carried out by the Steel Structures Research Committee (3) (4) in England, by C. R. Young and K. B. Jackson (5) in Canada, and by Rathbun(6) in New York.

The relation between end moment and the slope at the end of a beam is given by the slope-deflection equation

$$M = M_F - \frac{2EI\theta}{L} \qquad (6)$$

in which M is the end moment,
M_F the fixed end moment,
E the modulus of elasticity,
I the moment of inertia of the cross-section of the beam about the neutral axis,
θ the slope at the ends of the beam,
L the length of the beam.

The equation in the above form applies only to beams symmetrically loaded. In such a case it is obvious that the maximum moment on the beam will be reduced by an amount M, which may therefore be termed the allowable restraining moment. It has, however, been shown by Batho(7) that the same equation may be used to determine the allowable restraining moment in the case of unsymmetrical loading if the mean of the fixed end moments be substituted for M_F. It was further shown that when the end restraints are unequal the allowable restraining moment at either end of the beam may be determined on the assumption that an equal restraint is present at the opposite end of the beam. The allowable restraining moment at the position of maximum moment can then be determined by calculation or by drawing a bending moment diagram. This approximation involves a loss of economy in some cases and, considering the maximum moment in the beam, a very small error on the wrong side in a few cases. More accurate results, however, do not appear to be needed and could only be obtained by a great increase in complexity of the calculation. It should perhaps be pointed out that the calculation of the mean of the fixed end moments can be very simply made for any condition of loading. For example,

(a) For a single load P anywhere on the beam, the mean of the fixed end moments is $\frac{Pab}{2L}$, where a and b are the segments into which the span is divided.

(b) For a load uniformly distributed on a part of a span, the mean of the fixed end moments is $\frac{Wab}{2L}-\frac{Wd^2}{24L}$ where a and b are the segments into which the centre line of the load divides the beam and d is the length over which the total load W is distributed.

In order to consider the stiffness of the end connection it is necessary to introduce some scheme of classification of such connections. In the draft rules for design (Steel Structures Research Committee) four classes of connections, A, B, C, and D were established. Class A included connections which transmit very small moments, and Class D included connections of the wind bracing type which are nearly rigid. Classes B and C represented intermediate degrees of restraint. A somewhat simpler scheme of classification is to have only three classes, Classes A and B including the more flexible types of connections and Class C the rigid or nearly rigid types. Possibly this is as great a subdivision as can be justified on the basis of ordinary commercial practice.

The rigidity of any type of connection is increased if the connection is encased in concrete. This increase is very great for small loads but not so great for loads sufficient to cause cracking of the concrete. Batho[8] has described the results of a considerable number of tests on encased connections, some of which were provided with reinforcement. On the basis of these results and the tests by MacKay referred to previously it would appear to be reasonable to give a small amount of credit for concrete encasement without reinforcement especially with more flexible connections, and to give considerably more credit for the stiffening effect of concrete properly reinforced.

In addition to classifying end connections it has been found desirable also to classify beam sections. Such a classification makes possible a direct method of design; whereas in other methods it is usually necessary to assume some property of the beam such as its depth and recalculate the moment if the assumption did not prove to be correct. This classification has been accomplished by assuming that for any particular beam the depth, D, may be expressed in terms of the section modulus, S, by the equation

$$D=C_3S^{.412}\qquad(7)$$

and hence beams may be classified in accordance with the value of the constant C_3.

It is obvious that the fourth variable listed above, i.e., the stiffness of the members to which the girder is attached, is one that may introduce problems of great complexity. In order that a simple design method be possible, it is necessary to make some fairly drastic sort of assumption. This was done in the procedure recommended by the Steel Structures Research Committee by assuming that, in the case of a girder connected to the flange of a column,

$\frac{K_B}{K_U+K_L}$ is generally not greater than 1.5,

K_B is the stiffness of the beam,

K_U and K_L the stiffness of the column lengths above and below the beam respectively.

(The symbol $K=\frac{I}{L}$)

A figure of 1.5 was chosen after a survey of a considerable number of buildings and will include all ordinary cases except perhaps a few roof beams. In such exceptional cases it is probably simpler not to make any allowance at all than to try and derive some complicated method of calculation.

When a girder is connected to the web of a column, $\frac{K_B}{K_U+K_L}$ may exceed 1.5; in such cases allowance for end restraint can only be made in respect of the moment due to dead loads in approximately equal spans on either side of the web. When $\frac{K_B}{K_U+K_L}$ is less than 1.5, allowance can be made for end restraint in a girder connected to a web provided the web is stiffened so as to prevent excessive local deformation. It will be appreciated that under unsymmetrical loading the comparatively thin web of a column may be deformed considerably by reason of a beam connection attached to it.

It was also shown by Batho that, if various small corrections are omitted, the assumption that $\frac{K_B}{K_U+K_L}$ is equal to 1.5 may be expressed by modifying the equation (6) to read,

$$M=\frac{M_F}{2}-\frac{EI\theta}{L}\qquad(8)$$

in which M is the allowable restraining moment and θ the corresponding angular deformation of the end connection.

Design of Girders Having Rigid Connections (Class C)

In the case of girders having rigid or nearly rigid connections tests have shown that the relation between end moment and angular deformation is nearly linear and that the end moment will be about 80 per cent of the fixed end moment. This will be reduced approximately one-half by the allowance for flexibility of the columns. Thus, the minimum restraint when rigid connections are used can be assumed to be about 40 per cent of the fixed end moment. It is recommended therefore that the end restraint be assumed to be four-tenths of the fixed end moment in all

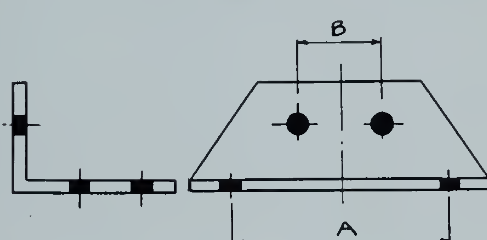

Fig. 5

cases where rigid or nearly rigid connections are used provided that $\frac{K_B}{K_U+K_L}$ does not exceed 1.5. This assumed value of moment is a lower limit value and the connections themselves should in most cases be capable of transmitting the full fixed end moment without failure.

Semi-rigid Connections

Much experimental work was carried out at the University of Birmingham from 1929-1935 upon the behaviour of semi-rigid connections. In particular, connections made up of angles attached to the flanges of the beam (clip angles) were investigated in great detail (see the First, Second, and Final Reports of the Steel Structures Research Committee) and sufficient information was collected to enable lower limit curves for various types of connections to be specified. These curves were found to be of the type,

$$M=C\theta^{\alpha}\qquad(9)$$

M is the moment transmitted by the connection,

θ the angular deformation of the connection, and

C and α are constants.

The constant α was found to be approximately 0.412 for all types of connections. Less complete investigations were made, however, upon the rigidity of connections having web angles as well as flange angles but it was shown that, although the rigidity of web connections alone is small,

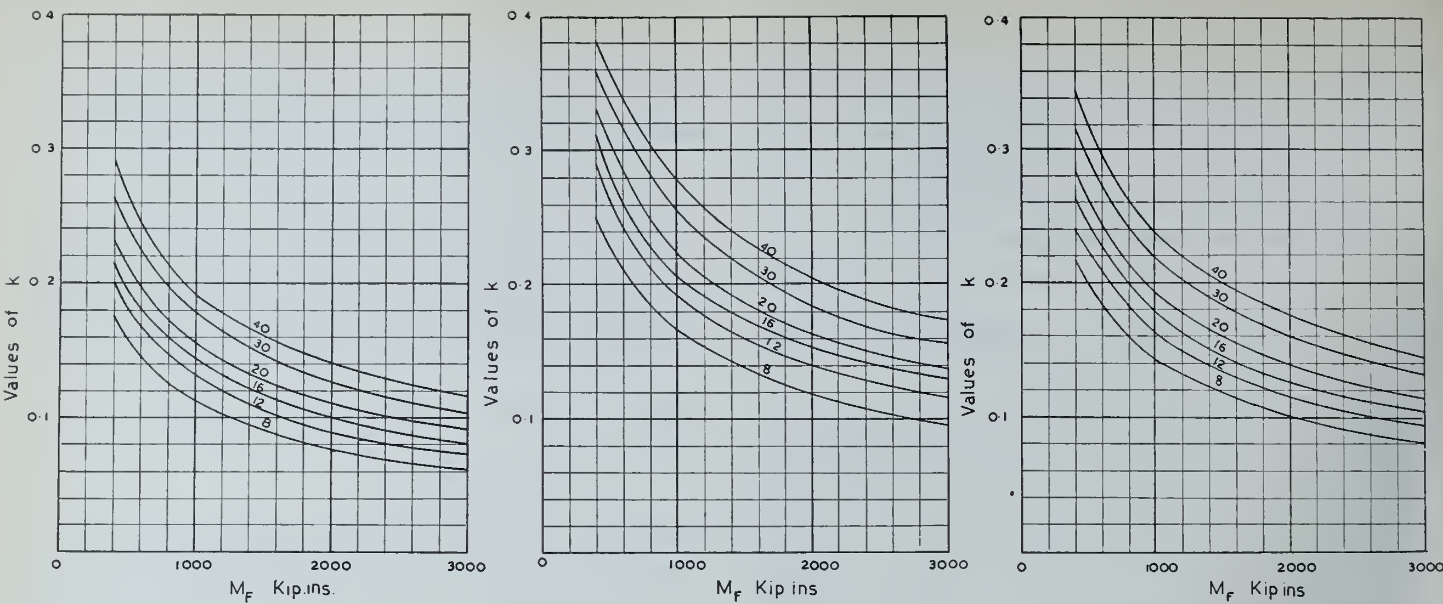

Fig. 6—Curves showing the relation between allowable restraint and fixed end moment when Class A connections are used. (The figures on the curves indicate the length of the beam in feet).

they add considerably to the total rigidity of the connection when used in conjunction with flange angles.

The results obtained from tests can only be applied directly to beams having the same depth as those used in the original tests. The curves can, however, be made of general application by putting them into the form,

$$\frac{M}{D} = C(\theta\ D)^{.412} \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

(in which the value of C is not the same as in equation (9)) Since the relation between end moment and load is not linear, this curve cannot be used directly for determining allowable end restraint at working loads. Reference to Fig. 1 will make this point clear. Hence, the Steel Structures Research Committee proposed a graphical construction for determining a design curve. This is shown also in Fig. 1 and the basis of the method will be readily apparent. The same result can be obtained without using a graphical construction since it can be shown that if the curve for the connection is $\frac{M}{D} = C(\theta\ D)^{.412}$, then the design curve for a load factor of two will be

$$\frac{M}{D} = .655C\ (\theta\ D)^{.412}$$
$$= C_4\ (\theta\ D)^{.412} \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

It is convenient now to bring together the various equations that have been assumed or derived. They are as follows:

$$M = \frac{M_F}{2} - \frac{EI\theta}{L} \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

$$\frac{M}{D} = C_4(\ \theta\ D)^{.412} \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

$$D = C_3S^{.412} \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

These equations may be solved in the following manner:

From (11)

$$\theta D = \frac{(M)^{\frac{1}{.412}}}{(C_4D)} = \frac{M^{2.42}}{C_4^{2.42}\ C_3^{2.42}\ S} \ldots\ldots\ldots (12)$$

From (8)

$$M = \frac{M_F}{2} - \frac{ESD\theta}{2L}$$
$$= \frac{M_F}{2} - \frac{ESM^{2.42}}{2L(C_4C_3)^{2.42}\ S}$$
$$= \frac{M_F}{2} - \frac{C_5\ M^{2.42}}{L} \text{ where } C_5 = \frac{E}{2(C_4C_3)^{2.42}} \ldots (13)$$

Let $M = kM_F$

From (13) $kM_F = 0.5M_F - \frac{C_5}{L}\ k^{2.42}\ M_F^{2.42}$

$$k = 0.5 - \frac{C_5}{L}\ k^{2.42}\ M_F^{1.42}$$

$$M_F = \left\{\frac{L}{C_5}\right\}^{0.703} \frac{(0.5-k)^{.703}}{k^{1.70}}$$

$$\text{or } M_F = \left\{\frac{L}{C_5}\right\}^{.703} C_K, \text{ where } C_K = \frac{(0.5-k)^{.703}}{k^{1.07}} \ldots\ldots (14)$$

$$C_5^{.703} = \frac{E^{.703}}{2^{.703}\ (C_4C_3)^{1.70}}$$

If $E = 29000$ kips. per sq. in.

$$C_5^{.703} = \frac{842}{(C_4C_3)^{1.70}}$$

Substituting in (14),

$$M_F = \frac{L^{.703}(C_4C_3)^{1.70}\ C_k}{842} \ldots\ldots\ldots\ldots\ldots\ldots (15)$$

Equation (15) means that the degree of restraint depends only upon the magnitude of the load, the length of the beam and the constants C_4 and C_3.

Having fixed values of C_4 and C_3 it is then possible to compute values of C_k and hence of k, the latter equation being most conveniently solved by the use of a curve. It is very important to notice that the depth of the beam has been eliminated and thus a direct method of design becomes possible (credit for this should be given to Dr. H. C. Rowan who first discovered that with many British Standard beams the end moment for a given load was independent of the depth). Equation (15) can only be used with advantage if the classification of beam sections by the use of Equation (7) is practical. This has been found to be the case and Fig. 2 shows the proposed classification graphically. It is also given in Table I.

TABLE I

Classification of Beams

Class of Beams	Value of C_3	Beams Included
M	Not less than 2.86	Junior beams and others less than the standard weight.
A	" " " 2.35	American standard beams. British standard beams (light). Some wide flange beams.
B	" " " 1.78	Some wide flange beams.
C	Less than 1.78	All beams not included in Classes M, A, or B.

The proposed classification of connections is shown in Table II together with its accompanying note.

TABLE II

Minimum Requirements for Class A, Class B and Class C Connections

Class	Details of Connection	Required Concrete Encasement
A	6″ x 4″ x ½″ clip angle	None required.
B	6″ x 4″ x ⅜″ clip angle with web angles (see Note)	None required.
	6″ x 4″ x ⅜″ clip angle	Solid encasement of the upper flange of the beam and a 2″ slab as shown in Fig. 3.
C	6″ x 4″ x ½″ clip angle	Solid encasement of the upper flange of the beam, 3½″ slab and special reinforcement as shown in Fig. 4.
	Split I	None required.
	Gusset plate	None required.

Note: Web angles shall be adequate to carry the total end shear.

(i) Where a clip angle is used the horizontal leg shall be fastened to the beam with not less than four rivets.

(ii) The seat angle shall be adequate to carry, in conjunction with the web angles (if any), the total end shear and shall be at least as strongly connected as the clip angle.

(iii) The clip angle shall not be less than 5 inches long and rivets not less than three-quarters inch in diameter shall be used, except that if the width of the flange or the width of the column to which it is attached is less than 5 inches the length of the angle shall be at least equal to the lesser width and the rivets shall be the largest that can be used but in no case less than ⅝ inch diameter.

(iv) The rivets connecting the clip angle to the beam are to be symmetrically arranged about the vertical axis of the cross-section of the beam.

(v) The inner row of rivets in each leg of the clip angle shall be not more than 2¼ inches from the back of the angle provided that a variation of ⅛ inch may be permitted on this dimension.

(vi) The lateral spacing of the rivets connecting the clip angle to the column shall not differ from the spacing of those connecting it to the beam by more than 8 inches (see Fig. 5).

(vii) Steel erection packings up to ⅜ inch in thickness may be introduced between the flange of the beam and either the top or the bottom connection angles.

(viii) When concrete encasement is specified the concrete shall have a minimum strength of 2000 lb. per sq. in. and shall provide a minimum cover of one inch over all rivet heads and other projecting parts.

(ix) Where concrete encasement is specified, care shall be taken to ensure that the dead load does not cause deformation of the connection before the concrete has set; or the connection shall be considered as unencased for that portion of the load applied before the concrete has set.

(x) Where a beam frames eccentrically into the flange of a column no allowance shall be made for end restraint if the distance between the centre line of the beam and the centre line of the column exceeds ⅙ of the width of the column flange or two inches, whichever is the lesser.

(xi) When a beam makes a skew connection to a column no allowance shall be made for end restraint if the angle of skew exceeds 15 degrees.

The above classification is based largely upon the work of the Steel Structures Research Committee except that only three classes are included and allowance is made for the stiffening effect of concrete encasement. The constant C_4 is assumed to be 43 for Class A connections and 68.6 for Class B connections. Using these values the curves in Figs. 6 and 7 have been constructed showing the degree of restraint which may be assumed to be present when designing beams. When these curves are used the load factor cannot fall below two and will in most cases be appreciably greater.

The above method of determining allowable restraining moments whilst differing in form from the procedure recommended in the Steel Structures Research Committee report is based upon the same fundamental work, with one exception. In the experimental determination of moment angle curves, observations were not normally made for angular deformations in excess of .01 radian. In the draft rules for design proposed by the Committee it was assumed that at or about this point the curve became horizontal and limiting values for $\frac{M}{D}$ were fixed. In the proposed method of design the curve has been assumed to be continuous and no limiting value has been taken. (It is impossible to incorporate a limiting value in the proposed method.) The moment angle curve does in fact continue to rise and a few experiments in which measurements were made up to .02 radian showed that there is no reason to doubt the validity of the lower limit curve up to this value. Experience of breaking tests shows that the curve continues to rise though at a decreasing rate until the maximum load is reached and consequently there appears to be good reason for the assumption that the moment angle relation is a continuous function. In practice, with the class of connection it is proposed to standardize it makes very little difference whether the curve be assumed to rise or not for values of θ in excess of .01 radian.

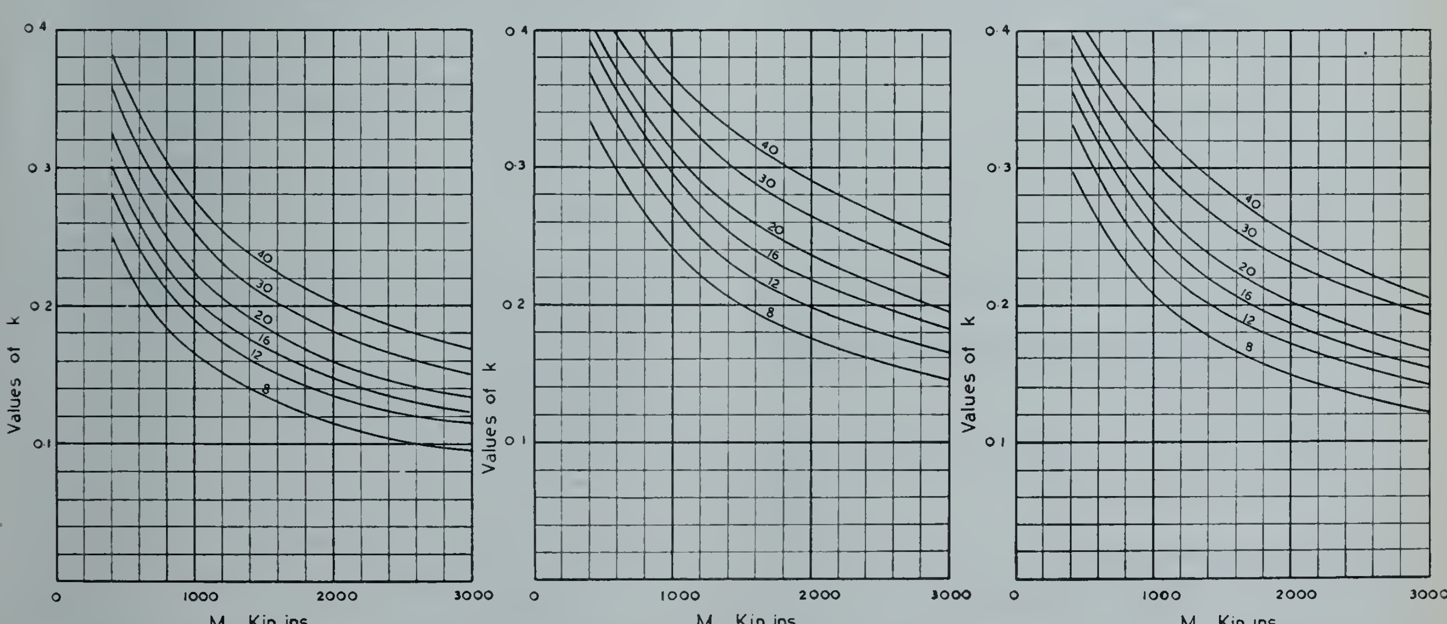

Fig. 7—Curves showing the relation between allowable restraint and fixed end moment when Class B connections are used. (The figures on the curves indicate the length of the beam in feet).

Effect of Concrete Encasement

The effect of concrete encasement is to increase the section modulus of the beam for a given depth and thus to decrease the value of C_3.

Thus, for an unencased beam

$$D = C_3 S^{.412} \quad \ldots\ldots(7)$$

but for an encased beam

$$D = C_2^{1} [S(1+P)]^{.412} \quad \ldots\ldots(16)$$

If we assume P has a maximum value of 0.16

then $C_2^{1} = 0.954\ C_2$.

Thus the effect upon the end restraint of a comparatively large allowance for encasement is small and it is felt that it can be neglected in all cases without introducing appreciable errors.

Examples

The following examples show the simplicity of the design procedure and give some indication of the saving in weight

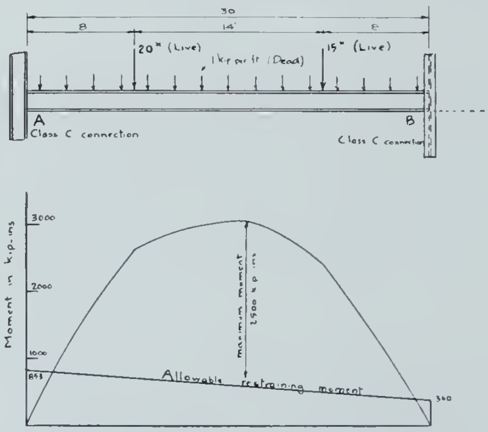

Fig. 8—Design of girder having unsymmetrical loads and restraints.

to be expected when the proposed methods are used. An allowable fibre stress of 20 kips. per sq. in. is assumed in all cases.

EXAMPLE (i) SECONDARY BEAM

Span: 20 ft.
Load: 48 kips uniformly distributed.
Girder solidly encased in concrete.

(a) *Using Supplementary Steel to Ensure Restraint*

$$M = \frac{2}{3}\left(\frac{WL}{8}\right) \frac{48(20)12}{12} = 960 \text{ kip-in.}$$

$$S = \frac{960}{20} = 48 \text{ in.}^3$$

Use 14″ x 6¾″ WF @ 34 lb.

Supplementary Steel

$$A_s^{1} = \frac{A_s}{4} = \frac{10.0}{4} = 2.5 \text{sq. in.}$$

If this is provided by reinforcing bars, use 4 — ⅞″ dia. about 8 ft. long.

If this is provided by a plate welded to the top flange, use a 5″ x ½″ Pl. about 2′6″ long.

Total Weight of Steel

Beam	680 lb.	Beam	680 lb.
Reinforcing bars	64 lb.	Plate	21 lb
	744 lb.		701 lb.

(b) *Without Supplementary Steel*

$$M = \frac{WL}{8} = \frac{48(20)12}{8} = 1{,}440 \text{ kip-in.}$$

$$S = \frac{1440}{20} = 72 \text{ in.}^3$$

Use 16″ x 7″ WF @ 45 lb.
Total weight of steel 900 lb.

EXAMPLE (ii) GIRDER

Span: 30 ft.
Load: 64 kips applied at the third points of the span.
It will be assumed that the girder is connected at each end to the flange of a column using Class B connections.

With Allowance for End Restraint

$$M_F = \frac{PL}{9} = \frac{64(30)12}{9} = 2560 \text{ kip-in.}$$

Assume Class A beam — From Fig. 7 $k = 0.208$

$$\text{Moment if simply supported} = \frac{PL}{6} = 3840 \text{ kip-in.}$$

Allowable restraining moment = 0.208 (2560) = 532 kip-in.
Maximum bending moment = 3308 kip-in.

$$S = \frac{3308}{20} = 165.4 \text{ in.}^3$$

Use 24″ x 9″ WF @ 74 lb.

Check class of beam from Fig. 2.

It will be found that this beam lies just below the line separating Class A and Class M. Since the restraint will be slightly increased if Class M beams are used the assumption of a Class A beam was on the safe side.

Without Allowance for End Restraint

$$M = \frac{PL}{6} = 3840 \text{ kip-in.}$$

$$S = \frac{3840}{20} = 192 \text{ in.}^3$$

Use 24″ × 9″ WF @ 87 lb.

EXAMPLE (iii) GIRDER

Span: 30 ft.
Load and end connections as shown in Fig. 8.
Depth of beam limited to 16 in.

Reactions

By taking moments, $R_A = 33.7$ kips
$R_B = 31.3$ kips

Bending Moments

Bending moment diagram assuming the beam to be freely supported will be as shown in Fig. 8.

With Allowance for End Restraint

At A, allowance may be made for restraint due to live and dead loads.

Dead load $M_F = 30(30) = 900$ kip-in.

Live load $M_F = \dfrac{35(8)22(12)}{60} = 1232$ kip-in.

Total 2132 kip-in.

Allowable restraining moment $(k = 0.4) = 0.4(2132)$
$= 853$ kip-in.

At B, allowance may be made for restraint due to dead load provided there is an approximately equal adjacent span.

Allowable restraining moment $(k = 0.4) = 360$ kip-in.
From bending moment diagram,

Maximum moment = 2500 kip-in.

$$S = \frac{2500}{20} = 125 \text{ in.}^3$$

Use 16″ x 8½″ WF @ 78 lb.

Without Allowance for End Restraint

Maximum bending moment = 3010 kip-in.

$$S = \frac{3010}{20} = 150 \text{ in.}^3$$

Use 16″ x 11½″ WF @ 88 lb.

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Abstracts of Current Literature

Abstracts of articles appearing in the current technical periodicals

BACTERIAL CONTAMINATION IMPROBABLE AS AN IMPLEMENT OF WAR

By Carl G. Flebus

From *Civil Engineering* (New York), March, 1941

The possibility of an enemy deliberately spreading an epidemic by polluting the water supply of a city has often been discussed. But it is improbable that resort will be had to this dreadful method of warfare—not because humanitarian considerations may be expected to sway an enemy who wages total war, but because the desired results would not be assured.

Repeated experiments made by various European powers on the pollution of reservoirs have given totally negative results. Owing to the nature of these experiments they were shrouded in the utmost secrecy, and the results were withheld from the public. However, during my last visit to Europe, I had the opportunity to discuss this phase of warfare with well-informed medical officers who had participated in the experiments. Though I am not sufficiently versed in the technical details to discuss the matter academically, I believe that I can give certain data that will be of interest.

The mere fact that a certain type of pathogenic bacteria is present in a body of water does not necessarily mean that persons who drink the water will immediately contract the disease. Much depends on the quantity of bacteria absorbed at one time and on the ability of the individuals concerned to resist the infection.

It appears that each continent, besides having its own climate, seasonal changes, and atmospheric ionization, has its own particular bacterial flora. Acclimatization and growth elsewhere vary extensively with the species and method of transplanting. It has been observed that only well-developed colonies survive when the transfer occurs within the original host, and a latent state occurs as soon as they have left it. Cultivated bacteria very seldom survive in a new environment. The water in a large impounding reservoir therefore can only be contaminated by aboriginal bacterial flora, and then only when local conditions are such as will foster the growth of the organisms.

Of 42 or more commonly known diseases caused by bacteria, few are caused by spore-bearing types. The majority are caused by mesophilic types which will not survive over eight days in a body of fresh water. Present prophylactic measures taken by health authorities are sufficient to impede the development of an artificially provoked epidemic.

While bacteriological studies definitely discard the possibility of contaminating a water supply by dropping bombs containing artificially cultivated disease bacteria, they do not rule out the possibility of contamination by saboteurs dropping soiled matter and infected articles in the water, or causing sewage to discharge into sources used for human consumption. After discussing this subject with well-informed members of the medical profession here and abroad, the writer is of the opinion that an epidemic in a nation at war is less likely to occur because of enemy action than because war activities may divert the attention of health departments from their routine prophylactic duties.

Large quantities of infected material are necessary to poison a large reservoir; however, it would be possible for a saboteur to poison filters, small reservoirs, stand pipes, and so forth. To provide against this danger and at the same time avoid expensive and delicate analyses, before the water is delivered to consumers a part should be by-passed through an artificial brook where mountain trout are cultivated in a natural environment. These fish are very sensitive to the slightest change in their water supply, and sharply react to poison of any nature, organic or otherwise, by coming to the surface, emerging their heads, and breathing heavily. In large cities where this method may not be feasible, colorimetric chemical analysis for various inorganic poisons can be developed, and used as a part of the regular daily routine.

AESTHETICS OF ENGINEERING STRUCTURES

By Oscar Faber

From *Journal of the Institution of Civil Engineers* (London), February, 1941

Engineers must conform to the reasonable demand that our cities shall be built with considerations of beauty and harmony, and that engineering structures, forming, as they do, important elements in our civilization, must conform to the same requirements and be things of beauty.

If this aspect of their work were lost, the public would remove from the control of such engineers the design of important engineering structures.

This aspect of the engineer's work is inadequately dealt with in the curricula of engineering colleges, and young engineers receive little training in this part of their work.

The author suggests that an engineering structure must satisfy four main requirements to be really satisfactory. It must fulfil all its functional requirements, be sufficiently permanent, sufficiently economical, and must give aesthetic satisfaction.

The paper deals with the things which go to determine whether the latter requirement will be met, and shows that the four main requirements are harmony, composition, character, and interest. These in turn depend on the proper handling of masses, colour, texture, rhythm, silhouette, expression of purpose, and expression of construction.

THE DEFENSE CHALLENGE

By Edward S. Bres

From *Civil Engineering* (New York), March, 1941

Several months ago our country was aghast at the realization that in spite of the magnitude of our industries and the super strides they had made, we would be unable to manufacture sufficient materials, ammunition, and supplies to equip, in less than a year's time, the first augmentation of our army of one million men. It was unbelievable.

More unbelievable was the fact that when five semi-motorized triangular divisions were ordered into the field in September, 1939, in connection with the largest manoeuvers ever undertaken, seven months were required to secure sufficient motor equipment even for these 55,000 men. True, the specifications called for motor vehicles not in all respects of commercial type; however, who could have believed this delay possible in our efficient motor industry, which manufactures several million units yearly!

A Crisis at Hand

We are face to face with a great national emergency—a serious social, political, and economic crisis. To meet and overcome this crisis a vast programme of National Preparedness for Defense has been instituted. Traditionally it has been the policy of our national government, after a crisis has passed, to ignore entirely the need for preparedness to meet emergencies that may manifest themselves in the future. In the face of this policy to ignore the future, when an emergency such as the present one appears, our task for preparedness assumes the proportions of an overload burden. I submit that this task and the burden falls primarily on the engineers.

To-day and at least for the next five years, we engineers are faced with the industrial development and procurement required for a standing army exceeding twenty times, at least, the size of the five divisions that we were unable to equip in less than seven months' time. During manoeuvers the food supply, alone, for a mobilization of 50,000 to 100,000 men is a daily problem that can admit of no failures or sudden changes.

Other Items of Supply

Visualize the gasoline requirements of the German Army for one day at 30 million gallons. Estimate the transportation needed for this item alone. In the German invasion of Belgium and France it is said that pipe lines were laid as the troops moved forward, and that fuel was pumped direct instead of being transported by truck and railroad.

In the invasion of Poland (lasting less than 30 days), a recognized masterpiece of military planning that was participated in by approximately 700,000 men, Germany's fuel expense, alone, was 40 million dollars. During the last world war the artillery fire of 3,000 guns for one day cost 300 million dollars; every minute London's anti-aircraft batteries are in action at least 100 thousand dollars' worth of ammunition is fired; for every soldier in the front lines two are required in the service of supply. Production, transportation, and distribution—all these responsibilities fall to the lot of the engineer.

Industrial Organization Also Essential

The vast expanses of seas separating our shores from all nations that might conceivably become aggressive have, in small part perhaps, been the reason or excuse for the so-called logic underlying our traditional policy of neglecting preparedness for the future. Now, however, the tremendous developments in the speed of all modes of travel and transportation have narrowed these sea barriers to a dangerous degree. The Army and Navy Munitions Board, recognizing the essential technical burdens, called a conference to prepare plans for organizing American industry. Partly as a result, there are now more than 40,000 engineers of various classifications at work on the country's mobilization for national defense.

It might be suggested that preparation for defense most certainly extends into preparation for ultimate offense. Else how can an aggressor be conquered and his activities in the future controlled? It follows, then, that after the factory has been enlarged, the innumerable machine tools made, and the machines of war constructed and their production output maintained, the engineer's task of manning, maintaining, and operating these machines goes right on.

Depends on Engineers

Illustrative of the time and cost of preparation is the big-gun problem. We are now in need of 16-in. gun carriages. Present arsenal capacity, now speeded up, can produce but four in one year. At first, at a large cost and with much delay, it was proposed to construct a plant to build them. Careful study and planning discarded this plan and the supply will be secured through augmentation of arsenal facilities and by contract arrangements.

If there are bottlenecks and obstructions in the production of all the essential elements, their dilation is our job—the engineer's job. Preparation of plans is estimated to require 20,000 man-years of the time of skilled technicians. Even with all this confronting us, it appears that complete national preparedness will be accomplished by the spring of 1942. However, with increasing patriotism in industry it may be hoped that the job will be practically completed by the late summer of 1941. It is an engineer's job. We must compute every stress and strain; design every structure to withstand every force applied to it. It is estimated that 80% of the personnel engaged in defense preparations consists either of engineers or of others whose every effort is planned, guided, and controlled by engineers. The magnitude of the purely civilian effort of technologists is tremendous.

In Military Units, Too

Consider the parallel tasks of engineers in the military service. Should we mobilize an army of 4,000,000 men, the purely engineering ratio of this vast force, both officers and enlisted men, will approximate 6 per cent, or 245,000 of the total number. In the German army this ratio is more than doubled, and it is interesting that officers for construction engineer units are taken from practicing civilian engineers.

With the strength of 1,400,000 now being mobilized, there will be approximately 73,000 engineer officers and men. In addition, other engineers not definitely classified as such will be used in the Artillery for computation of firing data, map interpretation, erection of field fortifications, and purely technical emergency service; in the Quartermaster Corps on construction, logistics, and lines of communications; in the Signal Corps for procurement and operation of telephone, telegraph, and radio equipment; in the Chemical Warfare Service; in the Ordnance Department for the design and manufacture of tanks and of cannon, small arms, and ammunition; and in many branches for work related to motor transport and air service.

A LARGE ALL-WELDED ELECTRICAL MOTOR

From *Electrical Review* (London), November 8th, 1940

By the fabrication of a 1,900 horsepower, three-phase motor from steel plates with the aid of oxy-coal-gas cutting and electric arc welding, important savings have been effected in production costs, together with economy in materials, a reduction in manufacturing time, and increased rigidity and strength in comparison with castings. The machine, of the synchronous-induction type, is 16 feet long by 14 feet high, and weighs 40 tons. It is designed to operate at unity power-factor on a 50-cycle, 11-kilovolt circuit, and is similar in construction to a slip-ring induction motor, except for a larger air-gap to ensure synchronous stability and more rotor copper to reduce losses. Self ventilation is effected by paddle-type fans and air-deflectors on the rotor. Details are given of the frames and windings of the stator and rotor, and of the starting system.

ARMAMENTS

From *Aeronautics* (London), November, 1940

Gun Turrets

On aircraft of earlier designs it was found that the wind pressure on the body of the air gunner was sufficiently great as to cause grave discomfort and to lead to inaccurate marksmanship. In winter, the intense cold experienced at any height aggravated the trouble.

With the suddenly accelerated upward trend of flying speeds of some five or six years ago, it became imperative for some form of protection for the air gunner, and as a result the movable gun turret was evolved.

This consists of a splinterproof glass enclosed compartment in which the air gunner is stationed. In the case of the gun position in the rear cockpit the glass covering is domeshaped and covers the full angular sweep of the horizon; similarly with those turrets which are, in certain types of bombers, let down from the belly of the fuselage. The gun turrets in the nose of the fuselage and in the tail unit do not allow of complete rotation.

The gun or guns project through a slit and the whole turret is rotated to bring the guns into the required position by the air gunner or indirectly by hydraulic or electrical means. Hydraulic turrets, developed by Captain Frazer-Nash and built by Parnell and others, are a distinctively British component.

Machine-Gun Equipment

In the majority of modern types of aircraft the front guns are fixed in the wing, but in some types the guns still fire through the propellor arc. In this case some form of mechanism is necessary to prevent the propellor blades being shot away. The Constantinesco gear is a device whereby an impulse is conveyed from the trigger to the machine gun along a column of oil.

The piston of an oil pump which is fixed to the engine shaft forces oil through a tube to which a second pump is attached. This second pump is mounted on the machine gun and operates the lock of the gun according to the impulses created by the shaft. By means of cams the impulse is timed to fire the bullets so that they miss the propellor blades.

The pressure in the oil tube is maintained by a hand-operated pump situated near the pilot, and only a few and occasional pumps are required.

The air gunner's guns are fixed to a rotatable mounting and can be easily moved in the horizontal and vertical planes.

TACOMA BRIDGE INSURANCE PAYMENTS IN DISPUTE

From *Engineering News-Record* (New York), March 13, 1941

Declaring the collapsed Tacoma Narrows suspension bridge a total loss, the Washington State Toll Bridge Authority, March 1, filed a proof of loss with underwriters for $5,200,000, representing 80 percent of its $6,500,000 value, and the full amount of the insurance. Answering the claim, the 23 insurance companies which underwrote the bridge declared in a formal statement that they believe the span can be restored to its original condition at a cost not exceeding $1,800,000.

Ask Almost Complete Dismantling

In making the claim for total loss, assistant state attorney-general Oliver Malm filed under a state law that provides that total loss may be claimed "where the structure insured cease to exist as such by reason of damage to it." It is contended that state statutes would supersede any exemptions or loopholes in the policies themselves by which the insurance companies might conceivably attempt to avoid payment of the full loss. Because the bridge had been in operation only four months, the Authority refused to write off any depreciation.

As bearing on the total loss claim, the Authority's board of consulting engineers reported, March 10, that only the piers are definitely salvagable, although there is a possibility that the central section of the towers and the three lower struts may be used. All the remaining superstructure, it is said, must be dismantled, before the causes of the collapse can be determined.

The statement by the underwriters was issued by Paul A. Carew, manager of the Marine office of America in Seattle, and chairman of a committee representing the interests of all companies involved. "Acting upon the advice of eminent engineers of national reputation," the statement said, "it is the definite opinion of the insurance companies that all damages to the bridge can be fully repaired at a cost of not exceeding $1,800,000, and, accordingly, as provided by the insurance policies, a demand for an appraisal to determine the actual amount of damage has been filed with the Washington Toll Bridge Authority."

The "demand for appraisal" means that the insurance companies have invoked the arbitration clause of their contracts with the Bridge Authority. This clause provides that in the event of a dispute over loss, both state and underwriters select an appraiser, and that the two appraisers then select an umpire, to whom they will submit all questions on which they cannot privately agree. The insurance companies named as their appraiser, Isaac Farber Stern, consulting engineer, Chicago.

In the event the appraisers fail to agree on an umpire, one would be appointed by a Washington court of record. The purpose of the board of arbitration would be to reconcile the differences existing between the state and the underwriters, and to make a formal finding of loss. It seemed generally agreed last week, however, that the dispute eventually will go to court.

Engineers advising the insurance companies, the statement said, had declared that the towers need not be taken down nor the cables respun. The insurance companies' repair cost of $1,800,000 was based upon use of the towers and cables and the construction of a new deck. Inspecting the bridge last week for the insurance companies were Clifford E. Paine of Chicago, H. D. Robinson and Shortridge Hardesty, New York, Prof. W. M. Wilson, University of Illinois, Clark Clarahan, Chicago, and Prof. Hardy Cross, Yale University.

BIG RISE IN CHARCOAL PRODUCTION

From *Civil Engineering* (London), December, 1940

Rapid changes in the technique of charcoal burning—one of Britain's oldest industries—have now made it possible to dispense entirely with imports, states the Ministry of Supply.

Wood charcoal is a vital raw material. It is used as a case hardening compound in the production of aero engine parts, in the manufacture of artificial silk, in the processing of rubber, and in the manufacture of cyanide for the extraction of gold. Another form of charcoal has an important use in the filters of our gas masks.

Before the war Britain produced less than half of the charcoal consumed, and the craft of charcoal burning, entailing a hard and solitary life, survived only in a few places. The charcoal burner's job was a constant round of digging, stacking, turning, watching and dousing. A change in the direction of the wind or a rain storm could spoil the work of weeks.

To-day production has been more than doubled by the use of a new kind of steel kiln which can be moved from place to place, wherever suitable wood is available, and can be worked by unskilled labour under skilled supervision.

The need for importing from remote sources of supply, including the Gold Coast, the Philippines and India, has now been overcome with consequent saving in foreign exchange and without risking men and shipping.

SEARCHLIGHTS AND THOSE WHO MAN THEM

From *Aeronautics* (London), November, 1940

Not until the beginning of the air offensive on Britain did people realize the importance of searchlight work and how much A.A. guns and fighter aircraft were dependent on their efficiency.

Royal Air Force personnel sometimes express a desire to know about the method of working the searchlights, their power and range and other factual matter, and this article is intended to meet that desire.

Searchlight batteries are a section of the Royal Artillery, from whom they receive their orders. Each battery is divided into a number of detachments which become in themselves complete and independent units under the charge of a non-commissioned officer. On receiving orders to take up position, each detachment, consisting of 10 men, is given a map showing the location of the site they are to occupy, and, with every piece of equipment required packed into just one lorry, they set off by themselves. In a matter of a few hours the equipment is erected and the crew is ready to go into action.

The searchlight itself is erected in the centre of the site. Its make-up is simplicity itself, and resembles on a large scale that of an ordinary pocket torch. The main features are the lamp, the projector and the mirror, the combination of which results in the beam with which everybody is now familiar. The lamp or source of light is situated in the centre of the projector, at the back of which is fixed an ordinary concave mirror serving to reflect the light through the front of the projector and to gather it together, as it were, and shape it into a beam. The light is obtained from a circuit of electricity, which causes carbons to burn with a sharp phosphorescent glow, developing up to 200 million candle power. This power gives the beam a range of about five miles. A point flying people do not always appreciate is that although range is apparently restricted in cloudy weather, in reality the beam can penetrate the clouds, and, controlled by the sound locator, can assist fighter aircraft to find the enemy machine.

The projector has a long arm at the end of which is a wheel so that bearing and elevation are controllable.

The projector, rotating on a base, has a long arm fixed to it at the end of which a wheel is used to regulate the elevation. The direction of the beam, both in bearing and elevation, can be controlled by one man, who, pushing or pulling the "long arm" and at the same time turning the wheel left or right, can very quickly move the beam into any position desired.

The adjustment and control of the beam are under orders from other members of the detachment who operate other pieces of equipment. These pieces include the sound locator, by which the course of a "heard" target can be plotted. There are also the two "spotters," equipped with binoculars, who aid in directing the beam on to "seen" targets. As several "heard" and several "seen" targets may pass over an area at the same time, obviously only one aeroplane can be engaged and only one man can give orders, which necessitates a high standard of drill and efficiency in the men employed. They must be able to pick out enemy aeroplanes from friendly, quickly and certainly, and expose on the right ones. For the protection of the site from low flying attacks, each site is equipped with an anti-aircraft light machine gun.

The technical side of the job is run by two men whose duty it is to see that the correct current is supplied to the generator. Also attention must be paid to the smooth and efficient burning of the carbons to assure a stable beam.

Men engaged in searchlight work generally have a longer and more intricate period of training than men of other units, for apart from their general drill and training in the use of weapons, they must learn to be efficient in at least three separate jobs on the detachment, so that in the event of casualties being sustained by enemy action, they may take the place of their comrades with confidence and with the knowledge that they can do the work properly.

Lastly they must always be ready to engage and attack any paratroops that may land in their area.

Perhaps one of the most important factors regarding searchlights is their remarkable mobility. Every piece of equipment can be taken down and packed away into the lorry, and, as there is still room to spare for the men and their kits, this one little complete unit can travel about in the shape of just one loaded lorry. Consequently in an area which might frequently become untenable owing to enemy action, or in the event of searchlight units backing up our own advancing forces to aid them at night, they can move freely from one place to another and be ready for action each nightfall. They thus maintain the British Army's reputation for being one of the most highly mechanised forces in the world.

These facts go to make searchlight work one of the most highly skilled and interesting jobs in the British Army.

SHORTAGE OF ENGINEERS

From *Engineering News-Record* (New York), March 13, 1941

There is a great need for co-ordination between the U.S. Office of Education and those who are administering the Selective Service Act if the reported shortage of engineers is not to become more serious as the defense effort increases in intensity. Last week a number of engineering educators met in Washington to discuss with executives of the U.S. Office of Education plans for speeding up the training of students now near the end of their engineering courses. At the same time, draft boards were calling young engineers and engineering instructors into service and assigning them to infantry or other units where the value of their engineering training will be wasted.

Responsibility for this anomalous situation does not rest on local draft boards, who must follow the letter of their instructions, but on the policy-forming officers of the War Department in Washington, who could relieve the possibility of a shortage of engineers by a few simple rulings.

First, there should be a decision as to whether engineering instructors and some or all engineers in training should be exempt from the draft. In Canada, young engineering educators are exempt because what they are doing is recognized as an essential war service. Then it should be decided whether students of civil, mining, chemical and electrical engineering should be switched to mechanical engineering wherever possible, as that is the field where the shortage is most acute. Finally, young engineers who are drafted should be assigned to engineer or shop regiments where they will be most useful and from where, in an emergency, they can be assigned to industries badly in need of engineers.

Our whole schedule of engineering training should not be upset until it is known how real the shortage is and how much it can be reduced by changes in administering the Selective Service Act. Agencies in Washington now working in separate channels should get together.

THE UHL RIVER HYDRO-ELECTRIC PROJECT

By Herbert Percival Thomas

From *Journal of the Institution of Civil Engineers,* (London), February, 1941

In October, 1921, a survey of the hydro-electric possibilities of the Punjab was commenced by Major R. N. Aylward, D.S.O., M.C., under the supervision of the late Colonel B. C. Battye, D.S.O., M.C., Assoc.Inst.C.E., on the instructions of the Punjab Government and attention was called to the possibility of developing power from the Uhl River.

The first project put forward was for the development of 118,400 kilowatts, at an estimated gross capital cost of 121,000,000 rupees. The scheme was to be developed in three stages. The first stage was to comprise head works in the Uhl river valley, a tunnel through the range between the Uhl river and Joginder Nagar, and a power house at Joginder Nagar. The second stage consisted of the addition of an arch storage dam, 220 ft. high, with a crest 612 ft. long, in a rock gorge in the Uhl valley, creating a storage of 21,500 acre-feet. The third stage was to utilize the tail water from the Joginder Nagar plant through a drop of 1,200 ft. made available by leading the water in a 4-mile flume round a spur below the power house which terminates above a bend of the Neri Khad.

The present development follows the lines of the first stage of the original project. The waters of the Uhl river and its tributary, the Lambadag, are impounded by weirs above the junction of the two rivers, and are led off through decantation chambers by flumes to the tunnel. The tunnel, 3 miles in length, pierces the range dividing the Uhl valley from that of the Neri Khad, a small stream which finds its way into the Beas river, and the water passes on down through penstock pipes to the power house 2,000 ft. below the intake on the Uhl river. The chief point of interest in regard to the head works is the equipment for ensuring that the water reaching the turbine jets is free from sand and gravel. The Uhl weir is equipped, in its mid-stream section, with a falling gate which subsides into the river bed and is capable of supporting 15-ton boulders as they are rolled down in the monsoon floods. The water taken in at the off-take above the impounding weirs is passed through decantation chambers, fitted with "venetian-blind" concrete slabs in the floors of compartments of the "hopper-bottom" type, through which the deposited silt is scoured into scour ducts, and so returned to the river below the weirs. The decantation is effected by enlarging the cross-sectional area of the chambers till the speed of flow is reduced to 1 ft. per second at full demand. This has been found most successful since no abrasive particles of sand or silt have reached the nozzles; the wear on the needles and buckets after five years is hardly discernible.

The 3-mile tunnel is 9 ft. 3 in. in diameter inside the lining, and in various places necessitated special methods of driving. The Himalayan mountains are amongst the newest known and are composed very largely of rocks, twisted and shattered by the working of the earth's crust which has caused their evolution, so that nowhere, throughout its entire length, did the tunnel penetrate rock of such a soundness that it could be left unlined; in many places progress was only made possible by installing steel sets made from rolled-steel joists at 4 ft. centres, supporting a sheathing of reinforced-concrete slabs. Those sets and the concrete slabs were embedded in the concrete lining of the completed tunnel. The tunnel was extremely wet owing to the infiltration of water from the seams, and, in places, jets of water spouting from the walls or roof, when confined, registered pressures ranging from 60 to 80 lb. per square inch. A detailed description of the methods used in driving and lining this tunnel is given in a paper presented before the Punjab Engineering Congress in 1932.

From where the main tunnel ends, two 6-ft.-diameter pipes, surrounded by 2 ft. of concrete, carry the water 1,100 ft. to emerge on the hillside at the valve house. Building the surge tank at the junction of these pipes with the tunnel constituted a difficult problem. When the second stage, including the 220-ft. dam, is built the surge-shaft chamber will be subjected to a static pressure due to a head of 300 ft; the rock at this point is so shattered that even the 6-ft. steel pipes had to be protected throughout their length of 1,100 ft. by a 2-ft. casing of concrete. Loss of water could not be countenanced and, furthermore, any leakage from the surge-shaft base would undoubtedly have found its way to the mountain side and have caused serious slips, endangering the whole scheme. Dr. Gruner, an eminent authority on pressure tunnels, was consulted, and the chamber was constructed according to his design, which consists of a cage of steel reinforcing-rods with steel-rod ties carried back into the main tunnel and the two pipe tunnels, the whole being united in place.

The power house is situated on the banks of the Neri Khad, and is designed for the ultimate accommodation of seven 12,000 kilowatt generators and their necessary switchgear. The building is of the earthquake-proof type, the entire structure being carried by heavy steel stanchions founded on a mat of concrete which is 12 ft. thick and is continuous throughout its length under the machinery hall and control block. The walls are merely partitions between the stanchions and consist of cement plaster on expanded metal. They are designed for a wind pressure of 25 lb. per sq. ft. The design is based on a seismic acceleration of 32 ft. per sec. There are four generators, each of 12,000 kilowatts output, and each directly connected to 17,000-brake-horsepower Boving impulse turbines of the overhung type with a speed of 425 revolutions per minute. They are equipped with high-speed excitation. The voltage of generation is 11,000 and this is stepped up to 132,000 for transmission to Amritsar, Lahore, and Jullundur, from which places 66,000-, 33,000- and 11,000-volt branch-lines radiate, making supply available in twenty-four towns and a rural area of approximately 20,000 square miles.

After installation, tests were carried out on both generators and turbines; the method employed in measuring the water was the subject of a paper by Mr. E. N. Webb, M.Inst.C.E.

The outlay on production works was 26,135,285 rupees and the installed capacity of the plant is, at present, 48,000 kilowatts, indicating an installation cost per kilowatt of 545 rupees; although this may appear high, it must be remembered that the headworks, tunnel, and surge shaft are all built to a design which makes them capable of passing sufficient water for the development of a total of 72,000 kilowatts. Furthermore, the footings of the anchors for the next two pipe-lines have been completed, which means that the capital expenditure of 26,135,285 rupees includes an amount of 9,000,000 rupees which has been expended on behalf of the second stage, so that this second stage may be constructed without interruption to supply, and so as to take advantage of the greater efficiency and lesser cost due to the construction being undertaken in conjunction with the first stage works. Taking this figure into account, the installation cost per kilowatt may be said to be 357 rupees. The cost per unit generated, even including the full capital expenditure made to date, works out at 2-5 pies (a pie is approximately 1/12 penny) and will be proportionately lower for the second and third stages. The average return obtained, at present, is 11 pies per unit sold and the load connected after 5 years' operation exceeds 30,000 kilowatts. Additional generating capacity will be necessary to meet the fast increasing demand in the year 1942, and proposals for suitable extensions are being considered.

From Month to Month

News of the Institute and other Societies, Comments and Correspondence, Elections and Transfers

BAD NEWS

It will be a disappointment to all members, as it has been to Council, to learn that changing soil conditions have made necessary certain major repairs to the Headquarters' premises. Most buildings in the neighbourhood have suffered similar damage, and extensive underpinning operations have been carried out in several places, as for instance at the University Club, and the McGill Union. In one instance a whole new front had to be built on a residence.

It is a little consolation to know that others are equally unfortunate, but it does indicate that the fault was not in the building itself. It is the contention of many (although not admitted by the company) that the tunnel under the mountain has lowered the water table thereby drying out the clay formation and causing the soil to recede. Test pits and subsequent excavation carried out at Headquarters showed clearly that the soil had subsided from two to six inches under all walls and piers and that the heads of the protruding piles under the footings had rotted sufficiently to permit settlement of the building.

The House Committee made a thorough investigation, and drew up plans and specifications which were figured on by five contracting firms, all closely associated with the Institute. The contract went to the lowest tenderer who did an excellent piece of work at a reasonable price. The work is now complete, and the task of moving the library stacks back into place and rearranging stationery and other supplies is well underway.

The President has written to the chairman of all branches explaining the situation and asking if they would be able to assist in meeting the cost of this extraordinary expense, amounting to $10,000. The Institute finances are in good shape with no bank loans and no outstanding debts of any kind, but it is not good business to spend reserves in time of prosperity. The experience of the last war indicates positively that conditions after this war will require the full use of reserves if the Institute activities are to be maintained, and services to the members not curtailed. It would be folly—if it can be avoided—to meet this major expense with funds that will have much more important work to do later.

The Montreal Branch has responded excellently. Regardless of the fact that Montreal members fees on the average are approximately two dollars a year more than any other members, they have set themselves a quota of four thousand dollars, and have notified the president of their plans to collect it. This should be an inspiration to other branches.

The president's two letters to the branches are printed herewith.

National Research Council,
Ottawa, Ontario.
3 March, 1941.

Branch Chairman,
The Engineering Institute of Canada,

Dear Sir:

The unfortunate accident to Dr. Hogg in January prevented him completing an important undertaking to which he had set his hand. Before leaving for the south on a recuperative trip he asked me to take up the proposal and complete it on his behalf. This I am very happy to do.

Due to changing soil conditions in the neighbourhood of our Headquarters, considerable damage to the building developed in the spring of 1940. On the recommendation of the House Committee, and after an investigation by that committee, Council decided to have the building underpinned in order to arrest the settlement. This work has just been completed at a cost of approximately $9,000. Last year's financial statement shows that we had an excellent year, and indicated that the Institute affairs are in very good shape, but such an unforeseen expenditure as this is very disturbing. It has been decided that the major portion of this cost will be met from our 1940 balance, and that some other means be devised for finding the balance.

The experience of the years after the last war leads Council to believe that the Institute will suffer a substantial reduction in income after this war, with increased opportunities for service. Consequently, it has seemed unwise to deplete our reserve now, if it can be avoided. The suggestion has been made that members might prefer to make some voluntary contribution in order to assist Council in maintaining our financial position.

Dr. Hogg was confident that members would react favourably to such a proposal, and intended to approach the branch officers to get the benefit of their opinions. Unfortunately, his accident now makes all this impossible. In Dr. Hogg's place I am proposing the plan which he had in mind.

If all members of the Institute with the possible exception of Students, contributed an average of one dollar each it would build up an amount of about $4,000 and would not seriously affect the finances of any individual. This sum would enable Council to meet the cost of the repair work without any sacrifice of reserve funds. Would your executive approve of such a proposal, and take whatever steps are necessary to collect the money? It has been thought that this collection could be done much better by the branch executives than by Council.

I would consider it a favour if you would let me have the benefit of your opinion as well as that of your executive at as early a date as is convenient to you. I feel this is an important matter, and one that concerns every member from coast to coast. The Headquarters building is a real asset to the whole Institute and not just to the Montreal Branch. The work was absolutely necessary and must be paid for. Your sympathetic consideration of this proposal will be greatly appreciated both by Dr. Hogg and myself.

Yours sincerely,

(*Signed*) C. J. Mackenzie, *President*,
Engineering Institute of Canada.

25th March, 1941.

Branch Chairman,
The Engineering Institute of Canada,

Dear Sir:

With reference to my letter of 3 March. As a result of correspondence with the chairmen of several branches, I would like to submit a few further observations on the motives which prompted Dr. Hogg and myself to initiate the proposal.

The general facts are that it became necessary to make extensive repairs in the foundations of the Headquarters Building last year and a sum of $10,000 was expended. The Council has sufficient funds in its reserve account to meet this item and it was originally proposed to do so. Some of the senior members of the Institute, including Dr. Hogg, felt, however, that, if at all possible, it would be unwise to seriously deplete any reserve at this time because it was thought that in all probability more serious days would come with the end of the War and it would be very desirable if the Institute could have some resources to meet the demands of that period.

As a Member who has never resided in the Montreal district, I would like to point out that the proposal to raise money by voluntary subscription from the membership at large did not originate in the Montreal Branch, and is of no particular advantage to that branch. In periods of depression, the larger branches are much more competent to take care of their problems than are the smaller branches and such branches, we felt, have a real interest in keeping our reserve at a high point at this time. Notwithstanding this situation, the Montreal Branch has put on a vigorous campaign to raise $4,000 which, I think, is an indication of their willingness to carry even more than their share of the project.

Most of the branches have shown their willingness to get behind this movement and I am hoping that we will be successful in raising a very material portion of the $10,000, and the Council as a whole, I think, will make every effort to conserve and add to our general reserves during this period, when even in the face of heavy taxation, our problems will probably not be as acute as they will be later on. We all realize that the different branches across Canada find themselves in different situations and we do not wish to be put in the position of unduly urging the proposal but anything which the branches can do, even although the actual contributions are very small, will be very much appreciated as we feel strongly that the proposal is a wise one, and the results will be beneficial to the entire membership.

Yours sincerely,

(*Signed*) C. J. Mackenzie, *President*,
Engineering Institute of Canada.

WARTIME BUREAU OF TECHNICAL PERSONNEL

Announcement has just been made of the Advisory Board of the Bureau, and of the appointment of the Assistant Director. The Board is made up of a representative and an alternate selected by each of the larger organizations associated with the proposal. The list is as follows:

The Engineering Institute of Canada—Dean C.J. Mackenzie, President of the Institute, and Acting President of the National Research Council.

Alternate: L. C. Jacobs, Supervisory Engineer, Dept. of Munitions and Supplies.

The Canadian Institute of Mining and Metallurgy—G. C. Bateman, Immediate Past-President of the Institute, and Metals Controller.

Alternate: G. C. Monture, Chief, Division of Economics, Bureau of Mines.

Canadian Institute of Chemistry—L. E. Westman, Acting Secretary of the Institute.

Alternate: Dr. Paul E. Gagnon, Hon. Treasurer of the Institute and Professor of Chemistry, Laval University.

Canadian Manufacturers Association (also representing Technical Service Council)—Geo. C. Carruthers, President, Technical Service Council and President, Interlake Tissue Mills Ltd.

Alternate: W. D. Black, Past-President of the Association and President, Otis-Fensom Elevator Co. Ltd.

Universities—D. S. Ellis, Professor of Civil Engineering, Queen's University.

Alternate: R. De L. French, Professor of Highway and Municipal Engineering, McGill University.

Provincial Professional Associations—R. E. Jamieson, President, Corporation of Professional Engineers of Quebec and Professor of Civil Engineering, McGill University.

In the March *Journal* it was announced that E. M. Little had accepted the position of Director, and now it is announced that the General Secretary of the Engineering Institute of Canada, L. Austin Wright, has been appointed Assistant Director. Mr. Wright, in association with the secretaries of the Canadian Institute of Mining and Metallurgy and the Canadian Institute of Chemistry, has been interested in the registration of technical personnel for the advancement of the war since 1938 and, therefore, is well informed on the work which is being undertaken by the Bureau. His time is made available to the Department of Labour by the Council of the Institute.

It is felt by Council that the work entrusted to the Bureau is of paramount importance to the members of the Institute, to the profession at large, and to the war effort. Under such circumstances the entire facilities of the Institute should be placed at the Government's disposal, and this Council does gladly. Certain adjustments of duties at Headquarters will be necessary; but the entire staff has declared itself as ready to co-operate to the utmost.

The Bureau has obtained office space in the Supreme Court Building at Ottawa where it can work very closely with the Department of National War Services. Other Departments with which the Bureau is associated are near at hand, such as Labour, Munitions and Supply, and National Defence. With the control of war effort both in industry and the combatant forces directed from Ottawa, the location is ideal for the Bureau.

It is necessary to canvass the situation thoroughly to determine the latest demand for engineers and chemists, as well as the available supply. Thus it is indicated that a questionnaire must again be circulated. There are many who feel they have answered enough questions and completed too many forms but the fact remains that there is no complete up-to-date list of technical personnel and that without it the job cannot be done.

The new form will probably reach the members of the various societies about the same time as this *Journal* appears. You are asked to complete it carefully and quickly. To-day there is no surplus of technical man power, and the indications are that the demand will increase with the expanding war programme. Therefore, it becomes of first importance that engineers' qualifications should be placed before this Government agency, along with some indication of their availability for war work if they are not already so engaged.

It is in everyone's interest that this information be gathered quickly, accurately and without omission. It is the intention to reach every qualified person whether or not he is a member of a professional or technical society. It is hoped that it will not be necessary to waste time and effort in following up on the original request. A prompt reply to the questionnaire will give you the assurance that you have done everything you can to assist the Bureau in its national effort.

There is also in process a canvass of industry and governmental departments, to determine the number of men who will be required, what their qualifications must be, and when they will be needed.

By these two operations it is intended to bring into one office reasonably accurate figures as to the number of men available as well as the number required. Only by such methods can an efficient and satisfactory relationship between supply and demand be maintained, and only by such methods can members of the profession make their maximum contribution towards the salvation of their country and their civilization.

CORRESPONDENCE

The Institution of Mechanical Engineers,
Storey's Gate, St. James's Park,
London, S.W.1.
31st, January, 1941.

L. Austin Wright, Esq., Secretary,
Engineering Institute of Canada,
2050 Mansfield St., Montreal, P.Q.

Dear Mr. Austin Wright:

James Watt International Medal

At the special meeting of the Institution last Friday, 24th January, we had the honour of the company of His Excellency the Swiss Minister in London, M. Walter Thurnheer, who received the Watt Medal on behalf of Professor Stodola in the presence of a large number of members and distinguished guests, including Mr. C. G. Du Cane (your Official Delegate), and Brigadier C. S. L. Hertsberg, M.C., Chief Engineer to the Canadian Corps. Prior to the meeting the Council held a special luncheon, at which our guests were entertained, together with the Hon. Vincent Massey, High Commissioner for Canada.

The meeting was eminently successful, and I hope to send you shortly a full account of the proceedings.

Yours sincerely,

(*Signed*) J. Montgomrey, *Secretary.*

The Institution of Engineers, Australia
Science House, Sydney, N.S.W.
February 14th, 1941.

The General Secretary,
Engineering Institute of Canada,
2050 Mansfield St., Montreal, P.Q.

Dear Sir:

I wish to express my deep appreciation of the kindly thought of your International Relations Committee in sending to me a card conveying the Season's Greetings.

May I believe that it is not too late in the New Year to hope that your Institute, its members in general, and the members of the International Relations Committee in particular, will triumph over the difficulties and troubles which are unavoidable in these days of world conflict. Each individual must make his personal contribution, and we are confident that in Canada, as in Australia, the professional engineer will not fail in his duty.

To you, Mr. Secretary, I convey my personal greetings.

Yours faithfully,

(*Signed*) E. S. Maclean, *Secretary.*

MEETING OF COUNCIL

A meeting of the Council was held at Headquarters on Saturday, March 15th, 1941, at ten-thirty a.m., with President C. J. Mackenzie in the chair, and ten other members of Council present; together with the newly appointed treasurer, John Stadler.

The Secretary read a cable just received from the Secretary of the Institution of Electrical Engineers advising that they would be delighted to arrange for the presentation of the Sir John Kennedy Medal to General McNaughton at the Kelvin Lecture meeting to be held on May 8th, when the presidents of other leading institutions are usually present. It had been ascertained that this date would be convenient for General McNaughton and also for the High Commissioners for Canada in London.

This arrangement was considered extremely satisfactory, and the Secretary was directed to thank the Institution for their co-operation. A number of possible guests were suggested, including Brigadier C. S. L. Hertzberg, Sir Alexander Gibb, Colonel DuCane, the Rt.-Hon. R. B. Bennett, and Dr. A. S. Eve. After some discussion it was agreed that the secretary should communicate with the Canadian High Commissioner in London, and that appropriate additional names be sent to the Institution.

At the Hamilton Meeting of Council it had been suggested that the president should call a meeting of representatives of the Ontario branches to discuss the possibility of establishing some system of rotation for the offices of vice-president in Ontario. The President reported that a suggestion had been made that the April meeting of Council might be held in Toronto to coincide with a meeting of the Council of the Association of Professional Engineers of Ontario, tentative arrangements for which had been made for the 19th or 26th, and it had been suggested that a special meeting of Ontario councillors might be called at that time. This proposal was agreed to.

At the Hamilton Meeting of Council the president had been authorized to appoint a committee to consider what further action should be taken with regard to the report of the Committee on Western Water Problems, and he had nominated Mr. Gaherty as a committee of one, with power to add. The president understood that Mr. Gaherty had had some conversations with various members of the government, and that other bodies were taking action on this matter.

The secretary read a letter from Mr. Gaherty advising that since the Annual Meeting the government had appointed an interdepartmental committee to make a study of the St. Mary's project. He had interviewed two members of this committee, to whom it had been explained that the Institute was anxious to co-operate with the government committee in any way it could, and to offer them constructive support.

The secretary reported that in response to the request from the Citizens' Committee for Troops in Training for a contribution towards a fund for the purchase of band instruments for the Royal Canadian Engineers in training at Petawawa, $160.00 had been raised by voluntary contributions from councillors and members attending the Annual General Meeting at Hamilton.

The membership of the following committees, as submitted by the chairmen, was noted and unanimously approved: Papers, Publication, Past Presidents' Prize, Gzowski Medal, Plummer Medal, Professional Interests, Western Water Problems, The Young Engineer, Radio Broadcasting, Board of Examiners and Education, Students' and Juniors' Prizes.

Acting on the recommendation recorded at the Hamilton Meeting of Council, the Finance Committee gave consideration to the proposal that the general secretary's services should be made available on a part-time basis to the Department of Labour at Ottawa in order to assist in carrying out the work of the Wartime Bureau of Technical Personnel in the capacity of Assistant Director.

After considerable discussion, in which the question was examined from all angles, the committee decided to give authorization to the proposal. It appears that the successful operation of this Bureau is not only of great importance to the Institute but to the war effort as well. It was pointed out that when the Bureau gets under way it is expected that it will replace the work now being done by the Employment Department of the Institute and that therefore a great deal of Mr. Trudel's time, which is now devoted to employment, would be available to assume additional duties now carried out by the general secretary. Mr. Durley had also offered to take over some additional work on the *Journal*. In view of the importance of the work at Ottawa, and of the assured co-operation of the balance of the Headquarters staff, the committee felt sure that the affairs of the Institute would not suffer unduly.

The recommendation of the Finance Committee that joint members in provinces where co-operative agreements are in force should still be entitled to the privileges of that membership if they were temporarily absent from their province on war work for the government, was unanimously approved.

Mr. Perry reported briefly on the repair work to the building which was now practically completed, and which, in his opinion, had been very satisfactorily done. Council expressed its appreciation of Mr. Perry's efforts, and of the splendid co-operation of the contractors, who were also members of the Institute.

It was noted that Dean Mackenzie had written to the chairman of each of the twenty-five branches with reference to the contributions which it was hoped would be raised by the branches from their members to assist in meeting the cost of the building repairs. There had been some delay in issuing this letter as, in the first instance, it had been planned that Dr. Hogg would write it. However, Dean Mackenzie had taken it over, and had worded his letter so that the request came both from him and from Dr. Hogg.

The president felt that the point should be stressed with all members that the Institute was anxious to go into the period after the war with a substantial reserve, so that it would be in a good position to serve its members at that time. Dean Mackenzie suggested that it might be desirable to write a letter to all councillors asking them to emphasize this point when the matter comes before their executives. Following some discussion, it was decided that this should be done, and the president agreed to draw particular attention to this phase of the situation when visiting the various branches.

The secretary presented a letter from Major C. C. Lindsay, M.E.I.C. (late Canadian Engineers), suggesting that the members of the Engineering Institute of Canada, through the local branches, might render valuable assistance in the war effort by co-operating with the various units of the Royal Canadian Engineers particularly in their endeavours to recruit a sufficient number of qualified men.

It was agreed that a copy of the letter should be sent to all branches for their consideration and action, explaining that Council was entirely in sympathy with this proposal, but felt it was a matter for each branch to settle in the light of conditions as they exist in each locality.

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

Admissions	
Members	3
Juniors	2
Affiiliate	1
Students	38

Transfers	
Junior to Member	3
Student to Member	3
Student to Junior	4

It was decided that the April meeting of Council should be held in Toronto to coincide with the meeting of the Council of the Association of Professional Engineers of Ontario, it being left with the General Secretary to arrange a convenient date.

The Council rose at one-fifteen p.m.

ELECTIONS AND TRANSFERS

At the meeting of Council held on March 15th, 1941, the following elections and transfers were effected:

Members

MacQuarrie, Archibald Henry, B.A.Sc. (Univ. of Toronto), sales engr., The Canadian Bridge Co. Ltd., Walkerville, Ont.

Richards, George Henry, manager, Lee & Nash, Civil Engrs. & Surveyors, Brantford, Ont.

Smith, Cleve A., B.A.Sc. (Univ. of Toronto), asst. engr., (Trans. Section, Elec. Engrg. Dept.), H.E.P.C. of Ontario, Toronto, Ont.

Juniors

MacKimmie, Robert Dunstone, B.Eng. (Elec.), (McGill Univ.), asst. engr., Can. Gen. Elec. Co. Ltd., Peterborough, Ont.

Parker, William Ernest Bain, B.A.Sc., M.A.Sc. (Univ. of Toronto), asst. research engr., H.E.P.C. of Ontario, Toronto, Ont.

Affiliate

Murchison, James Gray, consultant, Suite 5, Buntin Block, Fort William, Ont.

Transferred from the class of Junior to that of Member

Dale, James Graham, B.Sc (E.E.), (Univ. of Alta.), installn. engr., Northwestern Utilities Ltd., Edmonton, Alta.

Nesbitt, Michael Cullum, B.A.Sc. (Univ. of B.C.), supt. engr., Dawson Wade & Co., Contractors, Victoria, B.C.

Seely, Wallace Errol, B.Sc (Civil), (Univ. of N.B.), junior engr., Dept. of National Defence (Air Force), Montreal, Que.

Transferred from the class of Student to that of Member

Butler, John Arthur Tweed, B.Eng. (Mech).) (McGill Univ.), chief stress analyst, Fairchild Aircraft Ltd., Longueuil, Que.

Fogarty, James William Patrick, B.Sc. (Elec.), (McGill Univ.), professor of engineering, St. Francois Xavier University, Antigonish, N.S.

Spence, Graydon Dill, B.Sc. (Elec.), (N.S. Tech. Coll.), res. engr., N.S. Power Commission, St. Croix, N.S.

Transferred from the class of Student to that of Junior

Campbell, Duncan Chester, B.Sc. (Univ. of N.B.), asst. engr., Dept. of Transport, Civil Aviation Branch, Saint John, N.B.

Green, John Scott, B.A.Sc. (Univ. of Toronto), aircraft examiner, British Air Commission, Toronto, Ont.

Miller, G. Grant B., B.Sc. (Elec.), (Univ. of N.B.), sales engr., E. S. Stephenson & Co. Ltd., Saint John, N.B.

Zion, Alfred Bernard, B.Eng. (McGill Univ.), factory supt., Dominion Lock Co. Ltd., Montreal, Que.

Students Admitted

Barurek, Christian Stephen, (McGill Univ.), 5691 Brissette St., Montreal, Que.

Bradshaw, Thomas Earl, (Univ. of Man.), 549 Jubilee Ave., Winnipeg, Man.

Brenan, William Murdoch, (Univ. of N.B.), 215 Germain St., Saint John, N.B.

Burrows, James Louis, B.Sc., (Queen's Univ.), 37 Clergy St. W., Kingston, Ont.

Chilman, William Richard, (Queen's Univ.), 78 Barrie St., Kingston, Ont.

Coulthart, Eldred Norman, (Queen's Univ.), Monklands, Ont.

Cronyn, John B. (Univ. of Toronto), R.R. No. 3, London, Ont.

Cuthbertson, Robert Shedden, (Queen's Univ.), Cardinal, Ont.

Demers, Charles Eugene, (Queen's Univ.), 300 Earl St., Kingston, Ont.

Dowd, Elbert Watson, (Queen's Univ.), 159 First Ave., Ottawa, Ont.

Floud, John Rhys, (McGill Univ.), 20 Thornhill Ave., Westmount, Que.

Godbout, Adolphe Gerard, (McGill Univ.), 2100 Jeanne-Mance, Montreal, Que.

Haacke, Ewart M. (Queen's Univ.), 276 University Ave., Kingston, Ont.

Hastey, Wm. Kingsley Wright, (Queen's Univ.), 61 Maple Ave., Shawinigan Falls, Que.

Hopps, John Alexander, (Univ. of Man.), 136 Girton Blvd., Tuxedo, Man.

Kennedy, John Frederick, (Univ. of N.B.), 84 Grey St., Fredericton, N.B.

Kummen, Harold T., (Univ. of Man.), 317 Fort St., Winnipeg, Man.

Lindsay, Gerald Alec Edwin, (McGill Univ.), 520 Grosvenor Ave., Westmount, Que.

MacCallum, Wallace Allison, (N.S. Tech, Coll.), 28 Fenwick St., Halifax, N.S.

MacKinnon, Archibald Hugh, (N.S. Tech. Coll.), 72 South St., Halifax, N.S.

Madore, Paul Rene, (Ecole Poly.), 6798 Fabre St., Montreal, Que.

Magnan, Joseph Maurice, (Ecole Poly.), 5808A Des Erables, Montreal, Que.

Pageau, Marcel, (Ecole Poly.), 1791 Ave. de l'Eglise, Cote St. Paul, Montreal, Que.

Paget, Kenneth Kane, (Univ. of Man.), 520 Raglan Rd., Winnipeg, Man.

McInnis, John Francis, (N.S. Tech. Coll.), Maple St., Inverness, N.S.

Marantz, Oscar, (Univ. of Man.), 121 Euclid Ave., Winnipeg, Man.

McLaughlin, George Frederick Armstrong, (Univ. of N.B.), Perth, N.B.

Ronalds, Ivan Frederick, (Univ. of N.B.), 623 Scully St., Fredericton, N.B.

Ross, James Finlay, (Mt. Allison), 43 Westminster Ave., Montreal West, Que.

Schofield, Stewart Macleod, (Univ. of Man.), 231 Oakwood Ave., Winnipeg, Man.

Scott, Ainsworth David Houghton, B.Eng. (McGill Univ.), 631 Milton St., Montreal, Que.

Sergi, Frank Jose, (McGill Univ.), 772 Sherbrooke St. West, Montreal, Que.

Shearer, John Alexander, (Univ. of N.B.), Fredericton Junction, N.B.

Snodgrass, John Roscoe, (Univ. of N.B.), 634 Brunswick St., Fredericton, N.B.

Sokoloski, Steve, (Univ. of Man.), 390 Simcoe St., Winnipeg, Man.

Termuende, John Edward, (Univ. of Man.), 192 Canora St., Winnipeg, Man.

Wigdor, Leon, (McGill Univ.), 2183 Maplewood Ave., Montreal, Que.

Zweig, Irving, (Sir George Williams Coll.), 4156 DeBullion St., Montreal, Que.

Personals

News of the Personal Activities of members of the Institute, and visitors to Headquarters

Brig.-General C. H. Mitchell, M.E.I.C., has resigned from the position of Dean of the Faculty of Applied Science and Engineering at the University of Toronto, which he has occupied since 1919. The occasion has been marked in many ways, but perhaps the most outstanding event was the dinner given on Saturday, March 1st, by the Alumni, at which all members of the graduating class were guests. Many fine tributes were paid to the Dean and Mrs. Mitchell, and as a souvenir of the occasion an easy chair and a reading lamp were presented to him.

The Dean responded appropriately, and besides thanking the Alumni for the honour which had been done him, gave the graduating class some words of wisdom that would be of assistance to them in the professional careers that were before them.

Brig.-General C. H. Mitchell, M.E.I.C.

"Pat" Wingfield, president of the Alumni, occupied the chair, and was supported in the several features of the programme by Canon Cody, Professor Angus, Tony Reid, Ross Robertson and M. B. Hastings.

Dr. O. O. Lefebvre, M.E.I.C., has been elected president of the Corporation of Professional Engineers of Quebec, following the annual meeting held in Montreal last month.

Hew M. Scott, M.E.I.C., has been located in Montreal for the last few months and is on the staff of Allied War Supplies Corporation. He was formerly in Toronto where he was engaged in the contracting business.

H. V. Butterfield, M.E.I.C., has recently been appointed superintendent of maintenance in the Air Service Department of the Canadian Pacific Railway Company, at Montreal. Born in England he was educated at Leeds University where he was graduated in 1914. Upon graduation he joined the staff of Aircraft Manufacturing Company, Hendon, London. From 1917 to 1919 he was chief production engineer and assistant general manager of the National Aircraft Factory, Aintree, England. From 1919 to 1925 he was inspector in the mechanical service of the Ministry of Public Works, Cairo, Egypt. He came to Canada in 1926 as mechanical superintendent for Massey-Harris Company, Toronto, Ont., and later became plant manager. In 1934 he was appointed general manager of Leland Electric Canada Ltd., later becoming president and managing director. In 1939 he was appointed plant manager of the National Steel Car Corporation at Malton, Ont. For the last few months Mr. Butterfield had been employed with the British Air Commission at Washington, D.C.

L. G. Buck, M.E.I.C., has recently been transferred from the Toronto to the Ottawa office of the Bell Telephone Company of Canada. He entered the company upon his graduation from the University of Toronto in 1924, and after a period of training he was appointed field engineer in the Toronto division. In 1927 he became district plant manager at Toronto. From 1930 to 1934 he was exchange plant engineer for the eastern area and was located in Montreal. In 1934 he became division plant engineer at Montreal, and then he was transferred to Toronto as division plant supervisor.

A. W. Sinnamon, M.E.I.C., has recently joined the staff of the Hamilton Bridge Company Ltd., in Hamilton, Ont.

Engineer-Captain G. L. Stephens, M.E.I.C., has been appointed engineer-in-chief of the Royal Canadian Navy, and is now located at Ottawa in the Naval Service of the Department of National Defence. Lately he was stationed at Esquimalt, B.C., as chief engineer of H.M.C. Dockyard.

P. R. Sandwell, M.E.I.C., has recently been appointed resident engineer to the Australian Newsprint Mills Proprietary Limited, at Boyer, Tasmania. Born at London, England, he was educated at the University of British Columbia where he was graduated as a mechanical engineer in 1935. Upon graduation he joined the Dominion Engineering Works in Montreal as a mechanical draughtsman. In 1937 he became assistant to the chief engineer and was engaged in investigation and development work. Last year he went to Tasmania with the above named firm.

W. T. Dempsey, M.E.I.C., is now employed with Chemical Construction Corporation at Niagara Falls, Ont. He was graduated in civil engineering from the University of Saskatchewan in 1934. Since then he has been employed on several construction projects.

J. L. McDougall, M.E.I.C., has joined the staff of H. G. Acres & Company, consulting engineers, Niagara Falls, Ont. He had been connected lately with the Ontario Paper Company at Thorold, Ont.

J. A. Ogilvy, M.E.I.C., is now employed in the Department of Munitions & Supply at Ottawa. He was connected lately with the General Engineering Company (Canada) Limited at Toronto, and previously was with the Omega Gold Mines Ltd., at Larder Lake, Ont.

A. G. Moore, M.E.I.C., has joined the staff of Defence Industries Limited in Montreal. For the past two years he had been resident engineer with the Compagnie Immobilière de Ste. Marguerite, Lake Masson, Que. Previously he was connected with the Montreal Light Heat and Power Company.

R. N. Sharpe, JR.E.I.C., is now in Seattle, Wash., with the British Air Commission, and is doing inspection work on aircraft manufacturing. He was previously located in Toronto. Upon his graduation from the University of Manitoba in 1938 he joined the Department of Transport. Later he was in the employ of the Manitoba Government in Winnipeg.

A. LeB. Ross, JR.E.I.C., has joined the staff of Defence Industries Limited at Montreal. Upon his graduation in electrical engineering from McGill University in 1932 he went with Noranda Mines Limited at Noranda, Que., as a junior electrical engineer, and in 1934 he became technical assistant to the plant engineer. A few months later he joined the staff of Railway and Power Engineering

Corporation at Toronto, where he was engaged in the design, manufacture and sale of industrial motor control apparatus.

W. G. Hamilton, JR.E.I.C., has accepted a position with Canadian Car Munitions Limited at St. Paul L'Ermite, Que. He was graduated in mining engineering from Nova Scotia Technical College in 1935 and was employed with Canadian Johns-Manville Company Limited, at Asbestos, Que., and with Tashota Gold Fields Limited, at Tashota, Ont. In 1939 he went with Gold Coast Main Reef Limited, in West Africa. Lately Mr. Hamilton was located in Halifax.

J. G. Wanless, JR.E.I.C., has been transferred from the Toronto to the Montreal office of the Dominion Rubber Company. He joined the company upon his graduation from McGill University in 1934.

R. G. Rowan, S.E.I.C., is on the staff of the Bell Telephone Company of Canada in Montreal. He was graduated in civil engineering from Queen's University last year.

P. A. Weber, S.E.I.C., is, at present, employed with Canadian National Railways in Toronto. He was graduated in civil engineering from the University of Saskatchewan in 1940.

Percy Codd, S.E.I.C., has joined the staff of Defence Industries Limited, and is located at Valleyfield, Que. Upon his graduation from the University of Saskatchewan in 1939 he went with the Hudson Bay Mining and Smelting Company at Flin Flon, Man., and remained in the employ of the firm until his recent appointment.

H. G. Dickie, S.E.I.C., has been employed, since his graduation from Queen's University last spring, in the engineering department of Canadian Car and Foundry Company, Limited, at Fort William, Ont.

VISITORS TO HEADQUARTERS

Lieutenant R. F. P. Bowman, M.E.I.C., 10th Field Company, Royal Canadian Engineers, C.A.S.F., from Petawawa, Ont., on March 4th.

H. U. Ross, Jr.E.I.C., from Port Colborne, Ont., on March 5th.

R. C. Purser, M.E.I.C., from Ottawa, Ont., on March 6th.

P. A. Fetterly, M.E.I.C., Dominion Water & Power Bureau, from Calgary, Alta., on March 7th.

Max Gershfield, Jr.E.I.C., Aeronautical Inspection Directorate, Fleet Aircraft Ltd., from Fort Erie, Ont., on March 8th.

J. B. deHart, M.E.I.C., Department of National Resources, Canadian Pacific Railway Company, from Calgary, Alta., on March 10th.

H. J. Racey, M.E.I.C., Shawinigan Engineering Company Limited, from La Tuque, Que., on March 10th.

F. W. Gray, M.E.I.C., Assistant General Manager, Dominion Steel & Coal Corporation, from Sydney, N.S., on March 13th.

E. I. Glance, Jr.E.I.C., Montreal, on March 13th.

C. G. J. Luck, M.E.I.C., Assistant Engineer, National Harbour Board, from Churchill, Man., on March 19th.

James Oliver, S.E.I.C., from Arvida, Que., on March 18th.

F. S. Lawrence, M.E.I.C., Canadian National Railways, from Quebec, Que., on March 17th.

C. A. McVey, Bridge Engineer, Department of Public Works of New Brunswick, from Fredericton, N.B., on March 20th.

H. P. Moller, M.E.I.C., Electrical Superintendent, Lake St. John Power & Paper Co., from Dolbeau, Que., on March 24th.

Obituaries

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Percy Sandwell, M.E.I.C., died at his home in Hobart, Tasmania, on January 22nd, 1941. He was born at London, Eng., on November 7th, 1888, and was educated in the local public and technical schools. After having served his apprenticeship with Messrs. George Aston & Sons, London, he joined in 1909 the staff of Messrs. Hales Limited, haulage contractors, as an engineer, and was in charge of maintenance and management of a steam plant. In 1911 he became chief mechanical draughtsman with the Shepherds Bush Exhibition Limited in London, a position which he retained until 1913. During the war he first served with the 72nd Brigade R.F.A., and from 1916 to 1920, served as a lieutenant in the Royal Engineers. He came to Canada in 1920, and joined the staff of the Powell River Company at Powell River, B.C. From 1922 to 1926 he was assistant resident engineer, and from 1926 to 1932 he was resident engineer. In 1932 he was appointed assistant manager, a position which he retained until 1934 when he entered private practice as a consulting mechanical engineer in Vancouver, B.C. In 1938 he was appointed chief engineer on the construction of a newsprint mill in the Derwent Valley, Tasmania.

At the time of his death he was chief engineer of the Australian Newsprint Mills Proprietary Limited, and had just completed the first stage in the development of the first newsprint mill to be built in the Antipodes. He died during the period of preliminary testing, and did not, unfortunately, see the commencement of operation of the plant which he had been building for the last few years.

Mr. Sandwell joined the Institute as an Associate Member in 1923, and was transferred to Member in 1936.

Francis Joseph O'Reilly, M.E.I.C., died in the hospital at Victoria, B.C., on March 20th, 1941. He was born at New Westminster, B.C., on February 9th, 1866. He received his education at private schools in England, and at King's College, London. From 1883 to 1887 he served as an articled pupil to Messrs. Kinnipple and Morris, and was employed in the construction of docks at Greenock, Scotland, and later at Esquimalt, B.C. From 1888 to 1892 he was engaged as an assistant engineer on the construction of a section of the Great Southern Railway at Buenos Aires, South America. He then returned to British Columbia, where for fourteen years he was surveying in the Kootenays. In 1906 he founded the firm of Cross and Company in Victoria, B.C., and practised for several years as a consulting engineer and a provincial land surveyor. At the time of his death he was manager of the Belmont Building at Victoria, B.C.

Mr. O'Reilly joined the Institute as a Member in 1915.

COMING MEETINGS

American Institute of Electrical Engineers—Summer Convention, Royal York Hotel, Toronto, Ont., June 16th to 20th. National Secretary, H. H. Henline, 33 West 39th St., New York, N.Y.

American Water Works Association—Annual Convention, Royal York Hotel, Toronto, Ont., June 22nd to 26th. Secretary, Harry E. Jordan, 22 E. 40th St., New York.

Eastern Photoelasticity Conference—13th Semi-Annual Meeting, Cambridge, Massachusetts, June 12 to 14th. Chairman of the Local Committee, W. M. Murray, Massachusetts Institute of Technology, Cambridge, Mass.

Canadian Electrical Association—51st Annual Convention, Seigniory Club, Quebec, June 25th to 27th. Secretary, B. C. Fairchild, 804 Tramways Building, Montreal, Quebec.

News of the Branches

Activities of the Twenty-five Branches of the Institute and abstracts of papers presented

CALGARY BRANCH

P. F. Peele, m.e.i.c. - - *Secretary-Treasurer*
F. A. Brownie, m.e.i.c. - *Branch News Editor*

December 14th was the occasion of the joint annual dinner of the Calgary Branch of the Institute, the Alberta Professional Engineers of the Calgary district and the Rocky Mountain Branch of the Canadian Institute of Mining and Metallurgy. No ordinary annual dinner, however, it was also the occasion of the signing of the co-operative agreement between the Association of Professional Engineers of Alberta and the Engineering Institute of Canada.

In a carefully rehearsed ceremony pages presented the memoranda of agreement and a special gold fountain pen in turn to the various signers as follows: Dr. Hogg, president of the E.I.C., Mr. H. J. Maclean, president of the A.P.E.A., Mr. L. A. Wright, general secretary of the E.I.C., Mr. H. R. Webb, registrar of the A.P.E.A. and the respective witnesses Dr. O. O. Lefebvre, past president of the E.I.C., Mr. R. J. Gibb, past president of the A.P.E.A., Mr. P. M. Sauder, vice-president of the E.I.C., and Mr. R. A. Brown, past president of the A.P.E.A. Later the gold fountain pen was presented to Mr. Maclean as a memento of the occasion.

Other distinguished guests from outside Alberta, most of whom spoke briefly, were Dr. F. A. Gaby, past president of the E.I.C., C. K. McLeod, councillor for the Montreal Branch, J. A. Vance, councillor for the London Branch, J. Robertson, councillor of the Vancouver Branch, P. C. Perry, chairman of the Saskatchewan Branch and president of the Association of Professional Engineers of Saskatchewan, D. A. R. McCannell of Regina, president of the Dominion Council of Professional Engineers and A. P. Linton, councillor for the Saskatchewan Branch.

The main address of the evening on the subject **The Engineer and the War** was by Dr. Hogg. It is published elsewhere in this number of the *Journal.*

The general interest in this meeting was indicated by an attendance of over 150. Chairman for the evening was P.M. Sauder.

The guest speaker at the regular meeting of January 16, was Mr. R. M. Hardy, assistant professor of civil engineering at the University of Alberta who spoke on **Soil Mechanics and its Applications.** Mr. Hardy had spent the winter of 1939-40 doing some advanced work on this subject at Harvard University and, during that time, had the privilege of studying under Dr. Terzaghi, who is deservedly known as "father of soil mechanics."

Mr. Hardy's paper dealt very briefly with the history of this new field of civil engineering and discussed possible reasons why most engineers are so unfamiliar with the subject. One obvious reason is that some of the fundamental principles of soil mechanics are outside the field of an ordinary engineering training. The speaker dealt briefly with some of these principles such as the fact that soil must be recognized as a two or three phase system (soil particles and water and sometimes gas); the effect of soil water is tremendously important since although it has no strength in shear it can, of course, resist compression stresses and in the fine capillaries of clay can actually develop around 15,000 lb. per sq. in. in tensile strength. The different types of soil structures were also described.

The final section of the paper dealt with some of the applications of a knowledge of soil mechanics, such as in foundations, earth fill dams and in the study and solution of problems involving frost boils.

After an extended discussion the speaker was tendered a hearty vote of appreciation by the meeting.

The regular meeting of January 30th was devoted to a showing of seven reels of a very interesting film on "The Making of Steel" loaned by the U.S. Bureau of Mines.

One of the most enjoyable meetings of the season was that of February 13th in which the entire programme was in charge of the Juniors and Students. The first item was a talk on **Oil Well Servicing** by J. Langston. Mr. Langston described the manufacture and use of gun perforating equipment as developed by the Lane-Wells Company, illustrating his talk with a reel of films. With the help of a number of slides he then discussed the applications of this procedure in selective production of various horizons and the use of gun perforating before acidizing.

Mr. T. Stanley who also acted as chairman for the evening, then discussed the new **Cascade Development** now being undertaken by the Calgary Power Company. This development includes an earth fill dam at Lake Minnewanka, some three miles of combination canal, woodstave and steel pipe and a power plant near Anthracite containing one unit of 23,000 h.p. operating under some 340 ft. head.

The next item was a quiz competition between Members, Juniors and Students, conducted by Mr. F. T. Gale. The Members turned out to be the winners but admittedly rather by superiority of numbers than of intelligence.

The final item was a talk by Mr. W. G. Sharp on **Modern Movie and Sound Projection Equipment.** An outline was presented of the mechanical operation of the equipment followed by the showing of a reel of films on a popular subject.

An extended, informal discussion followed in which members were allowed to examine certain apparatus brought to the meeting by Mr. Sharp and Mr. Langston.

EDMONTON BRANCH

B. W. Pitfield, Jr.E.I.C. - - *Secretary-Treasurer*
J. F. McDougall, m.e.i.c. - *Branch News Editor*

The February dinner meeting of the Edmonton Branch of the Institute was held at the Macdonald Hotel on February 25th. Immediately after dinner, Chairman E. Nelson called the meeting to order and introduced the speaker of the evening, Mr. C. W. Carry, sales engineer of the Standard Iron Works Limited.

The title of Mr. Carry's paper was **Arc Welding in Industry.** Mr. Carry stated that the ease and speed with which weld metal can be satisfactorily deposited is mainly dependent on the stability of the arc. The arc which can be maintained for the longest period, other things being equal such as current and electrode size, will deposit the greatest amount of weld metal during a given period.

He then proceeded to describe the relative advantages of alternating and direct current in producing welding arcs. Alternating current is imperative for the double carbon arc to keep the consumption of both electrodes equal and in the atomic hydrogen arc for the same reason. In the structural steel and medium weight plate shop, the direct current arc is more popular for producing general purpose work. A 200 amp. machine is suitable for say gauge plate work, and tacking heavier plates in assembling a structure. A 300 amp. machine is suitable for medium plate up to ¼ or 5/16 in. thickness, and a 400 amp. machine is the favourite for continuous duty on work up to say 1 in. thickness.

He stated that the five separate and distinct forces at work when weld metal is being deposited through the arc to the parent metal are gravity, gas expansion, electromagnetic force, electric force and surface tension.

When molten weld metal is exposed to the air, it absorbs a harmful volume of nitrogen, and also suffers partial oxidation. Such metal tends to be brittle, even though it may have a tensile strength of 50,000-60,000 lb. per sq. in. In many cases its use is satisfactory and economical. It is produced generally by the use of bare or uncoated electrodes, without the use of a shielding flux, and is known as the unshielded arc process.

The use of fluxes and inert gases are intended to shield the arc from the air, and also to protect the deposited and base metal from molton to cold stage by forming a slag covering. This is known as the shielded arc process.

The author next dealt with the residual stresses which are left in welded joints and explained how these are commonly dealt with by letting the material ways as it cools, letting the weld warp by using a ductile welding rod or by annealing the welded structure.

He told how the hull plates of the new battleship "King George V" were welded instead of riveted and predicted a great future for the welding process in ship construction.

A lengthy discussion period followed Mr. Carry's paper after which a hearty vote of thanks to the speaker was moved by Mr. Hansen.

About forty members were present at the meeting.

HALIFAX BRANCH

S. W. Gray, M.E.I.C. - *Secretary-Treasurer*
G. V. Ross, M.E.I.C. - *Branch News Editor*

Dr. C. D. Harvey, provincial archivist of Nova Scotia was guest speaker at the dinner meeting in the Halifax Hotel on February 20th. He traced the origins of the various peoples who first settled in Nova Scotia and outlined the contributions which each group made to the life of the province.

Our first citizens were the Micmac Indians, who gave us the canoe, the snowshoe, many of the trails which have developed into the highways of to-day, and a knowledge of our geography.

First from the old world were the Acadians. Longfellow, in his "Evangeline" has painted a tragic picture of the expulsion of these people in 1755, but history is less unkind to the English rulers of that time. They left a lasting memorial in the dykes, those walls of sod and marsh mud which still hold back the tides of Fundy from the rich lands around Grand Pré.

The first English settlers, along with some Germans were mostly ex-soldiers and sailors. They were sent out primarily to farm and to fish, but were chosen with an eye to defence.

Halifax, prior to the American Revolution, had been dominated by English people who had come from the New England States. The first English settlements outside Halifax were established when the great influx of New England planters took place between 1760 and 1765. These people laid the foundations of British civilization in this province and from their stock came Tupper, Borden and Bennett to be leaders in Canadian life. Then came the Loyalists. They doubled the population of the province, and since many were highly educated, they contributed much to the life of that time. They produced Richard Haliburton, Joseph Howe and Samuel Cunard; formed the bishoprics, a college, and a magazine.

Scottish settlers began to arrive in numbers in 1773 and from Pictou they spread out over the Northern part of the mainland and to Cape Breton Island. Inspired by a love of learning, they have made great contributions in the field of education, not only in Nova Scotia, but throughout Canada.

The language and customs of the Welsh who came in 1817 or 1818, have all but disappeared. Many Irish settled around Minas in the early 1800's but large numbers of them later moved on to the United States.

Dr. Harvey called the period from 1834 to Confederation, the "Spacious Days of Nova Scotia," when Nova Scotians reached for the stars and almost brought them down. Those were the days of the wooden sailing vessel, when every bay had its shipyard and Bluenose ships were trading in every port of the world.

Following the talk by Dr. Harvey, Mr. R. L. Dunsmore outlined the highlights of the recent Annual Meeting in Hamilton. S. W. Gray, formally took over the work of secretary-treasurer of the Branch, succeeding L. C. Young, now serving in the R.C.C.S.

Seven senior students of the Nova Scotia Technical College were present as guests of the Branch.

HAMILTON BRANCH

A. R. Hannaford, M.E.I.C. - *Secretary-Treasurer*
W. E. Brown, Jr.E.I.C. - - *Branch News Editor*

The meeting of the Hamilton Branch, held on Monday, March 10th, in the Lecture Theatre at McMaster University was addressed by Professor K. B. Jackson of the University of Toronto. His subject was entitled, **Aerial Surveying.**

Before the lecture, Michael S. Layton was presented with the gold medal, awarded for his successful paper entitled

Michael S. Layton receives the Duggan Medal of the Institute, from W. L. McFaul.

"Coated Electrodes in Electric Arc Welding" as part of the G. H. Duggan Prize.

For the first time the G. H. Duggan Medal and Prize has been awarded to a Junior member of the Engineering Institute. Mr. Layton formerly with the Steel Company of Canada at Montreal, is now attending No. 1 Gunnery and Bombing School at Jarvis, Ontario. Owing to his military duties he was prevented from attending the Annual Meeting at Hamilton last month to receive his award.

Before the presentation was made at the monthly meeting of the Hamilton Branch, the Executive invited Mr. Layton to a reception dinner at the Royal Connaught Hotel. The Mount Hope Airport was represented by Manager G. Moes and Flying Officer Jeffery. The speaker of the evening, Professor K. B. Jackson was also present.

Chairman W. A. T. Gilmour, opening the meeting in the Lecture Theatre at McMaster University said that the first part of the meeting would be taken up by our members doing honour to Mr. M. S. Layton, winner of the Duggan award. W. L. McFaul, member of Council for the Hamilton Branch, made the presentation and in a few well chosen words expressed the congratulations of headquarters and particularly the honour enjoyed by the Hamilton Branch in having the duty of making the presentation.

Mr. Layton, wearing the uniform of the Royal Canadian Air Force, modestly acknowledged the honour. He expressed the hope that his studies might be of some benefit to those engaged in arc welding.

Professor K. B. Jackson was introduced by T. S. Glover. The speaker showed various methods of taking pictures from the air and described the equipment used and showed by slides of charts, diagrams and photographs how aerial surveying is carried out. He also showed how surveys are made by camera, on the ground. He explained the various merits of high oblique, low oblique and vertical exposures. Mr. Jackson described a camera taking a centre picture and several radial pictures together with the method of plotting and necessary corrections for distortion, and also the manipulation of an angle extractor.

The explanation and showing of a number of anaglyphs was remarkable and illustrated stereoscopically the third dimension. The views of mountainous country were very beautiful and each one in the room was supplied with a pair of coloured glasses so that the desired result was obtained from the slides.

At the end of the address Chairman W. A. T. Gilmour said that he would not ask for the customary movement of a vote of thanks to Mr. Jackson but would see what applause the audience would give and the result was spontaneous. The meeting then adjourned for coffee and sandwiches.

KINGSTON BRANCH

J. B. Baty, M.E.I.C. - *Secretary-Treasurer*

An unusually well attended and interesting meeting was held in connection with a dinner at Queen's Students' Union on Thursday, January 30th. Mr. T. A. McGinnis, chairman, presided and a total of forty-three members and guests were present. Lt.-Col. Le Roy F. Grant presented the framed certificate, signifying the award of the Institute prize for 1940 at Queen's University, to Mr. James M. Courtright, Science '41 student at Queen's.

An excellent paper on **The Aluminum Industry of the World** was presented by Mr. M. N. Hay, works manager of the Aluminium Company of Canada Limited, Kingston, Ontario. The paper was illustrated with interesting coloured motion pictures.

Aluminum was first isolated in 1825 by a Dutch chemist. Commercial production was originated in 1856 in France by a slow and expensive method. The cost of aluminum was $90.00 a pound. Napoleon III subsidized the industry in France, thinking that it might be useful for military purposes.

In 1939, Canada is listed as the third producing country in the world, a position which Mr. Hay believes it will also hold in 1940. Germany is in first position and United States second. The speaker said that since 1932, Germany's aluminum production has shown an almost ten-fold increase to the output of 1939. He pointed out that the Nazis have regardless of cost, attempted to make themselves self-sufficient in aluminum production, and have subsidized the industry in order to feed their vast war machine.

He discussed the economic production of aluminum in the chief producing countries under the headings of "electric power, bauxite, coal, transport and other facilities." Considering all these factors, he placed Canada in number one position, with United States second and Germany third. To highlight this assertion, which he stressed was purely a personal one, he pointed out that Canada has, at Arvida, the largest aluminum plant in the world.

Dr. A. L. Clark, Hon.M.E.I.C., Dean of the Faculty of Applied Science at Queen's University, very fittingly moved the vote of thanks to Mr. Hay.

Another good meeting on Tuesday, February 25th, held in connection with a dinner at Queen's Students Union, manifested a renewed spirit in the Kingston Branch this winter. Forty-seven members and guests, including a large group of students, were in attendance. Chairman T. A. McGinnis presided.

Professor D. S. Ellis, newly-elected member of Council from Kingston reported upon the annual meeting of the Institute in Hamilton, with particular reference to the meetings of the Committee on the Training of the Young Engineer. Mr. McGinnis and Professor L. M. Arkley, who also attended the annual meeting, supplemented Professor Ellis' report. Mr. McGinnis expressed his pleasure at the attendance of the large number of student-members present at the branch meetings and encouraged them to continue their interest and activities in the Institute.

Dr. A. E. Berry, director of the Sanitary Engineering Division of the Ontario Department of Health, a past-chairman of the Toronto Branch and at present a member of Council of the Institute was the guest speaker. His subject was **The Engineer in Public Health.** In a most interesting and enlightening manner, Dr. Berry explained the relationship of engineering to public health. "The public-health engineer has two objectives," said Dr. Berry, "the protection of the health of the citizens in a community, through the sanitary control of environment, and an improvement in the standard of living—an indirect effect on health—such as better housing, ventilation, lighting, heating, and improved working conditions."

By lantern-slide illustrations, Dr. Berry showed the developments in the fields of water purification, sewage treatment, refuse collection and disposal, safe control of milk supplies and swimming pool sanitation—all accomplishments of the sanitary engineer or public-health engineer.

Col. N. C. Sherman moved the vote of thanks to Dr. Berry.

LAKEHEAD BRANCH

H. M. Olsson, M.E.I.C. - *Secretary-Treasurer*
W. C. Byers, Jr.E.I.C. - *Branch News Editor*

On Wednesday evening, February 14th, the Lakehead Branch held its customary Ladies' Night which, this year, took the form of a St. Valentine Supper Dance in the Norman Room of the Royal Edward Hotel.

The dance was very well attended by the members and their friends who greatly enjoyed the occasion. One hundred and six couples participated in this gay entertainment which is rapidly becoming one of the outstanding social events at the Lakehead.

The guests were received by H. G. O'Leary, chairman of the Lakehead Branch, and Mrs. O'Leary; Mr. B. A. Culpeper, vice-chairman and Mrs. Culpeper; and wife of ex-councillor, Mrs. P. E. Doncaster.

E. J. Davies, chairman of the entertainment committee, was greatly responsible for the successful entertainment.

The ballroom was nicely decorated in the spirit of St. Valentine with an added engineering touch such as destroyer and aeroplane models and a miniature high tension wire post, etc. The focus of interest, however, was a large revolving illuminated glass globe made up of hundreds of minute mirrors and held aloft by a tapering tower. This ingenious arrangement was located in the centre of the ballroom casting myriads of multi-colored reflections on the dancers and the spacious dance floor of the Norman Room. Several large shields bearing the crest of the Engineering Institute of Canada adorned the walls.

Card tables were also arranged on the mezzanine floor overlooking the ballroom, but dancing was preferred.

Even the dance programme reflected the spirit of the profession with such appropriate innovations as the Slip Stick Tango, the Hurricane Foxtrot, the Floating Power Waltz and many others. Music was provided by Joe

Turner's Six Piece Orchestra aided by Miss Gladys Smith, vocalist.

A midnight supper was greatly enjoyed in a candlelit dining-room also festive with St. Valentine decorations. After supper, dancing continued till two o'clock when the programme was brought to a close with the singing of "God Save the King."

Other members on the entertainment committee were J. I. Carmichael, S. E. Flook and Elizabeth M. G. MacGill.

LETHBRIDGE BRANCH

E. A. Lawrence, s.e.i.c. - *Secretary-Treasurer*
A. J. Branch, m.e.i.c. - - *Branch News Editor*

A regular meeting of the Lethbridge Branch of the Engineering Institute of Canada was held, Wednesday evening, at 8 p.m., in the Marquis Hotel, with Wm. Meldrum presiding.

Mr. J. E. Campbell introduced the speaker, Mr. L. B. George, Divisional Master Mechanic, Canadian Pacific Railway. Lethbridge.

Mr. George took as his subject **A Visit to an Aeroplane Factory.**

Mr. George said: "During the past few years we have been quietly preparing both our air force and our aeroplane industry against a possible war."

Prior to the war, however, there was a number of small Canadian plants manufacturing light aeroplanes for private flying, for training and some for commercial freighting in the Northland. During the past two years this picture has changed. Rumblings of a possible war brought a British military mission to Canada in 1938, the result of which were the placing of "educational" orders for bombing planes in Canada.

Canadian manufacturers also sought orders for aeroplanes in Central and South America, Turkey and Spain. All these orders were experience for the Canadian aeroplane industry which began to expand in early 1939 and we were able to take orders for bombers, fighting and training planes for both the British and Canadian Governments.

New plants and extensions on existing plants were built in industrialized areas of both Ontario and Quebec. A central assembly company was set up by six aircraft manufacturers to take care of the specific British orders for bombers. These six companies are making parts which are shipped to newly built central assembly plants near industrial areas. Engines for these planes have been shipped to Canada from Great Britain.

At the beginning of the war Canada had no engine factories, but now we are building certain types of aircraft outright. Among the types built in Canada are the Hawker Hurricane, British Hanley Page, Hampden Bomber, Vickers flying boats, and others. Since the outbreak of war, production has been considerably stepped up.

Canada has sent large numbers of men over to England to get specialized training in the large aeroplane factories. Furthermore some of the large concerns over there have sent key men to Canada in order to assist in the large factories.

Skilled workers in an aeroplane plant include: machinists, fitters, welders, electricians, painters, erectors, sheet metal workers, heat treatment operators, patternmakers and moulders. The next important worker is the Class "A" production worker, then the Class "B," and after them come the helpers and learners who may be promoted as they become proficient.

Turning to a discussion of the industry in England the authors mentioned that decentralization was being adhered to. Different parts of the aeroplane are manufactured at points 10 to 50 miles away from the assembly plant, in order to cut down losses in time and equipment caused by enemy bombing action. Most of the factories are built either above or below the ground and those above the ground have no windows in them.

In the sub-assembly department we find benches well equipped.

In his closing remarks the speaker mentioned that there is one man in the office for every ten men on the floor. The work in the dope department is practically all handled by women, who have to wear gas masks for this job.

In England, Mr. George said each factory has its air raid shelter below the ground which is reached by means of the stairs and, if in a hurry, by means of the fireman's slide pole. Sentries and fire watchers are posted about the plant at all times.

Following a short discussion period, Mr. C. S. Glendening moved a hearty vote of thanks to Mr. George for his excellent address.

The Regular meeting of the Lethbridge Branch of the Engineering Institute of Canada, was held in the Marquis Hotel, on Wednesday, evening, February 5th, 1941, with Wm. Meldrum presiding.

In his opening remarks the chairman paid tribute to H. W. Meech who has recently been made a Fellow of the Royal Architectural Institute of Canada. He then introduced Mr. John Dykes, as the speaker for the evening, his subject: **Robert Burns.**

Mr. Dykes began his talk by referring to the sterling character and humble circumstances of the parents of Robert Burns, with special reference to his mother. He then touched on the highlights of the life of the poet himself.

He told how early in the 18th century for championing the cause of freedom and liberty, Burns was branded a democrat (in those days a disgraceful thing). The speaker went on to show how great has been the change since those days. To-day the whole British Empire is championing the cause of freedom and liberty. Frequently throughout his talk, Mr. Dykes pointed his remarks with apt quotations from the works of Robert Burns.

Everyone present enjoyed his address and so expressed themselves to Mr. Dykes, who was thanked by Mr. Meldrum.

LONDON BRANCH

H. G. Stead, Jr.e.i.c. - - *Secretary-Treasurer*
A. L. Furanna, s.e.i.c. - *Branch News Editor*

The London Branch of the Engineering Institute of Canada held its first meeting of the 1941 series on Wednesday, February 19th with R. Garrett as chairman. The meeting was held in the Board Room of the London Board of Education. Guests included the speaker, H. Boardman, C. H. Burns, chairman, and W. R. Manock, councillor of the Niagara Peninsula Branch of the Institute. Mr. Boardman, chief testing engineer for the Chicago Bridge and Iron Company, gave his lecture demonstration on the **Stress Analysis of Welded Joints by Polarized Light.**

The speaker opened his lecture with a brief explanation of the theory involved in this method of stress analysis and a description of the apparatus he was about to use. It must be realized that in this analysis the original member is judged upon the performance of a model of its section subjected to stress. This imposes certain requirements upon the model and certain limitations upon the results. The model is made from an elastic material so that under stress its reaction will be similar to steel. However, this similarity between the model and the original exists only as long as the steel is not stressed beyond its elastic limit. The model must also be transparent in order to allow passage of the examining polarized light. The third requirement of the model is that its shape be a faithful reproduction of the original. The limitations imposed by the model upon the value of the analysis are as follows. Firstly, the stress distribution observed is that due to shape only. Secondly, internal stresses in the original member, due to rolling or the presence of foreign material, do not appear in the model. Thus, it is important to remember that the load stresses in any such member are superimposed upon the internal stresses, but the polarized light reveals only those due to the load. The apparatus was simple. It consisted of a projection lantern, a set of polaroid lenses, a bracket for holding the model, a projection lens and screen, arranged in that order. The bracket was so built that the model could be stressed in tension by turning a thumb screw.

The relative magnitude of the various stresses was determined by the colour it produced upon the screen. The unstressed model showed up a pale yellow colour. As the stress was applied and increased, this yellow became deeper, turning to orange, then red violet, green, and finally blue. If the stress is further increased the foregoing cycle repeats itself until the model fails. The point of maximum stress is that point where the colour cycle is farthest advanced.

Mr. Boardman showed a large number of models of various welded joints. The first models indicated the waste in extra reinforcing, the resultant high stress around a hole in the weld and the disastrous effect of undercuts in a weld subjected to pulsating loads. Other defective welds were incomplete, or contained a valley in their surface. The ideal type of weld was found to be a double butt weld, having its surfaces flush with the surface of the main metal. Some welds using backing bars were examined. It was found that this bar should not be welded to the plate because it offers little or no help in transmitting the stress across the weld. Two other joints examined were the lap welded joint and a riveted joint. The riveted joint in particular indicated high stress concentrations.

In several of the above cases, Mr. Boardman had slides of test samples showing how actual members failed and that the failure was in keeping with the evidence given by the polarized light. In the case of the ideal butt weld the member failed outside the weld indicating one hundred per cent efficiency for the weld.

The enthusiasm shown by the meeting during the question period following the lecture was in keeping with the very interesting demonstration.

There were fifty-six members and guests present.

MONCTON BRANCH

V. C. Blackett, m.e.i.c. - *Secretary-Treasurer*

On Tuesday evening, March 18th, a meeting of the branch was held in the Council Chamber of the City Hall. F. O. Condon was the presiding chairman. A four-reel sound film was shown, illustrating operations at the Sudbury Basin mines of the International Nickel Company of Canada. The pictures first dealt with the drilling and blasting of the ore in the underground workings, some of which extend more than 4,000 ft. below the surface of the earth. Succeeding scenes showed methods of raising the ore to the surface. Then followed smelting operations, the refining of the nickel and the copper, and the recovery of precious metal by-products such as gold, silver and platinum.

A vote of thanks to the International Nickel Company for the loan of the films, and to F. L. Tuck for motion picture equipment, was moved by T. H. Dickson and seconded by J. A. Godfrey.

OTTAWA BRANCH

R. K. Odell, m.e.i.c. - *Secretary-Treasurer*

Military Explosives was the subject of an address given before the Ottawa Branch at a noon luncheon at the Chateau Laurier on February 13th, 1941. E. T. Sterne, manager of G. F. Sterne & Sons, Limited, of Brantford, and at present with the Chemical and Explosives Division of the Allied War Supplies, was the speaker. T. A. McElhanney, newly-elected chairman of the local branch, presided. A number of prominent engineers from United States were present and were introduced to the gathering by Victor Meek of the branch.

Military explosives in the present war, stated Mr. Sterne, are pretty much the same as they were during the last Great War. Developments since that time have been more in the nature of technique and in refinements of manufacture and use rather than in the actual explosives themselves. Such things as costs, for instance, have to be considered. Thus toluol, an explosive ingredient that cost as much as seven dollars per gallon during the Great War, can normally be produced now at 30 cents per gallon. Lyddite, an expensive disruptive explosive that was considered once as standard for its purpose, has given way to trinitrotoluene (T.N.T.) a fairly cheap explosive, safe under normal conditions and "A gentleman to handle, but when it does go off there is no fooling about it." It was first used to any considerable extent in the Great War. The result is that so far as known there is no lyddite commercially manufactured as an explosive on the American continent today.

Mr. Sterne divided military explosives according to their use into the initiatory group, the propellant group, the disruptive group, and fuse powders. The initiatory group are used to carry the impact to the main explosive as in caps and detonators. Although highly sensitive they should be safe to make and to handle. The propellant group are those applied to the base of the projectile so that it can arrive where it is sent. Inasmuch as there are different types of projectiles there must be different types of propellants. The disruptive group are those that burst the shell when it arrives where it is sent. Whereas a propellant may burn at the rate of a few metres per second a disruptive explosive may burn at the rate of thousands of metres per second. As for the fuse powders, they represent a small but important class wherein the time element in their burning is a first consideration. Gunpowder has been used in these.

In selecting a site for the manufacture of explosives two things in particular must be carefully considered. There must be a dependable supply of good cool water, since much of it is used for cooling purposes, and some suitable means for getting rid of waste products should be available since much of these waste products are in highly coloured liquid form and acid in character. Other influencing factors are labour markets, power supply and transportation charges.

At the commencement of the luncheon proceedings the chairman remarked upon the honour that had been paid to the Ottawa Branch this year at the recent annual convention of the Institute by the election of members of the Branch to the office of president of the Institute and also vice-president for the province of Ontario. These are, respectively, C. J. Mackenzie, acting president of the National Research Council, and K. M. Cameron, chief engineer of the Department of Public Works.

Mr. Mackenzie in acknowledging the honour paid him, spoke briefly and paid a tribute to two former presidents of the Institute who were present at the luncheon, namely, Dr. Charles Camsell, deputy minister of the Department of Mines and Resources; and G. J. Desbarats, formerly deputy minister of the Department of National Defence. Mr. Cameron also spoke briefly.

At the noon Luncheon at the Chateau Laurier on Thursday, February 27th, G. L. McGee, supervising engineer of aerodromes, Department of Transport, gave a talk illustrated with slides on the **Planning and Construction of Aerodromes.** T. A. McElhanney, chairman of the Ottawa Branch, presided.

Ten years ago 6,000 lb. was a standard weight for passenger aircraft, stated Mr. McGee, requiring a landing field 1,800 ft. long. To-day, with the increase in size of aircraft, a minimum length of landing field of 4,000 ft. is required and there is every reason to believe that aircraft weighing 60,000 and even 80,000 lb. will be in use before very long.

Designers of the earlier days did not foresee these remarkable developments, commented Mr. McGee. On account of the difficulty of expanding their landing areas an aerodrome at Detroit, for instance, has had to abandon its location after the expenditure of two million dollars. Similar examples may be cited for other localities.

Nowadays there should be three or even four runways at least 4,000 ft. long each and 150 ft. wide at sea level, though a 200 ft. width is better and the runways should be capable of expansion to 5,000 ft. with one at least to 6,000 ft. The United States Navy, as an indication of the trend, is reported to have one airfield under construction with runways two miles in length.

Special attention must also be given to the approaches to the airfield, so that a plane in landing or taking off can do so on a proper gradient. For this reason it should not be too close to the built-up portion of a city. For a main airport a minimum of 600 acres of land is required, which must be reasonably level but not to the extent that drainage would be seriously interfered with. In fact, drainage is one of the most important problems in selecting a site.

Mr. McGee spoke then on the various considerations affecting the efficiency of a landing field with particular reference to drainage, to the design and layout of buildings, the setup of the beacon, and other features.

PETERBOROUGH BRANCH

A. L. Malby, Jr.E.I.C. - *Secretary-Treasurer*
E. Whitely, S.E.I.C. - *Branch News Editor*

On January 16th, 1941, Mr. A. E. Davison, Electrical Engineering Department, Hydro Electric Power Commission, addressed the members of the Peterborough Branch on **Power Transmission.**

The paper traced the origin of various problems as they arose in the development of our modern transmission lines and showed how they have been solved or are now being attacked. Among the points covered were: tower design, corona effect, lightning protection, line clearances, sleet formation, and conductor vibration. A variety of slides provided plenty of illustration for the talk.

In addition, two very interesting movies gave a more detailed picture of some main points. One, "Dancing Conductors" showed the peculiar vibrations which are set up in some transmission lines under certain conditions of icing and wind. These vibrations if persisting often lead to mechanical failure of the lines.

Mr. Davison showed how maintaining a suitable conductor temperature by electrical load on the line will prevent adhering of the ice or sleet and avoid the vibrating. There was evidence to confirm this, but in some cases it is an unsatisfactory solution as lines cannot always be loaded to capacity.

The second film, which incidentally was a masterpiece of amateur colour photography, showed the building of a wood-pole transmission line from Ear Falls to Uchi Mines. A series of still pictures taken from this film were shown before the picture itself and accompanied by Mr. Davison's comments illustrated the problems that had to be met in this particular transmission line. The mines of northern Ontario owe much of their present productive capacity to the work of Mr. Davison and his colleagues in bringing extension water power and rich oil deposits together though separated by many miles of rough wilderness.

The branch met again on February 13th, 1941, this time to hear Mr. L. E. Marion, industrial application engineer, Canadian General Electric Company Limited, Toronto. A number of years in active association with his subject, a very well organized series of slides, and evident careful preparation, all combined to make an outstanding paper on **Some Modern Trends in Industrial Applications.**

A few examples of old and modern equipment showed the obvious changes that have taken place in industrial control and motor equipment in the years since their beginning. On the basis of this development, especially the more recent changes, some trends were easily seen.

For instance, there is a trend towards the building of this equipment in factory-assembled units; compact, protected units; easily installed or re-located if necessary at any time. Large sections of switchboard are now built up at the factory complete with meters, relays, switches, disconnects and interconnecting bus. These units are all ready to drop into place, connect to incoming lines and load and the installation is complete. This, combined with the trend toward enclosure, has revolutionized switching and control equipment.

The trend to enclosure is noticeable also in motors. Better design and materials combined with rapidly widening fields of application has led to smaller, more reliable motors.

There is a trend towards the use of colour. Switchboards have put off their sombre black and now appear in cream, buff, grey or bronze to harmonize with well decorated switch rooms. This is not mere aesthetic exuberance. With surroundings of certain colours an operator can do better work, both because it is easier to see with more light and better contrasts, and because colour of surroundings influences his state of mind.

Machines and their driving motors are tending toward higher speeds. Improved technical knowledge and better materials have made this possible.

New applications are continually arising. In textile mills there are now high speed motors especially designed for their job, and lint-free motors of a special open construction such that lint does not readily accumulate. High frequency motors have appeared for high speed drive of wood working tools.

There is an increasing use of synchronous motors or capacitors for power factor correction. Both have been developed tremendously in the last decade to make their use in this way more economical and satisfactory.

A trend to variable speed drives, flexible distribution systems, and load centred distribution systems were among the other trends also mentioned.

SAULT STE. MARIE BRANCH

O. A. Evans, Jr.E.I.C. - *Secretary-Treasurer*
N. C. Cowie, Jr.E.I.C. - *Branch News Editor*

The second general meeting for the year 1941 was held in the Grill Room of the Windsor Hotel at 6.45 p.m. on February 28th, 1941, when twenty members and guests sat down to dinner.

Chairman E. M. MacQuarrie called the meeting to order at 8.00 p.m. The secretary then read the minutes of the previous meeting which were adopted as read.

The chairman then introduced the speaker of the evening, N. C. Cowie, engineer for the Great Lakes Power Company who had for his topic, **Kilowatts, Horsepower and Water.** Mr. Cowie just explained the topic of his speech. In his address the speaker brought to light many interesting facts concerning the production and uses of electricity, a few of which are listed below. A man when working hard only develops one-eighth horsepower or the same amount as that of one of the smallest motors. One kilowatt hour will heat enough water for forty-five cups of tea, drive the motor in the home refrigerator for eight hours, or heat an electric iron for one hour, also keep the coil in the motor of your car warm for two hours. A fully electrified home would only use some 350 kilowatt hours per month.

The electrical industry, even in the depression, had a steady growth. In 1931 there was 5.6 million prime horsepower in Canada while in 1940 there was 7.38 million. The capital investment in 1931 was 1.23 billion dollars while in 1940 it was 1.63 billion dollars. The revenue derived from the sale of electricity in 1931 was 123.7 million dollars at an average of ¾ cent per k.w.h. while in 1940 it was 150.66 million dollars at an average of ½ cent per k.w.h.

The speaker cited the fact that the growth of the Great Lakes Power Company roughly paralleled that of the Dominion. In 1931 there was 51,200 hp. while in 1940 there was 71,200 hp. with a capital investment of 171 dollars per hp.

The speaker then dealt with the uses of electricity in industry. The ferro alloy industry was a case of where electricity was almost entirely used for its manufacture. Large amounts were used in the production of the various alloys as the heat required to melt the charge was furnished by the electricity.

In the discussion that followed, J. L. Lang and L. R. Brown debated the causes of surges in the local transmission lines.

L. R. Brown thanked the speaker for his interesting address. The chairman then thanked the speaker on behalf of the branch.

SASKATCHEWAN BRANCH

STEWART YOUNG, M.E.I.C. - *Acting Secretary-Treasurer*

The annual meeting of the Saskatchewan Branch, was held in the Saskatchewan Hotel, Regina, on Friday, February 21st, 1941, with P. C. Perry, the Branch chairman, presiding.

The report of the papers and meetings committee, presented on behalf of the convenor, D. D. Low, indicated six meetings held during the year, with an average attendance of 57. Supplementary to this report was the report of the Saskatoon Section, presented by N. B. Hutcheon, indicating five meetings held during the year with an average attendance of 38. The report stated that the students at the University are showing an increased interest both in the Engineering Institute of Canada and in the Association of Professional Engineers.

A. P. Linton reviewed his activities for the past year as the Saskatchewan representative on the Institute Council, stating that he had attended the Regional meeting of the council held last fall at Calgary, Alberta.

After the meeting all members attended the Annual Dinner of the Association of Professional Engineers where the guest speaker, Hon. A. T. Proctor, Minister of Highways and Transportation delivered an address on the value to the public of the professions generally and the engineering profession in particular. He severely criticized a series of articles recently appearing in the press, intended, apparently, to undermine public confidence in the professions.

Mr. Proctor suggested the advisability of an organized campaign by professional men generally to inform the public of the useful part they play in our every day life. He closed his address with an appeal to uphold the ideals of our democratic system.

TORONTO BRANCH

J. J. SPENCE, M.E.I.C. - *Secretary-Treasurer*
D. FORGAN, M.E.I.C. - *Branch News Editor*

A very interesting meeting of the Toronto Branch was held on the evening of February 20th at Hart House, University of Toronto, when Mr. George W. MacLeod presented a paper entitled, **The Helen Mine and Beneficiating Plant.**

The branch chairman, Mr. Nicol MacNicol, opened the meeting and welcomed those members of the Canadian Institute of Mining and Metallurgy who were in attendance. Professor C. Williams of the University of Toronto introduced the speaker.

Mr. MacLeod pointed out that not so very many years ago a talk on iron mining would not have occasioned very much interest. One does not associated the same amount of romance with the mining of iron that one does with gold mining. The war has certainly changed the status of iron to one of considerable national importance. There were over 70 members in attendance at the meeting and this in itself served to indicate the interest in the subject.

The speaker pointed out that the earliest prospecting for iron was carried out in the province of Quebec in the 18th century. This spread to other provinces and since 1886, when records were first kept over seven million tons of iron have been mined. The province of Ontario is Canada's biggest iron producer, being credited with 72 per cent. Of this the Algoma properties contribute 63 per cent.

The Helen mine was discovered in 1898 by a man by the name of Gates who was prospecting for gold in the Wawa Lake district. The deposit which was uncovered was found to be a high grade hematite. Mr. F. H. Clergue took over the property soon after its discovery and commenced the building of the Algoma Steel Corporation Limited.

Mr. MacLeod traced the history of the mine. He told how its ore deposit was exhausted and how the Magpie mine was developed in its place. The ore at the Magpie mine was siderite, which contained 35 per cent iron in the natural state. It was found that by roasting three tons of the ore two tons of ore grading 50 per cent iron could be developed and this was then found to be quite satisfactory for blast furnaces. The ore structure was very good and the ore contained about three per cent manganese and enough lime to be self-fluxing. The Magpie mine produced about one million tons of iron before it was shut down in 1921. A few years before the Magpie mine was shut down it was noticed that a large cone shaped hill near the site of the old Helen mine was another deposit of siderite. A check-up revealed the presence of over 100 million tons. This deposit was really not given serious consideration until 1937, when the Ontario Government established a bounty on iron ore production. Sir James Dunn then took a very active interest and under the direction of Mr. C. D. Kaeding an intensive study was undertaken to determine the most economical and effective method of mining and preparing the ore for the blast furnace. A means had to be devised for reducing the high sulphur content of the ore. Finally, a continuous refining process was developed which practically eliminated the sulphur content and left approximately 51 per cent iron.

Mr. MacLeod showed a number of lantern slides of the quarrying operation, and the aerial tram which conveyed the ore from the mine the four miles to the sintering plant.

Mr. MacLeod also explained in detail the quarrying operation. He pointed out how they were able to mine approximately 3,000 tons of ore per day with the expenditure of an average of only ¼ lb. of blasting powder per gross ton of ore mined.

The ore, as mined, is conveyed in the buckets of the aerial tram, each of which has a capacity of one gross ton, and of which there are 120 on the line. There is a 200,000 ton ore storage at the sintering plant.

The sintering operation is very interesting and it is remarkable to consider that the sinter which leaves this plant is practically free of sulphur and contains 53½ per cent iron. This product is known as Algoma Sinter. It is ideal for blast furnace operation and it has been found that it is most economical in coke consumption.

The sinter is hauled by rail to the terminal at Michipicoten, where it is dumped from the railway cars into a 14,000 ton hopper from which it in turn is loaded into the boats for transfer to the steel plant at Sault Ste. Marie. A conveyor belt system transfers the ore from this large hopper to the boats, loading directly into the vessel hatch at the rate of about 1,500 gross tons per hour. It is possible to handle up to 2,000 gross tons per hour, which will result in loading a boat in five hours. Up to the end of 1940 this conveyor belt system has handled over 471,000 gross tons of sinter.

An interesting question period was carried on when Mr. MacLeod had finished his paper, at the conclusion of which Mr. S. R. Frost moved a vote of thanks. The hearty handclap which Mr. MacLeod received was indiciative of the extent to which his paper had been enjoyed.

After the adjournment the members retired to one of the private dining rooms where refreshments were served.

VANCOUVER BRANCH

T. V. BERRY, M.E.I.C. - - *Secretary-Treasurer*
ARCHIE PEEBLES, M.E.I.C. - *Branch News Editor*

The Vancouver Branch met on Wednesday, February 26th, at the Hotel Georgia to hear an address on **The Origin, Theory and Dynamics of Tides.** The speaker was Ralph Hull, professor of mathematics at the University of British Columbia.

Dr. Hull based his interpretation of the causes of tidal phenomena on the equilibrium theory, which is the principle followed in forecasting and the preparation of tide tables. The fundamental mathematical relationships derived from this theory are fairly simple, but when all factors affecting the variables are taken into account, the result is a very intricate series of equations which have to be solved simultaneously. Actually, the computations are done on a type of integrating machine, of which there are only five or six in existence, one of these being at Liverpool, where tide tables for Canada are prepared.

Tides exhibit several different sets of variations, each due to a different cause and independent of the other, although their effects are inter-related. Principal variations are the semi-diurnal, fortnightly, and long range variations. Semi-diurnal changes take place in an average time of 12 hrs. 25 min. and are the result of the passage of the moon over the meridian of any local point. Fortnightly changes are in the range of tide between high and low, and in the equality or otherwise of highs and lows. Variations in range are spoken of as spring and neap tides, and are the result of the attractions of the earth and the moon either supplementing or cancelling each other. This is also known as the synodic effect. Long range variations are less noticeable, and are chiefly due to changes in the maximum declination of the moon because its orbit is not parallel to that of the earth.

In some localities one effect will predominate more than the other, as regards the long range variations. The synodic effect is most pronounced in Atlantic tides, and those of Hudson's Bay and the St. Lawrence. On the Pacific Coast, the declinational effect is the predominant one. The anomalistic effect, or that due to the moon's elliptical orbit, is noticeable in the tide of the Bay of Fundy. Prediction calculations are made for five locations on the coast of British Columbia, and corrections are applied for other locations. Calculations for currents and tidal estuaries are usually made by hand in a local office. Corrections have to be made for each month of the year.

Engineers are interested in tide phenomena where they have to deal with bridge foundation problems, dredging, dock construction, sewage disposal, etc. A great deal of discussion took place along these lines, much of which concerned the experiences of those present in various parts of the country. Many peculiarities of tides cannot be explained on the same basis as tide predictions are made, because they are due to local terrestrial influences.

The chair was occupied by Dean J. N. Finlayson, branch chairman, and a warm vote of thanks was extended to Dr. Hull by Mr. H. N. Macpherson. About sixty members and guests attended.

Clad Metals, their manufacture, application in industry and anti-corrosive properties, was the subject at a meeting of the branch on March 7th at the Universtiy of British Columbia. In the absence of Dean Finlayson the chair was occupied by W. O. Scott.

The address was given by E. C. Gosnell, chemical engineer, Lukens Steel Company of America, through the courtesy of Wilkinson and Company Limited, their Vancouver representatives. In introducing his subject, the speaker pointed out that anti-corrosive materials are used for the following reasons: to increase the life of the structure, to maintain the quality and prevent contamination of products, to permit sterilization of equipment, to reduce maintenance costs, to reduce weight, and for better appearance.

Clad metals at present available employ nickel, monel, inconel and stainless steel as the anti-corrosive or cladding material. They are manufactured by placing two sheets of one of these metals between thick steel plates which have been sand-blasted and fluxed on the side adjacent to the clad. The clad metal is not as wide as the steel backing plate. Steel strips are then welded around the edge of the layer of four plates to make a gas tight joint. After heating to rolling temperature the layer is rolled out to finished thickness, each metal being proportionately reduced, thus maintaining a known thickness of clad. A bond is secured between the clad and the steel backing which will not separate during any fabrication. The two pairs of plates separate after rolling when the edges have been sheared off, thus providing a completely clad steel plate of proper thickness. Test pieces to test the strength of the bond have all broken outside of the bonded surfaces, and a bond strength of 57,900 lb. per sq. in. has been reached. It is believed that under rolling, the clad metal is densified and that an anti-corrosive layer is secured which is less porous than one laid on by electrolytic processes.

Any metal may be used as a clad which does not have an appreciably different melting temperature from that of the backing material. For this reason it is not yet possible to clad steel with aluminium, which will not maintain its properties at the rolling temperature of steel.

Clad metals have already found widespread use in industry for the manufacture of tanks, kettles, piping, mixers, table tops and similar equipment.

Applications in the industry were shown by lantern slides, which were explained in complete detail by Mr. Gosnell. In summarizing, he stated that his company was equipped to furnish clad plates up to 162 in. width, and dished heads up to 162 in. diameter. Larger sizes can be fabricated by welding separate plates. It is expected that with increased application, clad plates will become cheaper, as the tonnage produced increases, and a more economical disposal of the scrap material which is sheared off around the edges is effected.

A number of questions were asked regarding the best materials for certain corrosive substances, and some problems in fabrication. A hearty vote of thanks was proposed by Mr. Ernest Smith and the agreement of the audience was quite apparent. Forty-five members and guests were present.

Library Notes

Book notes, Additions to the Library of the Engineering Institute, Reviews of New Books and Publications

NATIONAL BUILDING CODE
PART 3; ENGINEERING REQUIREMENTS*

National Research Council, Ottawa, 1941
256 pp., 5½ x 8½ inches, $1.75

Reviewed by S. R. Banks, m.e.i.c.**

The purpose of the National Building Code, which is produced at the instance of the Department of Finance, the Royal Architectural Institute of Canada, and other organizations concerned in the elimination of unsatisfactory construction, is the establishment of a model building-code to meet particularly the needs of smaller municipalities. The code in itself bears no mandatory powers, though provincial laws in general require that any work carried out under its regulations shall be designed and supervised by a properly-qualified engineer or architect.

The part now under review was prepared, under the National Research Council, by committees recruited from men of high standing in the appropriate fields of theory and practice. The product of three years' work, it is a thorough, comprehensive, and valuable document, bearing every indication of the influence of close examination of the results of recent research on this continent and overseas, together with observation of modern trends in the numerous parallel codes that exist. The compilers have not hesitated to make useful and frequent reference to the standards of well-known authorities, chief among which are the Canadian Engineering Standards Association and the American Society for Testing Materials. The editing throughout is of a high standard, and the indexing is good. The reproduction and binding of the text, however, are not of the standard merited by a publication of this nature and origin.

The outstanding contribution of the book lies in the presentation, for the first time as Canadian standards, of specifications relating to Wood Construction, Masonry Construction, and Excavations and Foundations. In the first of these sections, the tabulation of allowable stresses and of safe loads for various types of connection alone forms a serviceable addition to engineering reference. A feature of the second is the recognition and control of reinforced brickwork, gypsum masonry, and glass block as building materials. The third section is of special interest in view of the large amount of research currently going forward (or, unfortunately, deferred), in many countries, into the behaviour of foundations, particularly in cohesive soils. The provisions of the code in respect to the classification of soils and maximum allowable pressures thereon are generally in accord with modern usage, although the specified limit appears high in some cases. A caution is given regarding the anticipation of settlements, and reference is made to the value of positive tests. The Hiley formula for pile-driving is presented: this formula is of British origin, and Kempe's Year-Book gives it prominence as yielding satisfactory results.

The section relating to Reinforced Concrete Construction also fills a growing Canadian need. A cursory comparison of this standard with the commonly-used Joint Committee Report of the U.S.A. reveals several interesting innovations in the detailed treatment of this material, but space does not permit of their present discussion. The regulations pertaining to structural steelwork do not differ greatly from those of the C.E.S.A. except in that a method is propounded for the estimation of the restraining-effects of common beam-connections. Among other items in the book may be mentioned the logical treatment accorded to wind-forces and snow-loads, and the inclusion of a method for computing earthquake-forces. There are also regulations dealing with walls and roofs.

Apart from judgement of its intrinsic worth, however, it is pertinent to look at the Code in its relation to other engineering standards, notably those of the C.E.S.A. While it is appreciated that a fresh and vigorous outlook upon, and an independent study of, specification requirements cannot but offer the stimulus of competition to the existing organization, yet from the standpoint of the practising engineer it is somewhat confusing to be confronted with two official standards of approximately the same weight and differing only in matters of detail. Such a state of affairs is well exemplified in the publication, within a year's time, of the two C.E.S.A. specifications relating to steel structures for buildings and metallic arc welding and of the section of the code that deals with the same subjects. It may furthermore be conjectured that the C.E.S.A. will before long produce a revised specification for reinforced concrete. It will no doubt occur to many engineers that the work of this new code might, with the advantages of simplicity and economy, have been carried out under the auspices and with the co-operation of the longer-established authority, the more so in view of the similarity of standing of the two personnels concerned, and of the two results insofar as they have been achieved.

* Part 5, Requirements Bearing on Health and Sanitation, has already been published. Parts 1, 2, and 4, Administrative Requirements, Definitions, Fire Protection, respectively, are not yet available.

** General Engineering Department, Aluminum Company of Canada Limited.

ADDITIONS TO THE LIBRARY

TECHNICAL BOOKS

Elements of Mining:

By Robert S. Lewis, New York, John Wiley & Sons, Inc., 1941. 579 pp., 9½ x 6 in., $5.50.

REPORTS

Canada Department of Mines and Resources—Mines and Geology Branch—Bureau of Mines:

Investigations in Ore Dressing and Metallurgy, January to June 1939. Ottawa, 1940.

Canada Department of Mines and Resources—Mines and Geology Branch—Geological Survey, Memoirs:

Geology of Saint John Region, New Brunswick by F. J. Alcock, Memoir 216; Geology of the Southern Alberta Plains by L. S. Russell and R. W. Landes, Memoir 221.

Canada Department of Mines and Resources—Mines and Geology Branch—Geological Survey Papers:

Preliminary Map George Creek, Alberta, paper 40-17; Preliminary Report Natural Gas in Brantford Area, Ontario, Paper 40-22.

Canadian Engineering Standards Association:

Canadian Electrical Code Part 2, Essential Requirements and Minimum Standards Covering Electrical Equipment, Specification No. 69. Construction and test of Porcelain Cleats, Knobs, and Tubes.

Canadian Government Purchasing Standards Committee:

Specification for Interior Paint, Semi-Gloss; Exterior Priming Paint, White Lead-Linseed Oil Type; Marine Enamel, White and Grey; Exterior Linseed Oil Paints, White and Tinted; Exterior and Marine Enamel, Signal Red and Post Office Red; Exterior Enamel, White and Tinted.

Electrochemical Society—Preprints

The Effect of Gas Pressure on the Passivity of Iron; The Effect of Silver (0.05 to 0.15 per cent) on Some Properties and the Performance of Antimonial Lead Storage Battery Grids; Formation of Anodic Coatings on Aluminum; Indium Plating. Preprints Nos. 79-9 to 79-12.

International Nickel Company of Canada, Limited

Annual Report, for the year ended December 31, 1940.

Ohio State University Studies Engineering Series—Engineering Experiment Station Circulars

America's Sources of Power and National Defense, No. 38; Notes on the Properties of Clay Casting Slips, No. 39; The University and Industry, No. 40.

U.S. Department of Commerce—Building Materials and Structures:

Strength, Absorportion, and Resistance to Laboratory Freezing and Thawing of Building Bricks Produced in the United States, BMS60; Moisture Condensation in Building Walls, BMS63; Methods of Estimating Loads in Plumbing Systems, BMS65; Stability of Fiber Sheathing Boards as Determined by Accelerated Aging, BMS69.

U.S. Department of the Interior—Geological Survey Bulletins:

Subsurface structure in part of Southwestern New York and Mode of Occurrence of Gas in the Medina Group, 899-B; Chromite Deposits in the Seiad Quadrangle Siskiyou County, California, 922-J; Chromite Deposits of the Pilliken Area, Eldorado County, California, 922-O; Chromite Deposits in the Sourdough Area, Curry County and the Briggs Creek Area, Josephine County, Oregon, 922-P.

U.S. Department of the Interior—Geological Survey Professional Paper:

Geology and Biology of North Atlantic Deep-Sea Cores, Paper 196-A.

U.S. Department of the Interior-Geological Survey Water-Supply Paper:

Maximum Discharges at Stream-Measurement Stations Through December 31, 1937, with a supplement including changes through September 30, 1938. Paper 847.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet the books are not in the Institute Library, but inquiries will be welcomed at headquarters, or may be sent direct to the publishers.

A.S.T.M. STANDARDS ON RUBBER PRODUCTS

Prepared by Committee D-11, December, 1940. American Society for Testing Materials, Philadelphia. 256 pp., illus., diagrs., charts, tables, 9 x 6 in., paper, $1.75.

Thirty-four standard and tentative methods of test and specifications pertaining to rubber products are presented in convenient form for laboratory use and reference. The standards cover chemical analysis, physical properties and various kinds of equipment. There is a nine-page bibliography of recent references on the mechanical testing of rubber.

ANALYTICAL MECHANICS FOR ENGINEERS

By F. B. Seely and N. E. Ensign. 3 ed. rewritten. John Wiley & Sons, New York, 1941. 450 pp., diagrs., charts, tables, 9 x 6 in., cloth, $3.75.

The principles of mechanics that are essential for engineers are presented in four parts: statics; kinematics; kinetics; and a group of special topics. The aim has been to present these principles clearly, to develop them from common experience, to apply them to concrete practical problems, and to emphasize their physical interpretations. A new chapter on mechanical vibrations and many new problems have been added in this edition.

(The) AVIATION MECHANIC

By C. Norcross and J. D. Quinn. McGraw-Hill Book Co., Whittlesey House, 1941. 563 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $3.50.

Intended as a comprehensive course for the prospective airplane mechanic, this text presents first a simple exposition of aerodynamical theory. The very complete section on airplane construction includes a step-by-step description of the building of a light, all-metal airplane and of mass production methods. Maintenance practice for all types of planes is explained in detail, and in this section, as well as the rest of the book, there is a wealth of practical illustrations. Tool requirements for the airplane mechanic are appended.

BIBLIOGRAPHY OF SPECTROCHEMICAL ANALYSIS. 2 ed. 1940.

Compiled by D. M. Smith. British Non-Ferrous Metals Research Association, Euston St., London, N.W.1. 55 pp., 10 x 6 in., paper, 3s.

This bibliography includes all the references published in the 1935 "Bibliography of Literature on Spectrum Analysis," supplemented by articles published in the more important scientific journals of all countries up to August, 1940. The references are broadly classified and have short explanatory notes. There is an author index.

COMMERCIAL TIMBERS OF THE UNITED STATES

By H. P. Brown and A. J. Panshin. McGraw-Hill Book Co., New York, 1940. 554 pp., illus., diagrs., tables, 9½ x 6 in., cloth, $5.00.

The first half of this comprehensive work is devoted to a full exposition of the structure of wood with special attention to identification features. Two keys are then given for the identification of the more important commercial woods of the United States, one based on characters visible to the naked eye and the hand lens, the other based on microscopic features. The descriptions by species record and explain important uses, and selected references are given. There is a glossary.

CROSBY-FISKE-FORSTER HANDBOOK OF FIRE PROTECTION

Edited by R. S. Moulton. 9th ed. National Fire Protection Association, Boston, Mass., 1941. 1,308 pp., illus., diagrs., charts, tables, 7 x 4½ in., lea., $4.50.

This comprehensive manual contains essential information on all phases of fire prevention and fire protection. All new developments during the five years since the last edition in hazards, protective equipment and methods have been included in this revision, to continue the policy of providing an authoritative review of accepted practice.

EXPERIMENTAL ELECTRICAL ENGINEERING and Manual for Electrical Testing, Vol. 2

By V. Karapetoff and B. C. Dennison. 4th ed. revised. John Wiley & Sons, New York, 1941. 814 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $7.50.

The second volume of this laboratory manual for students and engineers contains theory and tests for more advanced study of the subjects introduced, in their simpler aspects, in volume I, and describes the more complicated electrical equipment not covered previously. The thorough revision includes the treatment of new methods and types of apparatus and the addition of some three hundred new drawings and cuts. There are chapter bibliographies.

FOURIER SERIES AND BOUNDARY VALUE PROBLEMS

By R. V. Churchill. McGraw-Hill Book Co., New York and London, 1941. 206 pp., diagrs., tables, 9 x 6 in., cloth, $2.50.

This book presents an introductory treatment of Fourier series and their application to the solution of boundary-value problems in the partial differential equations of physics and engineering. The aim is to give the student a conception of orthogonal sets of functions and their use in the classical process of solving these problems. References and review problems are included.

GEOLOGY OF COAL

By O. Stutzer, translated and revised by A. C. Noé. University of Chicago Press, Chicago, Ill, 1940. 461 pp., illus., diagrs., charts, maps, tables, 10 x 7 in., cloth, $5.00.

Based on a standard German work, this considerably revised translation presents comprehensive data from world-wide sources on the character and varieties of coal and the techniques of its examination. The origin, chemical and physical constitution, and structure of coal beds are fully explained, including their significance in the preparation and utilization of coal. A long list of references accompanies each chapter.

HANDBOOK OF THE GLASS INDUSTRY

Compiled and edited by S. R. Scholes. Ogden-Watney Publishers, New York, 1941. 209 pp., diagrs., charts, tables, 9 x 6 in., cloth, $5.00.

This reference manual for the factory engineer, chemist and plant executive provides practical information on raw materials, glasshouse fuels, compressed air, properties of glasses, furnaces, pyrometers and ware defects. Extensive use of graphs and tables increases its ready-reference value. Necessary related data are included, and there is a glossary of glass-house terms.

MASTERING MOMENTUM

By L. K. Sillcox, Simmons-Boardman Publishing Corp., New York, 1941. 274 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $2.50.

Modern transport trends are discussed with particular reference to their influence upon the equipment of American railways. Current developments in train operation and braking, wheels, axles, trucks and draft gear which will improve control, wear factors and riding quality are described. Illustrations and reaction graphs of various brake systems are appended.

(The) METALLURGY OF DEEP DRAWING AND PRESSING

By J. D. Jevons, with a foreword by H. W. Swift. John Wiley & Sons, New York, 1940. 699 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, $10.00.

This comprehensive work covers the many phases of the subject in such a way as to be of value for both practical workers and scientific students. The author first describes the production of brass and steel sheet, including the metallurgical considerations. The defects and difficulties met in deep-drawing brass, steel and other metals are discussed in detail and the mechanical equipment is described. Test methods, material specifications, new applications and desired improvements in metals and methods occupy separate chapters. There is a large list of references.

PETROLEUM INDUSTRY, an Economic Survey

By R. B. Shuman. University of Oklahoma Press, Norman, Okla., 1940. 297 pp., tables, maps, charts, 9 x 6 in., cloth, $3.00.

All phases of the petroleum industry are discussed from the viewpoint of an industrial enterprise. The technological subjects of production and refining, transportation and storage are tied in with considerations of marketing practice, investment and financial policies, taxation, etc. Labor relations and international trade are covered briefly, and a considerable chapter is devoted to questions of conservation and control. Much information is condensed into tables and diagrams. A bibliography is appended.

PRELIMINARY NOTICE

of Applications for Admission and for Transfer

March 29th, 1941

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, 1941.

L. Austin Wright, General Secretary.

*The professional requirements are as follows:—

A **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 attainment 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

COURCHESNE—CHARLES EDOUARD, of 324 Laurier Ave., Quebec, Que. Born at Quebec, April 5th, 1892; Educ.: 1910-12, Laval Univ., Land Surveyor, June, 1912, Reg'd. Prof. Land Surveyor 1914. R.P.E. of Quebec, 1938; 1913-14, dftsman., Transcontinental Rly.; 1914-15, instr'man., Gauvin & Beauchemin; 1916-20, instr'man., Quebec & Saguenay Rly.; 1920-37, divnl. engr., and 1937 to date, asst. district engr., Provincial Highway Dept., Quebec.

References: A. Gratton, J. O. Martineau, J. A. Lefebvre, R. J. L. Savory, P. Vincent.

JOHNSTON—BRUCE HENRY, of 4502 Royal Ave., Montreal, Que. Born at Port Stanley, Ont., Jan. 4th, 1894; Educ.: B.A.Sc., Univ. of Toronto, 1922; 1910-13, four year ap'ticeship course, testing elect'l. apparatus, Can. Gen. Elec. Co. Ltd., Peterborough, Ont.; 1914-16, on power plant constrn., installing rotary converters, switchboards, oil circuit breakers, etc.; 1916-19, overseas, Lieut., Can. Engrs.; 1922-25, on export sales—specialist on motors, control and industrial devices, International General Electric Co., Schenectady, N.Y.; 1925-30, sales engr., apparatus sales dept., Can. Gen. Elec. Co. Ltd., Toronto, Ont.; 1930 to date, Montreal district manager, i/c transformer sales in eastern Canada, Moloney Electric Co. of Canada Ltd., Montreal.

References: E. Gray-Donald, R. H. Mather, W. H. Noonan, G. A. Vandervoort, R. N. Coke.

LAJOIE—GERARD, of Quebec, Que. Born at St. Epiphane, Que., Oct. 21st, 1909; Educ.: B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1937; 1937-40, i/c as asst. for wharves constrn., retaining & diverting walls, breakwaters, dredging, harbour improvements, etc., Public Works of Canada, Quebec; 1940 to date, i/c of constrn. of intercepting sewer, City of Quebec, for Arthur Surveyer & Co., Montreal, Que.

References: J. M. Begg, A. R. Decary, P. Vincent, L. G. Trudeau, A. Surveyer, J. G. Chenevert.

LANG—EDWIN GEORGE POWER, of 1290 Fort St., Montreal, Que. Born at Wimbledon, England, March 5th, 1896; Educ.: Stanley Technical, London, England. Croydon Polytechnic, Croydon, England: 2nd Class Diploma, College of Preceptors, London, England; 1917-20, with the R.A.F.; 1920-25, on constrn. for C.N.R. and C.P.R.; 1925-26, surveys, Shawinigan Engineering Company; 1926-33, field engr., Canadian Car & Foundry Co. Ltd.; 1934-36, private geological investigations and surveys; 1937-39, geological investigator, rock, gravel & sand, Canada Cement Company; June, 1940 to date, res. engr. i/c constrn. & mtce., No. 12 Equipment Depot, R.C.A.F., Montreal East. (Civil Service Status—senior asst. engr., Dept. of National Defence for Air).

References: J. A. McCrory, J. M. Breen, W. McG. Gardner, C. R. Lindsey, L. McCoy, G. S. Stairs, J. L. Pidoux.

MARTIN—ARTHUR LEY, of 1181 Mountain St., Montreal, Que. Born at Winnipeg, Man., Nov. 12th, 1909; Educ.: B.Sc. (C.E.), Univ. of Man., 1934; 1935 (Sept.-Nov.), junior engr., Manitoba Good Roads Dept.; June, 1936, asst. inspr., C. D. Howe & Co. Ltd.; 1936 (July-Nov.), sub-grade inspr., Manitoba Good Roads Dept.; 1937 (Jan.-Apr.), inspr., Greater Winnipeg Sanitary District; 1937-40, dftsman., Truscon Steel Co. Ltd., Toronto, Ont.; At present, dftsman., General Engrg. Dept., Aluminum Co. of Canada, Montreal.

References: A. E. Macdonald, S. R. Banks, H. H. James, D. G. Elliot, G. H. Herriot, J. N. Finlayson.

NARSTED—GEORGE KENDALL, of Windsor, Ont. Born at Sault Ste. Marie, Ont., May 29th, 1917; Educ.: B.Eng. (Mech.), McGill Univ., 1940; 1936-37-38 (summers), machine shop work: 1939 (summer), dfting & estimating, F. L. Smidth Co., New York; 1940-41, assembly layouts & work in purchasing dept., Canadian Bridge Co. Ltd., Walkerville. At present, machine tool designer, Eaton Wilcox Rich Ltd., Windsor, Ont.

References: F. J. Pollock, H. L. Johnston, A. H. MacQuarrie, T. R. Durley, W. L. Saunders.

PEACE—JOHN THOMAS, of 103 Earlscourt Road, Toronto, Ont. Born at Reigate, Surrey, England, Sept. 4th, 1905; Educ.: Central Technical School, Toronto. Corres. course, elec. engrg., Bell Telephone Co. of Canada. Qualified as Sergeant in Military Engrg. at Kingston, 1925, and as Warrant Officer in 1929; 1926-39, with the Bell Telephone Co. of Canada, Toronto. With the Royal Canadian Engrs. as follows: 1929-36, Company Sergeant Major, 2nd field Co., Toronto; 1936-39, Regimental Sergeant Major, 2nd Dist. H.Q.; 1939-40, Engineer Clerk, Sergeant Major, No. 1 Workshop & Park Co., C.A.S.F. At present, Regimental Sergeant Major, 1st Battn., Canadian Army (overseas). (Asks admission as Affiliate).

References: C. S. L. Hertzberg, H. R. Lynn, A. J. Kerry, A. L. Tregillus, P. L. Debney, A. M. Reid, R. G. Saunders, H. N. Gzowski.

PRITCHARD—WILLIAM ROBERT, of the Town of Mount Royal, Que. Born at Brantford, Ont., May 8th, 1904; Educ.: B.A.Sc., Univ. of Toronto, 1925; With the Bell Telephone Co. of Canada as follows: 1925-29, asst. mtce. engr., 1929-37, central office engr., 1937-38, personnel supervisor, 1938 to date, repair supervisor, involving general staff methods and results of work re exchange mtce.

References: G. S. Ridout, A. M. Mackenzie, H. E. McCrudden, J. L. Clarke, H. J. Vennes.

RANKIN—ROBERT ARTHUR, of Montreal, Que. Born at Glasgow, Scotland, Nov. 19th, 1902 Educ.: Diploma in Engrg. Science, Royal Technical College, B.Sc., Glasgow Univ., 1925; M.Eng. (Indust. Economics), 1933, M.Sc. (Metallurgy), 1937, McGill Univ.; R.P.E. of Quebec; 1916-17, Ferme Colliery, Rutherglen, Glasgow; 1917-22, John McNeil & Co., Glasgow, dfting., pattern, foundry, fitting, machine shops—erection & testing (heavy mech. & power equipment); 1922-24, with the Armstrong Construction Company (Armstrong Whitworth, Glasgow), work included steel trans. lines in New Zealand, hydro-electric & paper mill equipment in Nfld., rotary-converter & transformer stations in England, dry dock equipment, etc.; 1924-27, Naval Dockyard, Dalmuir, Scotland (operated by Wm. Beardmore Ltd.), design, testing, trial trips, etc., power, propulsion, technical services; 1930-31, manager, Morton Engrg. & Drydock Co., Quebec; 1931 to date, general industrial consltg. practice in Montreal (a) with Ernest Cormier, M.E.I.C., incl. mech. & elec. work at University of Montreal, Le Petit Journal press room & plant, the Supreme Court of Canada; (b) partner—Robert A. Rankin & Company, incl. work for Algonquin Paper Co., St. Lawrence Paper Co., The Ogilvie Flour Mills Co. Ltd., and the Brown Corporation (Canada). Retained by two latter companies for supervision of all mtce., engrg., and development of new projects, etc.

References: F. S. B. Heward, F. J. Bell, H. T. Doran, R. E. MacAfee, A. Stansfield, W. J. Armstrong, J. A. Kearns, J. M. Robertson, R. Calvin.

SMITH—WALTER H., of 7 Kingscourt Drive, Toronto, Ont. Born at Toronto, April 10th, 1887; Educ.: Toronto Technical Schools. R.P.E. of Ontario since 1922); 1909 to date, with the T. Eaton Co. Ltd., Toronto. Work included design and superintendence of erection and installn. of numerous lighting, heating, ventilating and sprinkler systems, elevators, cold storage plant, vacuum cloth drying equipment, private water supply at Oakville, constrn. and all mech'l. services for lowering of store basement and sub-basement, foundry bldg., air cooling system, also installn of three new boilers with coal and ash handling equipment, in power house of store bldg. At present, chief engr., i/c of power plant, electricians, plumbers, steamfitters, tinsmiths, carpenters, painters, etc.

References: W. H. M. Laughlin, A. R. Robertson, E. T. Bridges, W. W. Gunn, F. E. Wellwood, P. M. Thompson.

(*Continued on page 217*)

Employment Service Bureau

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party. Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted upon request after a lapse of one month. All correspondence should be addressed to THE EMPLOYMENT SERVICE BUREAU, THE ENGINEERING INSTITUTE OF CANADA, 2050 Mansfield Street, Montreal.

SITUATIONS VACANT

SALES ENGINEER for pulp and paper mill machinery, woodworking and machine tools. Salary $60 a month plus 1% commission. Apply to Box No. 2250-V.

STEAM ENGINEER wanted by paper mill in Ontario. Applicants should be University graduates in mechanical engineering with experience in the generation and distribution of steam. Apply stating full particulars of education and experience, and giving references to Box No. 2283-V. Applications will not be considered from persons in the employment of any firm, corporation or other employer engaged in the production of munitions, war equipment, or supplies for the armed forces unless such employee is not actually employed in his usual trade or occupation.

ENGINEER—Age 35-45. To sell and demonstrate metal spraying equipment. Must have successful sales record and own his own car. Salary paid while training, then on a drawing account against commissions earned. Apply Box No. 2309-V.

ALLOY METALLURGISTS with a knowledge of physical chemistry and elementary metallography. Apply Box No. 2326-V.

YOUNG MECHANICAL ENGINEER interested in research and mechanical testing rather than production for work in Canada. Apply Box No. 2327-V.

GRADUATE MECHANICAL ENGINEER in good health, energetic, to work with large industrial concern in British Guiana. Applications should be sent to Box No. 2328-V.

MECHANICAL ENGINEER, preferably graduate, familiar with diesel engines, tractors and shovels for maintenance work with large industrial firm in British Guiana. Applications should be addressed to Box No. 2329-V.

CONSTRUCTION MAN with experience in heavy construction for either a long or short term contract in British Guiana. Applications should be addressed to Box No. 2330-V.

SITUATIONS WANTED

CHIEF ENGINEER—twenty years industrial construction, production and operation. Structures, equipment, steam, hydro. Experienced conferences, preliminaries, organizing, preparing plans, estimates, specifications, negotiation of contracts. Apply to Box No. 36-W.

OFFICERS URGENTLY REQUIRED FOR TECHNICAL UNIT

The Commanding Officer of the No. 4 Army Field Workshop, R.C.O.C. (AF) has advised us that there are several vacancies in his officer establishment for men with engineering training and experience. Generally speaking the qualifications necessary are as follows:

Age—25-42 (British Subject).

Education—A degree in mechanical or electrical engineering is preferred, but is not essential if practical experience has been considerable.

Experience—(Civil) Should have been along general mechanical lines, machine shop, maintenance, etc. A knowledge of motor vehicles is desirable. Military experience is desirable, but not essential.

Character—Satisfactory character reference must be submitted and personality will be taken into consideration.

A short description of the composition and functions of an Army Field Workshop would be of natural interest to any candidate.

The A.F.W/S. is completely mobile and consists of a Main Shop, Recovery Sections and Light Aid Detachments. The officers are known as Ordnance Mechanical Engineers and the other rank personnel is mainly composed of tradesmen, such as fitters, machinists, electricians, welders, mechanics, etc.

The equipment is extraordinary, consisting of workshop lorries, breakdown and recovery vehicles, stores lorries, as well as transport vehicles, motorcycles, etc.

The principal functions of an A.F.W/S. are to take care of 1st and 2nd line recovery, repair and maintenance of practically all equipment used by an Army in the field. This includes small arms, mobile artillery up to 9.2 inch, radio and other electrical equipment, textiles, all motor transport except that operated by the Army Service Corps.

Apart from the privilege of giving to his country the benefit of his knowledge and training, an officer in a unit of this type has a great opportunity for the acquirement of very valuable experience.

All inquiries may be addressed to the Officer Commanding the unit at Westmount Barracks, 4350 St. Catherine St. West, Westmount, Que.

PRELIMINARY NOTICE (*Continued from page 216*)

WALES—CHARLES CLARKE, of Indian Point, Ont. Born at Sharon, Penn., July 25th, 1900; Educ.: B.A.Sc., Univ. of Toronto, 1924; Regd. Prof. Engr., State of Ohio, 1936; 1924-25, graduate students' course, Westinghouse Company, East Pittsburgh; 1925-27, asst. chief metallurgist, 1927-29, supt., open hearth blooming mill, Bar Mills, and 1929-37, chief engr., Otis Steel Company, Cleveland, Ohio; 1939 to date, vice-president and general manager, Hamilton Bridge Co. Ltd., Hamilton, Ont.

References: A. Love, H. A. Cooch, T. S. Glover, W. J. W. Reid, W. D. Black.

FOR TRANSFER FROM THE CLASS OF JUNIOR

GRAHAM—GEORGE, of 5880 Cote St. Antoine Road, Montreal, Que. Born at Winnipeg, Man., Feb. 7th, 1907; Educ.: B.Sc. (Civil), Univ. of Sask., 1933; Summers—1924-26, municipal engrg.; 1927-31, inspr. i/c of road constrn., City of Saskatoon; 1935, i/c field party, Dept. of Mines; 1935-36, instr'man, townsite & mine work, Lake Arthabasca district; 1936-37, writing reports as obtained on summer surveys; 1937, constrn. work for Joy Oil Co., Toronto; 1937 to date, consltg. engr. to and fire protection engr. for The Canadian Underwriters Assn. and associated insurance companies. (Jr. 1937).

References: R. A. Spencer, E. K. Phillips, G. D. Archibald, F. C. C. Lynch, A. J. Foy, J. K. Sexton, A. J. Wise.

SVARICH—JOHN PAUL, of Edmonton, Alta. Born at Vegreville, Alta., Dec. 2nd, 1904; Educ.: B.Sc. (Civil), Univ. of Alta., 1929; 1928-29 (summers, timekpr. & instr'man., on bldg. constrn.; 1929-30, drftsman, Town Planning Commn., Edmonton, and Driscoll & McKnight; 1930-32, drftsman., engrs. dept., City of Edmonton; 1932-37 (not engaged in engrg. work—teaching); 1938-40, dftsman., tech. divn., Dept. of Lands and Mines, Alta.; 1940 (Feb.-Aug.), dftsman., City of Edmonton; Sept. 1940 to date, dftsman., Alberta Nitrogen Co. Ltd., Calgary, Alta. (St. 1927, Jr. 1934).

References: R. J. Gibbs, R. S. L. Wilson, J. V. Rogers, R. G. Watson, A. W. Haddow.

FOR TRANSFER FROM THE CLASS OF STUDENT

BROSSARD—LEO GERARD, of 280 Maple Ave., St. Lambert, Que. Born at Laprairie, Que., Sept. 23rd, 1912; Educ.: B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1936. M.Sc., McGill Univ., 1940; Prior to 1937, student asst. on various field parties with Quebec Streams Commn., Quebec Bureau of Mines, Geol. Survey of Canada; 1937-40, asst. professor, of mineralogy & geology, Ecole Polytechnique, Montreal; Lecturer to prospectors at various periods from 1937 to 1941; 1939, geologist, Cournor Mining Co. Ltd., Perron, Que.; At present, lecturer, Bureau of Mines, Quebec. (St. 1936).

References: A. O. Dufresne, O. O. Lefebvre, A. Circe, A. Frigon, L. Trudel.

DUSSAULT—JEAN EDOUARD, of 108—4th Ave., Pointe aux Trembles, Que. Born at Montreal, Nov. 11th, 1911; Educ.: B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1938; Summers—1931-36, municipal work, 1937, instr'man., Canadian Hoosier Co.: 1938, asst. res. engr. on highway constrn.; 1938-40, temp. junior engr., Public Works Dept., Ottawa; May, 1940 to date, res. engr., Air Services Branch, Dept. of Transport. (St. 1937).

References: A. Circe, J. A. Lalonde, P. P. Vinet, R. A. Laferriere, E. F. Hawley.

HOWARD—HENRY MERVYN, of Orillia, Ont. Born at Lynden, Ont., June 22nd, 1906; Educ.: B.A.Sc., Univ. of Toronto, 1940; 1927-32, assisted in work necessary in starting sand & gravel business—bldg. & operating plant, sales delivery, purchasing, collections (for N. H. Howard-father); 1932-36, full charge of above operation, which was formed into Howard Sand and Gravel Co. Ltd., Aldershot, Ont.; 1937-40 (summer work), asst. assayer & asst. engr., Hard Rock Gold Mines Ltd., asst. mill operator, Lamaque Gold Mines Ltd., i/c mill research, etc., Hard Rock Gold Mines Ltd., materials engr., munitions plant constrn. for Fraser Brace Engrg. Co.; Oct. 1940 to date, metallurgical sales engr., i/c of sales & engrg. on milling equipment, incl. filters, roasters, flotation equipment, etc., for E. Long Ltd., Orillia, Ont. (St. 1940).

References: E. P. Muntz, C. G. Williams, P. C. Kirkpatrick, L. T. Rutledge, W. I. Shuttleworth, J. J. Spence.

LEROUX—JACQUES, of 3686 St. Hubert St., Montreal, Que. Born at Montreal, July 2nd, 1914; Educ.: B.A.Sc., Ecole Polytechnique, Montreal, 1939; 1930-38 (summers), instr'man., drftsman., junior engr., Quebec Streams Commn. & Public Works of Canada; 1939-40, asst. engr., Public Works of Canada, Montreal; 1940 to date, res. engr., civil aviation branch, Dept. of Transport, Montreal, Que. (St. 1937).

References: A. Circe, J. A. Lalonde, J. A. Wilson, F. J. Leduc, O. O. Lefebvre.

LOCHHEAD, JOHN STARLEY, of 3417 Patricia Ave., Montreal, Que. Born at Lachine, Que., Dec. 26th, 1913; Educ.: B.Eng. (Civil), McGill Univ., 1937; with the Dominion Bridge Co. Ltd., as follows: 1937-40, plant work, and work in plant management office; 1940-41, boiler inspection (Marine); Jan. 1941 to date, shop foreman, small welding & detail dept. (St. 1934).

References: F. Newell, R. S. Eadie, H. W. McMillan, A. H. Munson, P. Millar, L. Jehu, Jr.

PERRY—GEORGE THOMAS, of 91 MacLaren St., Ottawa, Ont. Born at Toronto, Ont., Sept. 27th, 1915; Educ.: B.A.Sc., Univ. of Toronto, 1939; 1936-37, machine shop, Baker Platinum Co., Toronto; 1937-38, lab. technician, Connaught Laboratories, Toronto; 1939 to date, asst. to director, divn. of mech. engrg., National Research Council, Ottawa, Ont. (St. 1938).

References—J. H. Parkin, C. J. Mackenzie, B. G. Ballard, D. S. Smith, S. L. Grenzebach, J. J. Spence, W. S. Wilson, S. J. Murphy.

Industrial News

Industrial development — new products — changes in personnel — special events — trade literature

STEEL SPECTROSCOPE

Empire Engineering Co., Toronto, Ont., represent Adam Hilger, Ltd., of London, Eng., who have issued a 12-page booklet, No. 243/3, which describes at length and illustrates the Spekker Steeloscope, an instrument designed for rapid and reliable sorting, checking of steel stores, purchases and scrap and for general control of production.

MOLYBDENUM TUNGSTEN HIGH SPEED STEELS

A 12-page booklet issued by Jessop Steel Co. Ltd., Toronto, Ont., describes the company's molybdenum tungsten high speed steel. The physical properties, approximate analysis, hardness values at varying drawing temperatures and heat treating procedure are enumerated.

HANDLING EQUIPMENT

Lift trucks, die handling trucks, sheet handling trucks, and elevating tables, all hydraulically operated; also trucks with hydraulic elevating tables, utility trucks, steel frame skid platforms, and special handling equipment are all featured in a 2-page pamphlet published by Lyon Iron Works, of Greene, N.Y.

GLASS CLOTH

Irvington Varnish & Insulator Co. of Canada Ltd., Hamilton, Ont., are distributing an interesting folder, with samples attached, describing Irvington Varnished Fiberglas. The folder gives dielectric strengths of the five different cloth thicknesses now regularly manufactured when impregnated and coated with black or yellow insulating varnishes. Standard widths and lengths of rolls of both tape and full width cloth are given.

FRACTIONAL H.P. SILENT CHAIN DRIVES

Folder 1894, of Link-Belt Limited, Toronto, Ont., describes 3/16-in. pitch silent chain drive for fractional horse power duty, such as on cameras, picture projectors, ice cream freezers, machine tools, cigar machines, bread slicers, doughnut machines, stokers, meters, blowers, etc.

WATER CONDITIONING

A 48-page catalogue issued by Cochrane Corp., Philadelphia, Pa., describes and illustrates the company's Hot Process Water Softeners for removal of hardness, silica and other scale forming material from boiler feed and industrial process waters. It also contains a 9-page appendix of feed-water chemistry, also heat balances, flow diagrams, two-colour construction drawings and engineering tables and charts.

SOLDER FITTINGS AND VALVES

Catalogue "S"-B, 16 pp., issued by Empire Brass Mfg. Co. Ltd., London, Ont., covers the complete Empire line of cast brass solder fittings and valves for use with hard wall copper pipe. Price list included.

EQUIPMENT FOR BUILDINGS

Entitled "Equipment for Buildings and Institutions," bulletin WP-1099-B 27, issued by Worthington Pump & Machinery Corp., Harrison, N.J., features this company's extensive range of equipment for air conditioning, refrigeration, water softening and other requirements in the modern public building and industrial plant.

TRACTORS AND ROAD EQUIPMENT

Caterpillar Tractor Co., Peoria, Ill., have issued a 36-page illustrated catalogue listing more than 50 products—track-type tractors, road machinery, Diesel and natural gas engines, Diesel marine engines, Diesel automotive engines and Diesel and natural gas electric sets.

STEAM-JET EJECTORS

Worthington Pump & Machinery Corp., Harrison, N.J., announce the publication of bulletin W-205-B8 (two-stage type CPA) and bulletin W-205-B6B (single-stage type NPA). These two bulletins, 4 pp. each, provide illustrations, descriptive drawings and engineering data of these two types of steam-jet ejectors.

STAINLESS STEEL PANEL

A reprint from "Steel" describing and illustrating "Ludlite Bord," a stainless steel "Lumber" for all kinds of interior and exterior trim, has been issued by the Ludite Div. of Allegheny Ludlum Steel Corp. La Salle Builders Supply Ltd., Montreal, are distributors of this new product.

RADIO INTERFERENCE

A reprinted article from "Line" entitled "Prevention Easier Than Cure of Radio Interference" and illustrated by diagrams, is being distributed by Canadian Line Materials, Ltd., Toronto, Ont.

PUMPS AND SOFTENERS

Pumps and Softeners, Ltd., London, Ont., have issued three bulletins, in a binder, which contain complete descriptions of Duro shallow and deep well pumps (pneumatic water systems, hot water circulating pumps, condensation return units, cellar drainers, sump pumps) and Duro domestic water softeners and water conditioning equipment.

PUMPS

Bulletins 38-D, 58-C, 70-C and 76-H, entitled "Side Suction Centrifugal Pumps," "Vertical Steam Pumps," "Triplex Power Pumps," and "Small Size Self Oiling Power Pumps," have been published by The Smart-Turner Machine Co. Ltd., Hamilton, Ont. These bulletins are 8 pages each and contain illustrations, specifications and instructions.

POTHEADS

"Indoor and Outdoor Potheads" is the title of a thoroughly illustrated catalogue, No. 41-1, issued by Canadian Line Materials Ltd., Toronto, Ont., which contains reference data covering a wide range of types of potheads. Details of construction are clearly given and the features illustrated by descriptive drawings.

DRYER

"The Link-Belt Roto-Louvre Dryer" is the title of a 24-page catalogue, No. 1911, published by Link-Belt Limited, Toronto, Ont., which contains engineering data, photographs and installation drawings of this dryer. It is recommended for drying products of mine, chemical, process, food and agricultural industries and can be used also as a cooler.

DRILLING MACHINES

Describing and illustrating ten of the fourteen models of "Buffalo No. 18" drilling machines with chrome-nickel alloy spindles, Bulletin No. 3123, issued by Canadian Blower & Forge Co., Ltd., Kitchener, Ont., contains specifications, capacities and dimensional drawings.

CENTRAL ELECTRIC STATION OUTPUT

The chart, issued each year by Canadian General Electric Co. Ltd., Toronto, showing the kilowatt hour output of Canadian Central electric stations, contains the records from 1919 to the present.

CEMENT DISPERSION

In a 20-page pamphlet, The Master Builders Co. Ltd., Toronto, discuss the manner in which dispersing agents function in colloidal systems generally and describe the way in which this principle has been applied to cement. The pamphlet summarizes the effects of a dispersing agent on the properties of the hardened concrete or mortar.

AUTOMATIC CONTROLS

Designated as Catalogue No. 10, a 24-page book issued by Davis Automatic Controls Co., Toronto, Ont., illustrates the company's line of automatic controls with specifications in each case. This covers a wide range of controls for heating, refrigeration and industrial equipment.

MELBOURNE F. YULL

Formerly a partner in the firm of Potter & Company, Montreal, Mr. Yull has been appointed manager of the Montreal office of H. L. Peiler & Co. Ltd.

THE ENGINEERING JOURNAL

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REPORT OF THE COMMITTEE ON WESTERN WATER PROBLEMS

2050 Mansfield Street, Montreal,
April 26th, 1941

The Right Honourable William Lyon Mackenzie King, C.M.G., LL.D.
Prime Minister, Ottawa, Canada.

Sir,

The Engineering Institute of Canada submits herewith for the consideration of the Government of Canada the report of its Committee on Western Water Problems, dealing more particularly with the utilization of Canada's share of the waters of the international streams, the St. Mary and Milk rivers. If the projected irrigation development on these streams is to be proceeded with as a post war rehabilitation project the preliminary work will have to be commenced without delay. Therefore we suggest that early consideration be given to the appointment of the advisory board recommended in the report.

Respectfully submitted,

L. AUSTIN WRIGHT, *General Secretary*,
The Engineering Institute of Canada.

In 1935 the Council of the Institute appointed a committee under the chairmanship of G. A. Gaherty to study the problem of water distribution in the drought area of the western provinces. Subsequently a sub-committee was appointed, and between these two bodies a great volume of work has been accomplished. At the Annual Meeting of the Institute in Ottawa in 1939 eight papers were presented on this subject, as part of the work of the committee. Herewith is the complete report which was presented to Council on January 18th, 1941.—*Editor*.

The President and Council:

The Engineering Institute of Canada.

A progress report was presented to and accepted by Council on February 7, 1940, and was published in the Engineering *Journal* of March 1940. As indicated in the progress report, your Committee felt that the situation with respect to the international waters of the St. Mary and Milk rivers in Alberta and Montana had grown so pressing, that the Committee should devote its next efforts to a review of that situation, but without intending thereby to minimize the importance of other water problems of the West.

Also, in line with the progress report, a Sub-committee of western Members of the Engineering Institute of Canada was set up to assemble facts and arguments bearing on the matter.

The Sub-committee has been very active and has gone thoroughly into every phase of the situation and has explored all sources of information. In addition, the Sub-committee has been able to bring to bear on the subject the wide and long experience of its members, not only with the general conditions of the West, but also with the various phases of the subject itself.

The Sub-committee has produced and submitted to the Committee a most excellent and thorough report, which, together with a map, prepared for the Committee showing the areas involved and indicating the works proposed, is attached hereto, being exhibits as follows:

Exhibit A. The report of the Sub-committee, except—

Exhibit B. The paper in full by G. N. Houston, M.E.I.C., entitled "International Aspects of the Problem" attached to and a part of the Sub-committee's report, and

Exhibit C. The paper in full by D. W. Hays, M.E.I.C., entitled "Economic Development for Irrigable Land" which is also attached to and a part of the Sub-committee report.

Exhibit D. Map of portions of Alberta and Montana, showing sources of water and present and proposed irrigation developments.

The report of the Sub-committee and the other accompanying exhibits all bear directly on the St. Mary river and Milk river international situation and its solution through the development of the Lethbridge South-East Project. In addition, Mr. Hays' paper (Exhibit C) is of general application. He develops an important argument with respect to irrigation development and arrives at specific figures for allowable total costs and equitable allocation of costs. While there is room for difference of opinion with respect to his specific conclusions, there can, we believe, be general acceptance of the soundness of his reasoning, and of the method of his argument in arriving at conclusions.

The report of the Sub-committee is in such form that the Committee finds it desirable to incorporate it into its own report in full, rather than abstract and re-arrange the information it supplies. Therefore, your Committee recommends that the Sub-committee report, including the two papers by Mr. Houston and Mr. Hays, be published in full, together with the map, as parts of this report.

From the report of the Sub-committee, and from other sources, your Committee submits:

1. That the St. Mary and Milk rivers are international, that their waters are now partially used and can be fully used, beneficially, mainly for irrigation, but also, to some extent, for domestic and other purposes, by Canada and the United States together.

2. That the division of the waters between the two countries is governed by a treaty between Great Britain and the United States, dated January 11, 1909, and under the supervision of a permanent authority, the International Joint Commission.

3. That the International Joint Commission, after holding hearings over a period of about six years, made rulings under date of October 4, 1921, as to the methods of determining the allotment to each country, and on October 6, 1921, made certain recommendations regarding provision of storage reservoirs.

4. That either country may, for good and sufficient cause, ask for a re-opening of the matter and request modification of the regulations in its interest.

5. That since October 4, 1921, the waters have been divided between the two countries in accordance with the rulings, but that there has been no joint action with regard to storage.

6. That Canada's share of the waters of the two rivers allotted to her under the terms of the treaty as interpreted by the regulations of the Commission has averaged since 1922 about 393,000 acre-feet annually.

7. That Canada has been diverting and putting to beneficial use since 1935 an average of about 172,000 acre-feet annually, from the natural un-regulated flow of the St. Mary river and not more than 2,000 acre-feet annually from Milk river.

8. That Canada's share, still unused, amounts to an average of about 220,000 acre-feet annually.

9. That the Government of the United States has been and is proceeding diligently to use its share of the water of the two rivers. That works now constructed, in progress or contemplated are adequate to put to beneficial use all of its share and more.

10. That the general principle governing the right to the use of water for irrigation and other uses, in arid and semi-arid areas, is its application to beneficial use.

11. That, as a consequence, Canada, if she fails to exercise due diligence in putting her share to beneficial use, stands in danger of losing, in perpetuity, valuable rights allotted to her under the terms of the treaty.

12. That there is an economically sound method of beneficially utilizing Canada's share of these international waters.

13. That this utilization will create taxable wealth and a flow of trade far in excess of the cost.

14. That the utilization of this water in irrigating available lands will bring about an extension of intensive agriculture into one of the worst drought areas, a very desirable contribution to full national and provincial development, and a very substantial contribution to the solution of the perennial problems of drought, crop failure and relief costs.

With respect to the specific problems of water utilization, your Committee finds:

1. That it is economically desirable to associate the full development of the St. Mary river and the Milk river with plans for their common development with the waters of the Belly and Waterton rivers.

2. That it is quite feasible and relatively simple to carry the available waters of the Belly and Waterton rivers into the St. Mary river at a point between Cardston and Spring Coulee.

3. That it is feasible to create a storage reservoir of approximately 270,000 acre-feet capacity on the main channel of St. Mary river near Spring Coulee and below the point of inflow of the water diverted from the Belly and Waterton rivers.

4. That the proposed reservoir is ideally situated in that it will control the entire annual flow of St. Mary river below any important tributary, and that, together with the diverting works, canals and auxiliary reservoirs, it can conserve for beneficial use all of the available water of these three rivers, an estimated average of 760,000 acre-feet annually.

5. That after allowing for 210,000 acre-feet for lands already having irrigation rights, this amount of water will be sufficient to serve an additional area of 345,000 acres.

6. That there is an area of tributary land suitable for irrigation and intensive agricultural development very substantially in excess of the above area, which has been designated as the Lethbridge South East Project.

7. That the proposed development is economically feasible and is definitely related to national, provincial and local growth and self-sufficiency.

8. That climatic and soil conditions of the areas available for irrigation development are similar to those of the Lethbridge area. That crops that it is known can be grown to advantage under irrigation include alfalfa and other forage crops, sugar beets, potatoes, vegetables, and some fruits and coarse grains (as well as wheat), all of which lend themselves to building up intensive agricultural production and are important adjuncts to the livestock industry on adjacent grazing lands, as is so well exemplified in the present irrigated areas around Lethbridge and in other irrigated areas of the semi-arid region.

9. That there will be some important structures of large —but by no means unprecedented—size, and that the very considerable investigations already made indicate that there will be no serious foundation or other construction problems.

10. That the completed project will cost about $12,000,000 or not more than $40 per acre of irrigable land. That it lends itself to an orderly step-by-step development over a period of years. That its construction, in considerable measure, will lessen relief costs during the construction period and will thereafter result in the transfer of many farmers in the drought area from relief rolls to self-supporting, wealth-producing agriculturists.

Your Committee recommends that the Council of the Engineering Institute of Canada should, through the proper channels, suggest:

1. That the Dominion and Provincial governments, in co-operation, approve the development of the Lethbridge South East Project and constitute an agency for carrying out such development. That funds be made available for an early start on construction in accordance with a plan for orderly progress over a suitable period.

2. That an agency charged with development should, before final decisions are made with respect to important engineering structures and system layout, appoint an advisory board of engineers and at least one geologist to report on sites, foundations and designs.

3. That the same or another advisory board of engineers and economists be appointed to report on the joint engineering and economic aspects of the project.

4. That in the interest of allocating unused water to the best advantage, the Province of Alberta set up an advisory board to study this matter and advise the government. That pending the results of such procedure, action on applications for allotment of unappropriated water be deferred as far as possible.

Acknowledgments

Your Committee wishes to express its sincere thanks and appreciation to those persons and agencies who have given so much help to the Sub-committee and to whom the Sub-committee expressed its appreciation.

It also wishes to commend and express its appreciation to the members of the Sub-committee for their untiring efforts and for the splendid and valuable report they have rendered.

References

To the reader with limited interest, we suggest that the report of the Sub-committee should be read as part of this report in order to get a clear picture of the situation.

To those whose interest goes a little deeper, we recommend a reading and study of the two excellent papers by Mr. Houston and Mr. Hays.

To those who may wish to go more fully into the matter, a great many sources of information are available. Many papers on western water problems and related subjects have been presented to the Engineering Institute of Canada and published in its *Journal*. A number of these, dating back to December 1934, are indicated as follows:

1. Editorial—"Water for the Western Farmer," December 1934.
2. A symposium of twelve papers presented to the Annual Meeting of the Institute at Toronto, February 1935, published in April 1935, preceded by a short review of the papers, and followed by an editorial entitled "The Technical Aspects of the Western Drought Problem."
3. Two papers, one by Dr. E. S. Archibald, the other by Ben Russell, and an editorial on the work under the Prairie Farm Rehabilitation Act, May 1936.
4. "Irrigation Engineering" by S. G. Porter, June, 1937.
5. A symposium of four papers and four talks on Western Drought and Water Problems presented to the Annual Meeting of the Institute at Ottawa, February 1939. Three of the papers were published in the January 1939 *Journal* and the fourth, "Drought, A National Problem," by G. A. Gaherty, in the February 1939 issue.
6. "Stream Control in Relation to Drought and Floods" by P. C. Perry, June 1939.

Further information as to the papers and copies of the papers, or the *Journal* issues in which they appear, may be had by application to the General Secretary, Engineering Institute of Canada, 2050 Mansfield Street, Montreal.

Signed, on behalf of the Committee,

G. A. Gaherty, *Chairman.*

Dated, January 15, 1941.

EXHIBIT "A"

REPORT OF THE SUB-COMMITTEE TO THE COMMITTEE ON WESTERN WATER PROBLEMS OF THE ENGINEERING INSTITUTE OF CANADA

Preface

The Western Water Problems Committee of the Engineering Institute of Canada is much exercised over the situation developing in regard to the international waters of the St. Mary and Milk rivers. On the American side of the boundary, works are nearing completion that will enable the Americans to put to beneficial use not only the share presently allotted to them, but also water of Canada's share not put to use by Canada. As our right to the water is contingent upon our putting it to beneficial use with due diligence, we are likely to lose it forever unless prompt action is taken. This means that the existing irrigation users on the Canadian side will suffer a deficiency in water supply in perpetuity and that a tract of several hundred thousand acres south and east of Lethbridge that could be made highly productive under irrigation must continue permanently devoted to ranching or precarious dry farming.

The implications of the question are such that it is necessary to be sure of our ground. To this end, the Western Water Problems Committee nominated a Sub-committee to investigate the problem and prepare a detailed report setting out certain facts in so far as they can be ascertained.

The proposed diversions, storages and distribution systems to fully utilize Canada's share of the international waters supplemented by water from other sources as explained, and the lands served by them are collectively designated as the Lethbridge South East Project. For simplified layout, construction, operation and management it is probable that the existing irrigation systems diverting water from the St. Mary river and the lands served by them should be absorbed into the larger project.

Personnel

Members of the Sub-committee are:

F. G. Cross, m.e.i.c.,
Superintendent, Alberta Railway & Irrigation System,
Lethbridge, Alberta.

D. W. Hays, m.e.i.c.,
Manager, Canada Land & Irrigation Company Ltd.,
Medicine Hat, Alta.

G. N. Houston, m.e.i.c.,
Consulting Engineer (formerly Commissioner of Irrigation, Dominion Government),
Olds, Alberta.

P. M. Sauder, m.e.i.c.,
Director of Water Resources, Province of Alberta,
Edmonton, Alberta.

H. J. McLean, m.e.i.c. (Chairman)
Production Superintendent, Calgary Power Company Ltd.,
Calgary, Alberta.

Scope of the Report and Assignments

This report is directed primarily and particularly to a consideration of the proposed Lethbridge South East Project, and the utilization of Canada's share of the waters of the St. Mary and Milk rivers, in connection with which it is desirable to associate the developments of the available waters of the Belly and Waterton rivers and tributaries of the St. Mary river in Canada above the proposed St. Mary river reservoir.

Special assignments were made as follows:

(*a*) International Aspects to G. N. Houston.
(*b*) Economic Development to D. W. Hays.
(*c*) Water Supply to P. M. Sauder.
(*d*) Availability and Suitability of Irrigable Land to F. G. Cross.
(*e*) Engineering (with particular reference to the proposed St. Mary storage reservoir) to H. J. McLean.

Meetings

Three meetings of the Sub-committee were held:

First: At Calgary, May 22, 1940, at which Mr. S. G. Porter, member of the Committee, was also present.

Second: At Calgary, July 11, 1940, at which the following named members of the Committee were present: Messrs. G. A. Gaherty, chairman, S. G. Porter and A. Griffin.

Third: At Calgary, December 3, 1940. All members being present except Mr. Houston. Also present were Messrs. S. G. Porter and A. Griffin.

In addition, there were numerous meetings and consultations between two or more members of the Sub-committee and close contact was maintained with local members of the Committee.

Trips and Inspections

At various times, as opportunity permitted, all members of the Sub-committee, singly and in groups, visited the places and areas concerned and studied the various problems on the ground. In addition, Messrs. Hays, Houston and Sauder were able to bring to the various problems their intimate association with past investigations over a period of more than twenty years. Mr. Hays made a very exhaustive study of the same project some twenty years ago, reported fully by him under date of June 30, 1923.

Acknowledgments

1. To Dr. W. H. Fairfield, Superintendent of the Dominion Experimental Station, Lethbridge, for his opinions and advice as to the suitability of available lands for irrigation development.
2. To Dr. F. A. Wyatt of the Soils Department, University of Alberta, and staff, for Soil Survey Reports and other information supplied.
3. To the office of the Director of Water Resources, Province of Alberta.
4. To the reports of Surveys and Investigations over the past forty or more years by the Dominion Reclamation Service and other agencies.
5. To the Prairie Farm Rehabilitation Act (P.F.R.A.) organization and particularly to Mr. Ben Russell, Chief Engineer, Regina, and to Mr. W. L. Foss, District Engineer, Calgary, for access to the reports of the very extensive surveys, investigations and studies made during the past several years and for information and advice personally given.
6. To numerous others.

Reference

As evidence of the anxiety of the people of southern Alberta regarding the present water situation, reference is here made to the organization known as the South Alberta Water Conservation Council, formed October 4, 1939. The purpose of this organization is to secure the benefits of irrigation for their lands and communities and to impress upon our government the necessity of prompt action for the conservation of the water resources of southern Alberta and their complete agricultural utilization. More than 2500 farmers on irrigated land and more than 1500 farmers on drought-stricken land have subscribed to the funds of the organization. In addition, most towns, villages and municipalities and many business men in southern Alberta have also subscribed. It is a virile organization and has used every opportunity to bring the matter to the attention of our governments.

Submissions

(*a*) *International Aspects of the Problem.*

Mr. G. N. Houston has prepared a paper, which, on account of its thorough treatment of this important subject, is submitted in full, attached hereto. Following is a brief summary:

The author reviews the history leading up to the signing of the treaty of January 11, 1909, providing for the diversion of the waters of Milk and St. Mary rivers under the International Joint Commission. He quotes freely from the treaty, and from the proceedings and findings of the International Joint Commission.

The United States has developed storage and plans additional development in conformity with the spirit of the Commission's recommendations. The United States is now in a position to put Canada's share of Milk river water to beneficial use.

Approximately 50 per cent of Canada's share of St. Mary river water is now lost for want of storage facilities. Unless Canada proceeds promptly and actively to utilize her shares of the waters of these two rivers she will be left in a weak position to defend her claim to the rights to which she is entitled.

(*b*) *Economic development of Irrigable Land.*

Mr. D. W. Hays has prepared a paper dealing so thoroughly with this subject that it, also, is submitted in full, attached hereto. Following is a brief summary:

The author prefaces his paper by the statement that in the past history of irrigation development in Canada, the costs for development of irrigable lands have been based on the principle of repayment by the farmers who occupy the land. Recently and to the other extreme, it has been suggested that governments should build irrigation projects in the general interest of political economy without repayment of any capital costs by the farmer. The author states that both principles are wrong.

He indicates the advantages of irrigation farming: that a capable farmer can make a good living and a comfortable home on irrigated land and should be willing to pay in fair proportion to the benefits received and also indicates the advantages to governments in taxable wealth and concludes that benefits do accrue—

1. To the farmer who irrigates the land.
2. To local and regional centres in which developments are created and which aid through taxation in the maintenance of municipal and provincial government.
3. To the general development of the country at large by the business created, out of which the Dominion government gains by increased taxable wealth and the maintenance of employment and business activity.

The author states that past experiences show that irrigation districts, acting independently, cannot sell irrigation bonds without government guarantees and that private companies are not warranted in financing irrigation projects, limited as they have been to repayments by farmers only. He concludes that any future developments must be initiated and carried out by the provincial and Dominion governments or by one acting directly through equitable arrangements with the other.

In the event such developments are undertaken by governments, the author indicates the proportionate costs which should be shared by those benefited, the sum of which is the total permissible cost for irrigation development. He concludes that the share of the cost would approximate one-third to each beneficiary and that the total permissible cost would work out at $62.50 per acre. Making allowance for development cost during the transition period from initial development to completed settlement of lands, the author states, in round numbers, that $50 per acre is a permissible value for land and cost of irrigation works.

(*c*) *Water Supply.*

Mr. Sauder and the Sub-committee find:

That a safe, conservative estimate of the available water, on past records, is, in round numbers, as follows:

1. Canada's share annually, is—		
Milk river	36,000 acre-feet	
St. Mary river	357,000 "	393,000 acre-feet
2. Inflow into St. Mary river, north of international boundary		43,000 "
3. Combined flow of Belly and Waterton rivers, available and divertable to St. Mary reservoir		360,000 "
Total		796,000 "

NOTE: The greater part of the flow of St. Mary river originates in the high mountains of Glacier park in the United States. This is in an area of high precipitation with large snow fields which do not melt until early summer, and with a number of glaciers which contribute to late summer flow. The watershed of Milk river on the other hand reaches only to the foothills east of Glacier park. Precipitation is much less, snow runoff occurs in late spring and flow dwindles to the vanishing point in summer, except as revived by summer storms on the prairies and in the foothills.

After allowing for domestic and riparian needs and for estimated storage and transmission losses, this amount of water will adequately serve a total irrigable area of 465,000 acres, as follows:

Now served or entitled to be served with irrigation,	120,000 acres
Possible extensions	345,000 "

Up to the present time the only diversion from the St. Mary river in Canada has been by the Alberta Railway and Irrigation system, known as the A. R. & I., with headworks at Kimball, Alberta, a few miles north of the international boundary. There is no regulating storage, and diversion is limited to the day-by-day natural flow, or to the capacity of the canal (about 1300 cubic feet per second at the present time) depending on which is the lesser. This means, of course, that during periods when more than canal capacity is available, the excess must be wasted, while during the extended periods of low flow occurring each irrigation season there are severe shortages which limit both the area of land that can be irrigated and the effective use of such water as is available.

The lands which are irrigated through this system include not only the A. R. & I. lands but also the Magrath, Raymond and Taber irrigation districts. The Taber irrigation district is supplied from storage in Chin and Stafford reservoirs, which in turn are supplied through the A. R. & I. system. The irrigation of lands, except those of the Taber irrigation district, is wholly dependent on the day-by-day flow available to them. This leads, at times, to excessive use in times of plenty, in anticipation of shortages to follow —a crude and only partially effective method of conservation. During periods of shortage there is necessarily restricted and less effective use. This leads to excessive and inefficient use of the water supply as a whole, as compared with the economy and efficiency of the use of a regulated supply, such as would be provided by the adequate storage contemplated for the Lethbridge South East Project.

There has been a progressive increase in the capacity of the A. R. & I. diverting canal, so that for similar flow conditions of the river there has been some increase in the amount of water that can be diverted and beneficially used. During the four-year period 1936 to 1939 inclusive, the annual diversion has been from 152,000 to 195,000 acre-feet with an average of 172,000 acre-feet. Naturally, the amount that can be diverted depends on the total flow and its seasonal distribution. Unfortunately it is a fact that low total flow and poor distribution is associated with hot dry years when irrigation needs are greater. The capacity of the diversion canal is near its economic limit unless and until there is regulation by storage on the river above the diversion works (which is not very feasible, if at all, in Canada). In addition, there should be supplementary storage reservoirs within the irrigation system for best results.

Very little use has been made of Canada's share of Milk river water, the few existing licenses being for a total of only about 2,000 acre-feet annually.

(d) *Availability and Suitability of Irrigable Land.*

Mr. Cross and the Sub-committee find:

Within the area lying east of the St. Mary river and extending almost to Medicine Hat, and between the international boundary on the south and the Old Man river on the North, there are many tracts of land of good agricultural quality, in elevation below present and proposed diversions of water and capable of being served by such diversions and capable of being beneficially irrigated. Through investigations, surveys and studies over a period of more than forty years, areas suitable for irrigation development and capable of being served have been determined. Soil surveys have been made at various times by Dominion and provincial governments and other agencies. Quite recently and still in progress, are reviews of these earlier investigations as well as new and independent studies by the Prairie Farm Rehabilitation Act engineers. It is known that there is much more land suitable for irrigation and capable of being irrigated than the 465,000 acres which, it has been estimated, can be served by the available water. This land does not lie in one solid block, but is in tracts of various sizes only loosely connected to adjacent tracts, or in some cases completely separated by ridges or drainage lines.

The Alberta Railway Irrigation system has served a number of these tracts, beginning about forty years ago,

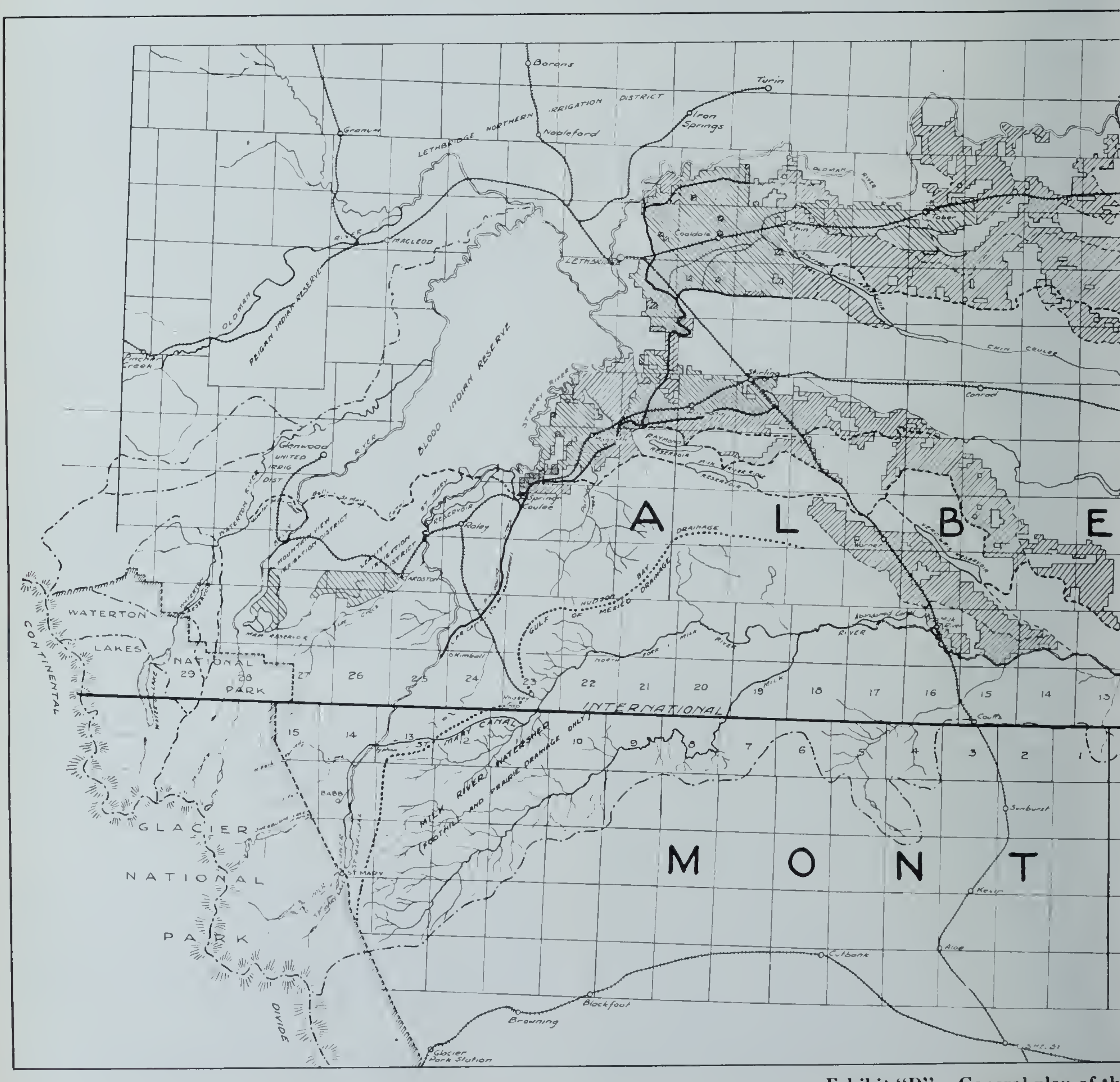


Exhibit "D" — General plan of the

either directly or indirectly through the Magrath, Raymond and Taber irrigation districts. The total area which can be served by this system (including the three irrigation districts), as approved by the government, is 143,661 acres, of which 120,193 acres received water or were entitled to receive water as of 1939.

All of these tracts are located within the arid or semi-arid portion of southern Alberta. Some, in the more favoured localities, are reasonably adapted to dry farming. The greater part are in the zone of precarious dry farming and a substantial portion are in the drought area, where relief conditions have been acute and there has been much abandonment by dry farmers. It is evident that it will be possible and desirable to exercise considerable discretion in choosing the particular lands that can be served to best advantage by the available water.

In addition to supplying full irrigation rights to most of the land to be served it is probable that it will be found desirable to devote a portion of the water supply to providing stock and domestic water and irrigation water for small isolated areas to serve the adjacent extensive ranching industry which will be permanent throughout the area.

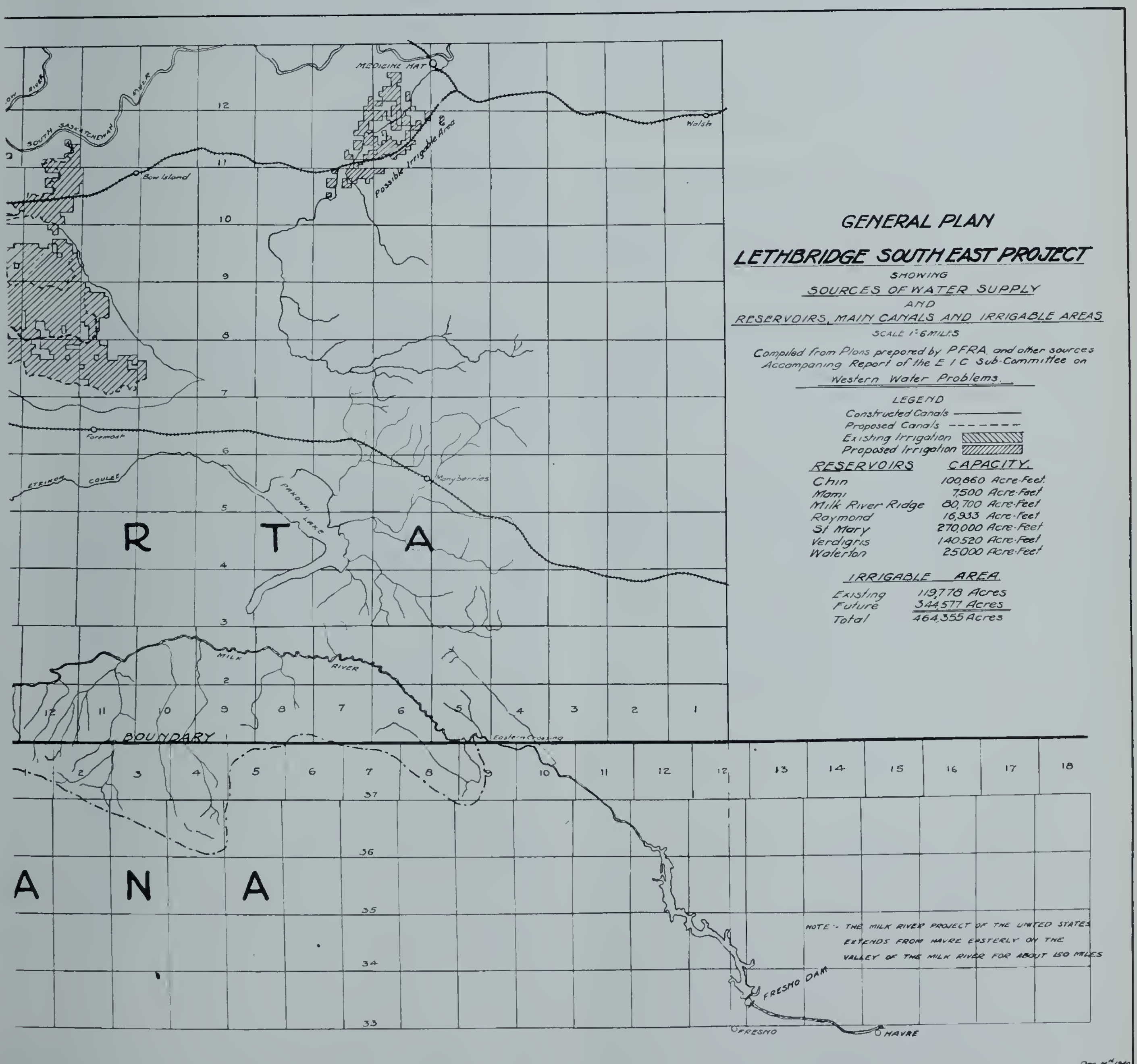
(e) *Engineering.*

Mr. McLean and the Sub-committee find:

The "works" for the Lethbridge South East Project would include a reservoir of 270,000 acre-feet capacity on the channel of the St. Mary river within Canada, at a point near Spring Coulee. This reservoir with appurtenant works would conserve the entire yearly flow of the St. Mary river passing into Canada, and also the substantial inflow from Lee creek and lesser tributaries in Canada.

A canal, of proposed capacity of 1100 cubic feet per second, would divert the available natural flow, within its capacity, from Waterton river into Belly river. A diverting canal of proposed capacity of 1700 cubic feet per second from Belly river would divert the water brought from the Waterton river plus the available natural flow of the Belly iver, within the capacity of this canal, into the St. Mar y reservoir. The estimated yield of these two rivers of 360,000 acre-feet annually is based on diversions during the ice-free period only and without the benefit of regulatory storage. A reservoir on the Waterton river storing 25,000 acre-feet is among the proposals, however.

A third diverting canal of 3,000 cubic feet per second



Lethbridge South East Project.

capacity would lead the accumulated waters of the three rivers easterly from St. Mary reservoir. Irrigable land would be reached within a few miles. A southerly branch would carry water into storage in Milk river ridge reservoir (80,000 acre-feet) and into Raymond reservoir (17,000 acre-feet). These two reservoirs command most of the irrigable land of the project, both proposed or now served. Water can also be diverted into Milk river ridge reservoir from Milk river and this may be done, unless, as is probable, a more satisfactory arrangement can be worked out involving an exchange with the United States of Milk river water for St. Mary river water.

Another branch of this diverting canal would join the A. R. & I. system, portions of which would need to be enlarged. This would supply the existing Chin reservoir which would be enlarged from 35,000 acre-feet to 100,000 acre-feet. These diverting canals from St. Mary reservoir would supply the distributing systems for certain tracts but the bulk of the new lands in the project would be served by distributing systems from the three supplementary reservoirs above mentioned. Under full development there will doubtless be other subsidiary storages provided in the lower portions of the distributing systems for special requirements of regulating flow, prevention of waste and salvaging of water that would otherwise necessarily be wasted.

Some of the main canals would be of large size and there would also be some rather large structures. However, there is nothing that will present any serious engineering or construction problem.

The reservoir on St. Mary river is a key feature to the whole project and the one that should be provided first. It also involves the largest and most important dam and other structures of the project and the ones presenting the most difficult engineering and construction problems. Therefore it is dealt with at some length.

St. Mary Reservoir

The investigatory work done by the Canadian Pacific Railway, the Reclamation Service, Mr. D. W. Hays and the P.F.R.A. indicates that a large storage reservoir on the St. Mary river, north of the international boundary, would be most desirable to conserve spring run-off and winter flow of the river. In 1938 a reconnaissance survey of the river was made by Mr. W. L. Foss, District Engineer, P.F.R.A., to investigate the possible and practicable storage sites on the St. Mary river. This survey indicated that a former suggested site between Spring Coulee and Magrath, would require a very high dam (height 225 feet) for a relatively small storage of approximately 100,000 acre-feet. Also, an outlet tunnel approximately three-quarters of a mile in length would be required to deliver water to the canal. Another site near Raley (Sec. 34-4-24 W. 4th M.) would provide approximately 250,000 acre-feet of storage, but would be relatively expensive owing to canal location which would involve heavy cuts. The P.F.R.A. concluded that both of these sites would be more costly per acre-feet of storage water than the one now selected near Spring Coulee which they find is a favourable site to meet all requirements.

A preliminary topographic survey has been made of the Spring Coulee site, also some test borings taken, which information permitted working out a tentative design for the purpose of obtaining cost estimates. This preliminary design is for an earth fill dam 186 feet in height with crest length of 2,600 feet and net effective storage of 270,000 acre-feet. The cost of the dam is estimated at $3,445,000 and the construction of the irrigation works complete to the existing A. R. & I. canal would bring this total to $3,800,000. An alternative design for a concrete gravity dam indicated that the cost would be approximately thirty per cent greater.

The St. Mary reservoir and outlet canal would be the first step in extension of the Lethbridge South East Project. It has been estimated that the total cost of the complete project would be approximately eleven to thirteen million dollars which would represent a cost of from $30 to $35 per acre of irrigable land. P.F.R.A. engineers are continuing the study of various alternative designs, methods and procedures.

A few remarks follow as to certain features of the proposed St. Mary reservoir dam:

(*a*) *Foundations.*

Additional test pits are required to permit study of the quality of the foundation rock, also the dip and strike of the strata for projection to areas not proved by test holes. Dr. R. T. D. Wickenden, Dominion Government Geologist, has the information obtained to date and it is expected that he will make a field examination and a thorough study of the sub-surface conditions at the proposed dam site and reservoir. This information is urgently needed since it will have an important bearing upon the type and design of structure proposed for the site.

(*b*) *Unwatering.*

The unwatering tunnel now being considered would be set on foundation rock and the upstream section of this would be sealed off by concrete, after completion of the structure, leaving an intake penstock through the concrete plug for the purpose of water supply to the small hydro-electric unit planned for the utilization of water discharged for riparian rights.

(*c*) *Intake to Irrigation Canal.*

As an alternative to the vertical pressure section and tunnel leading to the irrigation canal as shown in the P.F.R.A. design it is now proposed that the intake for the canal be placed on the bed rock at Contour 3538 with the intake entrance near the upstream heel. This conduit would be covered by the earth fill dam and the flow controlled by suitable regulating equipment.

(*d*) *Overflow Spillway Dam.*

A concrete spillway dam located at the north end of the bed rock would be provided with a concrete apron and chute to discharge approximately 36,000 cu. ft. per sec. at full supply level through stop log openings. Excavation at the site of the spillway dam would provide material for the earth fill structures.

Fairly detailed designs of the above listed features will be necessary before arriving at cost estimates, which are expected to be considerably less than those shown for the original design. The rolled earth fill dam would have a volume of approximately 3,200,000 cu. yd. and the volume of concrete would amount to 48,000 cu. yd. The earth fill material available on the north bank should be carefully tested and analyzed for both core material and side berms and it is noted that gravel supplies are not assured as yet.

It will be noted that it is planned to provide a spillway capacity of 36,000 cu. ft. per sec., which appears ample in view of the maximum recorded flow of 18,000 cu. ft. per sec. at Kimball in 1908, to which should be added the simultaneous flood flow of Lee Creek and intervening tributaries which are liberally estimated at 5,000 cu. ft. per sec. A further factor of safety lies in the fact that the flood stages are of short duration and occur at a time of the year when, under ordinary operating procedure, the St. Mary reservoir would have been lowered by the transfer of water to the lower reservoirs of the system. Another safety factor arises from the annual spring snow surveys from which close estimates are made of the total probable summer yield of the watersheds, and reliable information is obtained as to the probable magnitude and duration of normal flood flow.

Suggested Plan of Development

The Sub-committee finds:

The Lethbridge South East Project lends itself to a step-by-step orderly development over a period of years.

The first step should be an immediate start on construction of St. Mary reservoir, followed by a first stage in the construction of the diverting canal from the reservoir and first units of the distributing system. This will enable Canada to fully control the flow of the St. Mary river and put it to beneficial use and will constitute due diligence on her part. It will probably be found economical to complete the St. Mary reservoir and appurtenant works in one continuous operation. The 3,000 cu. ft. per sec. diverting canal can probably be built to a lesser capacity, with future enlargement, in two or three stages as required. Units of the lower storage system can be provided as required. The distribution systems to the various tracts can be built in units as land settlement and development proceed.

At a later stage the diverting canal from the Belly river can be provided and still later the diverting canal from the Waterton to the Belly. If it proves feasible and desirable to provide regulating storage on the Belly or Waterton rivers (or both) this would find its suitable place in a later stage of the plan.

The final place of Milk river in the plan is somewhat obscure due to the fact that it can be fitted in, in several different ways. It is quite feasible from an engineering standpoint to divert and use Canada's share of Milk river. However, it is a flashy stream with very little available to Canada during the irrigation season. It is not feasible to use it effectively without providing regulating storage on the main river, or alternatively, an unduly large diverting canal by means of which water could be carried into the proposed Milk river ridge reservoir. Both of these methods are relatively expensive. They are further complicated by the fact that Milk river in Canada carries United States water diverted from St. Mary river (as provided by the treaty and its regulations) and during much of the irrigation season this constitutes the bulk of the flow in Milk river. By far the larger portion of the flow of Milk river is allocated to the United States. The United States has provided, by Fresno dam, across the channel of Milk river, near Havre, Montana, a reservoir capable of storing more than the entire average annual flow of the Milk. This reservoir is capable of further substantial enlargement and the Chain-of-Lakes reservoir adjacent to Milk river is still being considered. In addition, the Nelson reservoir lower down the Milk river project in Montana provides an additional means of conservation of the Milk river flow as regulated by Fresno dam reservoir.

Since practically all land in Canada irrigable from Milk river can also be supplied from St. Mary river as a part of Lethbridge South East Project at lesser cost and with less probability of international complications, it would seem desirable to arrange an interchange with the United States of at least most of Canada's share of Milk river for a corresponding share of the United States rights in St. Mary river. The Verdigris Coulee reservoir, into which water can be diverted from Milk river and from which it can be returned to Milk river, has been proposed as an instrument of such interchange, but with the storage now provided and contemplated by the United States, it is, possibly, not of further interest.

SIGNED, on behalf of the Sub-committee,

H. J. McLEAN, *Chairman.*

Dated at Calgary, December 14, 1940.

EXHIBIT "B"

INTERNATIONAL ASPECTS OF THE SOUTHERN ALBERTA IRRIGATION PROJECT

G. N. HOUSTON, M.E.I.C.
Consulting Engineer, Olds, Alta.

History

The early settlers in the eastern States and provinces came principally from humid countries where the rainfall was sufficient to mature crops and they found the conditions in this new country similar to those to which they had been accustomed. There was no need of their using water from the streams for irrigation as the rainfall was sufficient. So the common law of riparian rights came with them. Briefly this allows an owner of land on a non-navigable stream to use the water flowing past his property providing he returns it to the stream practically undiminished in quantity and unpolluted in quality.

As settlement pushed westward to the semi-arid parts of the country, it was found necessary to divert water from the streams on to the land in order to mature agricultural crops or increase their yield. Most of this water being absorbed by the plants could not be returned to the stream, the volume of which was depleted by this amount and the lower riparian owners deprived of its use.

The settlers were obliged to abandon the law of riparian rights and adopt from the old Roman law the doctrine of prior appropriation and beneficial use which at present is the basis of all irrigation law. In brief this is as follows:

The appropriators of water from a stream are granted priority for its use in the order of their respective dates of appropriation: i.e., first in time is first in right, provided they proceed with due diligence to put the water to beneficial use. This basic principle is recognized wherever irrigation is practised in the United States and Canada. Between 1890 and 1904, surveys had been made and water appropriated for the irrigation of certain lands in Montana from the Milk river. Some of this land had been settled and irrigation started. The Milk river rises in the United States and flows north into Canada, thence easterly through Alberta some 210 miles, then turns south across the international boundary again into Montana and thence into the Mississippi river drainage. During the same period in Alberta, the Dominion government had granted an appropriation of 500 cu. ft. per sec. from the flow of the St. Mary river to the Canadian Northwest Irrigation Company for the irrigation of a block of land in the vicinity of Lethbridge. The St. Mary river rises in Glacier park, Montana, and flows north across the boundary into Alberta and thence into the Hudson bay drainage.

The Company completed some 90 miles of main canal from its head gates near the international boundary to Lethbridge.

In 1904, the several companies which were interested in the development of the lands, coal mines and irrigation in southern Alberta merged, forming the Alberta Railway and Irrigation Company (later acquired by the Canadian Pacific Railway Company).

This Company was granted a priority on all surface water supplies in southern Alberta which might be used, as development progressed to irrigate their land.

In 1904, they built a diversion dam in the Milk river and a canal running north to irrigate land in the vicinity of the towns of Milk River and Warner.

The early investigations on the United States side had shown that additional water for irrigation of the lands of the settlers in the lower Milk river valley could be obtained from the St. Mary river by an all United States canal, but estimates of cost showed this to be a very expensive development and it was decided to construct the canal only as far as the head waters of the Milk river in the United States. They would then use the Milk river channel as a conduit to run the water to their irrigation projects in the lower valley. This contemplated running the water through the 210 miles of river in Canada.

The building of this irrigation canal from the Milk river, by the Alberta Railway and Irrigation Company in Canada, immediately raised a protest from the United States settlers, that this would interfere with the proposed development on their side of the line; and they appealed to their government to protect them.

It should be noted that no water had been run from the St. Mary to the Milk river at this time, as the United States did not complete its 29-mile canal until 1916. The result of this protest is Article VI of the treaty entered into between the two countries on January 11th, 1909. This article is as follows:

"The High Contracting Parties agree that the St. Mary and Milk rivers and their tributaries (in the State of Montana and the Province of Alberta and Saskatchewan) are to be treated as one stream for the purpose of irrigation and power, and the waters thereof shall be apportioned equally between the two countries; but in making such equal apportionment, more than half may be taken from one river and less than half from the other by either country *so as to afford a more beneficial use to each.* It is further agreed that in the division of such waters during the irrigation season, between the first of April and the thirty-first of October, inclusive, annually, the United States is entitled to a prior appropriation of 500 cu. ft. per sec. of the waters of the Milk river, or so much of such amount as constitutes three-fourths of its natural flow, and that Canada is entitled to a prior appropriation of 500 cu. ft. per sec., of the flow of St. Mary river, or so much of such amount as constitutes three-fourths of its natural flow."

"The channel of the Milk river in Canada may be used at the convenience of the United States for the conveyance, while passing through Canadian territory, of waters diverted from the St. Mary river. The provisions of Article II of the treaty shall apply to any injury resulting to property in Canada from the conveyance of such waters through the Milk river."

"The measurement and apportionment of the water to be used by each country shall from time to time be made jointly by the properly constituted Reclamation Officers of the United States and the properly constituted Irrigation Officers of His Majesty under the direction of the International Joint Commission."

The division of water between the two countries proceeded under this treaty until 1915. The United States Reclamation Officers and the Irrigation Officers of the Dominion of Canada however were not able to agree as to the manner in which the waters of the two rivers should be measured. So the International Joint Commission, under whom they were working, decided that before making a ruling in the matter it would be proper to hear such representations and suggestions thereon as the parties concerned might see fit to make. To this end the Commission held several meetings during the years 1915 to 1921, inclusive, at various points in United States and Canada. At these meetings the governments of United States and Canada, the provinces of Alberta and Saskatchewan and various corporations and individuals appeared and presented their views. As a result of these hearings, the International Joint Commission, on October 4th, 1921, handed down a unanimous decision, interpreting Article VI of the treaty and ordering the division of the waters to proceed in accordance with certain rules which they presented. In brief these are as follows:

RULES

1. During the Irrigation Season.
   (a) When the flow in the St. Mary river at the international boundary is 666 cu. ft. per sec. or less, CANADA gets ¾ of the water. UNITED STATES gets ¼ of the water.
   (b) When the flow exceeds 666 cu. ft. per sec. CANADA gets 500 cu. ft. per sec. UNITED STATES gets 166 cu. ft. per sec. The balance is divided equally between the two countries.
   (c) When the flow in the Milk river at the easterly crossing of the international boundary, is 666 cu. ft. per sec. or less, CANADA gets ¼ of the water. UNITED STATES gets ¾ of the water.
   (d) When the flow exceeds 666 cu. ft. per sec. CANADA gets 166 cu. ft. per sec. UNITED STATES gets 500 cu. ft. per sec. The balance is divided equally.
2. During the Non-Irrigation Season.

   The flow of each river is divided equally at the boundary.
3. The tributaries of the Milk river, rising in Saskatchewan, (Battle creek, Lodge creek, Frenchman river etc.) and joining the main river in the United States beyond the easterly crossing are each divided equally at the boundary.
4. The flow in tributaries not naturally crossing the boundary are apportioned to each country.
5. Gives the methods in detail by which the flow at the boundary is to be computed.
6. 7. Directs where gauging stations are to be maintained.
8. Directs the reclamation and irrigation officers to make such additional measurements and take such further steps as may be necessary or advisable to insure the division of said waters as directed and "to operate the irrigation works of either country in such a manner as to facilitate the use by the other country of its share of said waters and subject hereto, *to secure to the two countries the greatest beneficial use thereof.*"
9. Disagreements are to be reported to the Commission.
10. Cancels a former order.

Two days later, October 6th, 1921, the Commission made certain recommendations regarding *storage of waters of the St. Mary and Milk rivers*, which in brief are as follows:

After a very thorough investigation they find *that the quantity of land in each country susceptible of irrigation development from the St. Mary river and Milk river and their tributaries far exceed the capacity of the rivers, even under the most exhaustive system of conservation.*

In order to avoid misunderstanding between the two countries it is therefore of greatest importance *"that every effort should be made to obtain maximum efficiency in irrigation from these waters"*; the Commission therefore recommends:

1. That the United States, in addition to the Sherburne Lake reservoir already constructed on the headwaters of the St. Mary, proceed to build the proposed Chain-of-Lakes reservoir in the Milk river valley, Montana, below the easterly crossing.
2. That Canada construct their proposed Verdigris reservoir on Verdigris Coulee in Canada.
3. That the construction of a dam at the outlet of the St. Mary's lakes in Glacier park which was proposed by the United States Reclamation Service, for creating storage for their own use, be made an international reservoir, the cost of construction to be borne jointly by the two countries and not charged against any particular project.

The title to the reservoir to be vested in the United States government.

4. In the opinion of the Commission the operation of these reservoirs under their direction would make it possible to conserve the entire winter flow and flood waters of the St. Mary and Milk rivers.

From 1922 to 1938, inclusive, the division of these waters proceeded under the rules of the Commission but none of their recommendations regarding storage of water was carried out. Notwithstanding the fact that the United States was operating Sherburne Lake reservoir on the head waters of the St. Mary, they were only able to make beneficial use of an average each year of 51 per cent of their share of the water. Canada without any storage during the same period used an average of only 46 per cent of its share. That is, 52 per cent of the average flow in the St. Mary river each year was going to waste.

It is quite evident from this that storage of the St. Mary river water is very necessary in both countries in order to get the maximum beneficial use of the water.

The Canadian Reclamation Service, from 1913 to 1921, made a survey of some 350,000 acres, known as the Lethbridge Southeastern Project, and in their 1921-22 report in connection with this project, recommended a storage site on the St. Mary river in Section 34, Township 4, Range 24.

Nothing was done toward developing this site, however, largely on account of the recommendation of the Commission for the joint development of St. Mary's lakes which would probably have been cheaper.

The development of St. Mary's lakes was not carried out however, partly because of the great distance the water would have to run (some 500 miles) before reaching the land to be irrigated on the United States side, and partly because of the general public sentiment in the United States against development of natural lakes in national parks as reservoirs, for fear of destroying their scenic beauty. In 1938, the United States completed the Fresno reservoir located a short distance below the site of the Chain-of-Lakes reservoir recommended by the Commission. This solved the storage problem for them and as a result they were able to use, last year, nearly 100 per cent of their share of the St. Mary water. Apparently they have not abandoned the development of the proposed Chain-of-Lakes reservoir for still more storage. The following excerpt from the *Reclamation Era*, May, 1940, page 138, presents their view of the matter. (This is an official publication of the United States Reclamation Service.)

"Construction of the Fresno dam and the creation of the Chain-of-Lakes reservoir, will not only supply additional water for the system, but it will help control the periodic floods of the river. The towns of Havre, Chinook and Harlem will use water and the Utah-Idaho Sugar Company has agreed to a contract for water. Success of the development plans for the entire valley depends directly upon this unit of the irrigation system."

Since the United States abandoned the proposed storage in St. Mary's lakes, Canada, through the Prairie Farm Rehabilitation Act organization, has located a storage site on the St. Mary river, on the Canadian side of the line.

This location is a short distance below the site recommended by the Canadian Reclamation Service in 1922.

With regard to the Milk river: the natural flow of this stream at the easterly crossing of the boundary rarely carries as much as 500 cu. ft. per sec. for any considerable length of time. Occasionally there are floods which carry double this amount but they subside rapidly. Canada's share is only one quarter of the usual flow. We have used a very small amount of this. There are no large projects taking water from this source, only a few individual farmers. The Milk river canal, previously mentioned, built in 1904, never ran water except to test the canal. The diversion dam has washed out and the canal has been abandoned.

On the eastern tributaries in Saskatchewan of Milk river the ruling provides that each shall be regarded as a separate stream and the flow divided equally at the boundary. Up to 1938 on this side of the line there were only a few individual farmers using water and no record was kept of the total amount. By 1938 however, the P.F.R.A. had developed two large projects on the Frenchman river, which, together with the existing diversions, used about 34 per cent of our share of the flow in this stream. Last year (1939), some 9,000 acres more had been added to the irrigated land on these streams and we used: on Frenchman river—15 per cent of our share: on Lodge creek—5 per cent of our share; on Battle creek—114 per cent of our share. It will be noted that we overdrew our account on Battle creek last year. The total flow last year on these three largest tributaries was about 144,000 acre-feet of which our share was 72,000. Of this we used a total of 22 per cent. It should be noted that the division of flow of the eastern tributaries has no direct bearing on the division of flows of Milk river west of the eastern crossing and St. Mary river.

Present Situation

This brings us up to the present situation, which is as follows. In view of the large area covered by the proposed Lethbridge Southeastern Project, Canada has proceeded with due diligence, from the time of its inauguration of the project in 1913, to the completion of the surveys and estimates in 1922, in preparing to put to beneficial use its share of the St. Mary and Milk rivers, so apportioned by the treaty.

Storage of the St. Mary waters was recognized as essential to this scheme and was provided for in the surveys.

The Joint Commission's recommendation, for the joint development of the St. Mary's lakes for this purpose, introduced a new element into the problem.

Owing to the delay and final abandonment of this solution by the United States, progress was held up in Canada by causes beyond its control.

There would have been little use in proceeding with the construction of the recommended Verdigris storage, as the chief value of this reservoir would be to store Canada's share of the Milk river together with water from other sources not available to the United States, to trade for additional water from the St. Mary.

Neither United States nor Canada was in a position then to use this additional water. Up to 1938, each country was able to use only about 50 per cent of its share of the St. Mary water.

With the completion of the Fresno reservoir by the United States, however, the whole situation has changed. They have put themselves in a position to use all of their share and more if available. The treaty cannot be enforced like an Act of Parliament. It is more in the nature of a gentleman's agreement. There is no time limit for its duration. Either party may repudiate the agreement and ask for a reconsideration of the whole matter if it is thought the terms are working against their interests.

At the time of signing, both countries had the same very definite object, namely, the maximum beneficial use of the water by each country. They were satisfied at the time that the terms of the treaty would produce that result.

In endeavouring to carry out the terms, however, many difficulties arose. In the discussion of these troubles before the Joint Commission in 1915, F. H. Newel, consulting engineer for the United States Reclamation Service, expressed the United States view as follows:

"In making the apportionment, therefore, the operation is to a certain extent simplified by being confined to a consideration of the water which may be used either by *direct diversion or storage.* On the other hand, *it should not be assumed that because one country is not prepared to use one-half of the water therefore the other country must be deprived of the use of any portion which otherwise would be wasted.*"

The water which Canada is wasting at present would supply not only the present settlers with much needed late water, but would irrigate at least one hundred thousand acres (100,000 acres) additional land.

Now that the United States is prepared to use its full share and more if available, we may expect that a revision of the treaty will be requested with the idea of getting some or all of Canada's share which is now going to waste, unless Canada proceeds promptly to put it to use.

In the event of a reconsideration of the whole matter, Canada would be in a very weak position to defend its claim to more than 50 per cent of the water to which it is entitled under the treaty, on the grounds of beneficial use, unless it is proceeding with an orderly development, and might lose this water to the United States permanently. There are other complications which might arise in the event of a reconsideration, which need not be considered here, but which make it very desirable to maintain the *status quo*.

It is, therefore, very essential to the future development of southern Alberta that storage be provided immediately on the St. Mary river, so that water for the gradual development of the Lethbridge Southeastern Project can be assured.

NOTE: (Use of italics in quotations is by the author.)

Olds, Alberta, December 10, 1940.

EXHIBIT "C"

ECONOMIC DEVELOPMENT FOR IRRIGABLE LANDS

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Some centuries ago farmers of the day used tread mills or buckets attached to sweeps to draw water from the Nile or the Yangtze rivers to sustain meager crops on a thirsty soil. The method was crude and the work hard but the farmers gained a living for themselves and their families. The kings of Babylonia built canals to irrigate lands in the valley of the Euphrates, thereby aiding to supply the food required for the subjects of an empire. They, too, knew the value of irrigation. From these early beginnings, irrigation has progressed throughout the centuries until today we have such massive monuments to the value of storage, irrigation and power as the Boulder and Grand Coulee dams with probably still larger projects to come.

Millions of dollars have been spent on irrigation projects and great countries have been enriched by the developments. Their useful purposes have been manifested. They serve a dual purpose, firstly, in the direct benefit to the individual who creates a farm home; secondly, in benefit to governments through increased taxable wealth and to all citizens in the many channels of trade and business activity. These interlocking benefits are generally recognized. To the uninitiated they are a misty apparition. To those close to the subject they are real though diffused and not in all respects tangible in the threads leading by many ramifications, in and out, to sundry political and commercial centres.

In the past history of irrigation in Canada, the costs for development of irrigable lands have been based on the principle of repayment by the farmer who occupies the land. Recently and to the other extreme, it has been suggested that governments should build irrigation projects in the general interest of political economy without repayment of any capital costs by the farmer. Both principles are wrong.

As to the first principle, no large project can be built with its attending development costs and be paid for with interest by the farmer. Private companies and bonded irrigation districts have learned this by sufficiently heavy losses. This principle, if it were to be fulfilled, would limit development to small projects cheaply built and easily settled, if these can be found, and ignore the value of the business accruing from them for which something should be paid by the public.

As to the suggestion that governments should build projects with no repayment of costs by the farmer, this foreshadows bad complications. Primarily it implies a gift of land or a water right or both to individuals favoured with irrigable land, on which they can make a living, as compared with the individuals who must buy land for purposes of dry farming which has less agricultural attributes. It discounts the property value to those who now own or have an equity in irrigated lands and in turn, by direct implication, further reduces if not destroys the value in property and irrigation works of company projects and irrigation districts. Moreover and perhaps of significant importance, there are the political repercussions which may thrive on patronage of this sort.

Reasons for Irrigation Development

It is known that a capable farmer can make a good living and a comfortable home on irrigated land. He is an independent and self-supporting citizen. Were he to buy land outside of an irrigated area, it would cost him money with less favourable prospects for sustained agricultural progress. Therefore irrigated land, properly farmed, is worth something to the farmer, for which he should be willing to pay in fair proportion to the benefits received.

From a provincial standpoint, it is evident that taxes on highly productive lands will exceed the taxes on sparsely settled lands in stock leases and on lands where poor crops are the rule rather than the exception. Government stock leases bear a combined rental and tax levy of about 4 cents per acre per year. On good productive farm lands the taxes average 30 cents or more per acre per year.

On dry farmed lands in the drought areas large sums of tax arrears remain unpaid and from time to time are written off. Likewise advances for various forms of relief remain unpaid and also must be written off. This is an unavoidable waste of money so long as dry farming is permitted in these areas.

The following figures are informative as related to four municipalities for the year 1937:—

Total population 3,964 individuals; total relief in seed grain, clothing, food and tractor fuel supplied in 1937 was $250,344.00. Taxes levied $86,552.00, amount unpaid $77,377.00. The year 1937 was very dry but every year has its deficits with poor prospects of meeting current yearly costs let alone paying arrears. The losses represent huge sums of money over a period of years about which both the provincial and Dominion governments are aware and gravely concerned.

In contrast to the above, lands having an appreciable area under irrigation and with similar soil and climatic conditions, have a population per square mile many times as large, have assessed land valuation five times as much per acre, create agricultural and live-stock wealth approximately ten times as great, promote and support general business activity proportionately larger and impose little or no burden on the governments for relief.

If some of these lands in the drought areas were irrigated or the inhabitants placed on irrigated land, capital costs as applied to irrigation would convert waste to profitable use, aid in the rehabilitation of farms and farmers and create an asset for posterity. Irrigation potentialities in Alberta of say 500,000 acres would supply irrigated farms to 3,500 or more families or enough to take care of a large part of the farmers in the drought areas of the province.

Benefits of Irrigation

Presuming it is recognized that general benefits do result from irrigation and that development is warranted as a government undertaking, it is the purpose of the author to assess the value of these benefits to individuals and to the public at large as a basis for a fair proportional repayment of the costs involved.

It is apparent that any payments of cost made by the public would be through taxation. It is therefore pertinent to this subject that some analysis be made as a basis for taxation. There is an old saying that for each family engaged in primary production there is a family engaged in the disposal of that primary production. This provides for the building of urban towns and regional cities, local and distant merchandizing and manufacturing centres, railways, elevators, etc., all subject to taxation.

It is a principle of political economy that production is a measure of national wealth and the distribution of that wealth is the basis of trade and commerce. Governments build railways, roads, waterways, buildings, etc., to facilitate the movement of commerce. Railways have been subsidized by land grants in the interest of national development. It is axiomatic that outgoing shipments of one product create an important movement of other products. One is essential for trade with the other. The products of irrigated farms are exchanged for other food products, textiles, machinery, etc. This in itself creates an exchange for the value of primany farm products. But there is still a further value which exists in excess of the amount received by the farmer for his primary product. This is represented in various services and functions, paid for by the ultimate consumer, for transportation, marketing, merchandizing and in outside manufacturing using raw farm products.

For example, it is the difference in the value of a bushel of wheat sold by a farmer, say in Alberta, and the value of the flour, shorts, bran, etc., obtained from the bushel of wheat plus containers, sold to a consumer living, say in Montreal. The primary product has undergone transportation, processing, wholesale and retail salesmanship, by which an earned increment in value has been created. These various functions require land, rails, elevators, buildings, equipment, which are built and enhanced in value because of primary production. If production should cease, in part or whole, of which we have examples in drought years, employment and capital values decrease. Conversely new agricultural development creates new wealth; in land, in urban and regional centres, in transportation, power and manufacturing at distant places. These are taxable as they may now exist and would sustain increased taxation arising out of business improvements or enlargements and by new development.

In recent years, a Royal Commission was appointed in Alberta to enquire into all phases of irrigation development in the province. In the course of their findings they made the following statement:—

"The Commission has been made fully aware that irrigation authorities now agree that the full capital costs of an irrigation project should not be charged up to the land fully benefited. The conversion of a non-productive area into lands intensively farmed, benefits not only the irrigation farmer but also the community, the Province and the Dominion, as well as many private enterprises such as railways and factories."

In respect to the above, it may be added that in irrigation districts in California and other states where urban values are taxed, they bear 25 to 35 per cent of the operation and maintenance costs and interest charges of the districts. This is the same approximate proportion which the increments in local urban land values bear to the total local value created.

On this subject other information goes to show that the increment in total values approximates five times the increment in farmed lands. It is known also, in irrigation districts, that the farmed land itself is generally placed as the sole security of bonds for irrigation works. In other words the farmer who may realize 20 per cent of the total values created is called upon to pay the whole costs for irrigation. This position is untenable as evidenced by the amounts of capital costs which have been written off in irrigation districts and by the private companies in reducing costs to the farmer to a point within his means. In the case of irrigation districts in Alberta, whose bonds have been guaranteed by the province, the amounts written off have been sustained by the public through taxation—a procedure which could have been anticipated had the views of relative responsibility for costs as indicated by this paper, been in effect when the districts were first started. In the case of private irrigation projects, the amounts written off have been sustained as a loss.

Proportionate Benefits of Irrigation

It will be recognized that benefits accrue to the farmer, to local urban and regional centres of business and to the country at large. These are broad conclusions. The details leading to such conclusions are greatly involved in the intricately woven fabric which makes up the country's business.

It is not difficult in an abstract way to arrive at a value of the farmers' primary production having regard to average yields and average prices. It is also not impossible to obtain a figure up to a point, which would fairly represent the earned increment in value of a certain processed raw product, ultimately paid for by the consumer. For example, in the case of a bushel of wheat grown in Alberta and its equivalent in flour or breakfast food sold, say in Montreal. Flax may appear as oil and oil-cake, and sugar beets as sugar or syrup. But to proceed further brings in complications. Oil may go into paint, soap or shoe polish and be shipped back to the point of the original flax production. Oil-cake may be fed to cattle locally and appear as beef on a consumer's table at some remote point.

Further illustrations of a complex problem are unnecessary and it is sufficient to say that details are not available to the author. It is, however, apparent that ultimately through many ramifications, benefits do accrue to:—

1. The farmer who irrigates the land.
2. To local urban and regional centres in which developments are created and which aid, through taxation, in the maintenance of municipal and provincial governments.
3. To the general developments in the country at large by the business created in transportation, marketing and processing primary farm products, for which the ultimate consumer pays, and out of which the Dominion government gains by increased taxable wealth and the maintenance of employment and business activity.

Division of Benefits

In a paper presented by Mr. Walter E. Packard at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers, the author deals with the economic feasibility of the Columbia Basin Project in the state of Washington. This project contemplates the irrigation of 1,200,000 acres of land. He predicts the ultimate value of the primary farm product (the price that would be paid by the consumer) and makes a division firstly, to the individuals or groups who would receive the proceeds and secondly, an allocation by location, i.e. local and regional centres or outside points, where the proceeds would be spent.

With respect to individuals or groups receiving the money paid by the consumer he concludes that it is divided:—

47 per cent to the farmer;

9 per cent to local manufacturers such as creameries, canning factories, meat packers and others.

44 per cent to transportation agencies, merchandizing interests and outside manufacturers.

With respect to the locality where the money is spent, through the various facilities necessary to the interchange of goods, he gives abstract figures as related to the Columbia Basin Project which are here reduced to percentages as follows:—

Total price paid by the ultimate consumer for product originating on the farm....	100 per cent
Less part of price arising for outside services, transportation, marketing, etc.	24.3 per cent
Remainder treated as a local fund........	75.7 per cent

This amount is an annual sum wholly dependent on farm production. It would disappear if production should cease. It is shown to be expended as follows:—

In local trade representing services required by the community including the farmer, approximately..........................	20 per cent
In regional centres, distributed to manufacturers, wholesalers, investors, and public utilities, approximately..........	34 per cent
In outside centres, manufacturers of machinery, auto equipment, textiles, processed food products and miscellaneous supplies..........................	21.7 per cent

Summarizing with respect to location where money is spent, we have:—

Remaining in community for local trade..........	20 per cent	
Spent in regional centres..	34 per cent	54 per cent
Outside:—Services, transportation, marketing, etc.	24.3 per cent	
Outside:— Manufacturing, machinery, textiles, etc..	21.7 per cent	46 per cent

Mr. Packard's figures are evidently based on the kinds of products, market facilities, and other factors bearing on the problem he had in hand. These may differ with respect to kinds of produce and other factors arising out of irrigation development in western Canada as they may affect the percentages stated.

The figures, however, do supply a basis for intelligent approach to a problem respecting financial requirements for irrigation, which has been long neglected in Canada. What has been done during the past by irrigation districts or private companies in adjusting debts, has been an aftermath created by necessity which has resulted in severe prejudices to irrigation generally. Whereas by an appreciation of the general benefits arising out of irrigation, not only to the farmer but to the public as well, a clearer understanding of the problem is obtained respecting future developments for which suitable provisions can be made for financial requirements.

Past experiences show that irrigation districts, acting independently, cannot sell irrigation bonds without government guarantees. Private companies are not warranted in financing irrigation projects, limited as they have been to repayments by the farmers only. Hence it is apparent that any future developments must be initiated and carried out by the provincial and Dominion governments or by one acting directly through equitable arrangements with the other.

Repayment of Costs for Development

Early irrigation developments in the United States and Canada as previously indicated were based on the principle that the entire costs for irrigation would be repaid by the farmer. The principle failed and various adjustments have been required. In Canada, adjustments had been made at sundry times and by sundry projects to meet local conditions. They were not uniform as between different projects nor determined by a similar procedure. The results were dissimilar and a farmer on one project compared his position with that of a farmer on another project and found reason to complain.

To meet this situation a Royal Commission was appointed in 1936 and requested to investigate into various phases of irrigation development in all irrigation projects in Alberta. This commission is commonly known as the Ewing Commission. The Commission was instructed, among other things, to enquire into (a) the ability to pay by a farmer of average attainments and (b) the value of land and water right to the farmer.

The Commission made exhaustive enquiry over all projects in the province.

Under (a)—With respect to "Ability to Pay" the findings stated:—"The Commission has endeavoured to arrive at an average ability to pay based on average production having in mind average capacity and average conditions." It based its findings on the production of wheat, oats, and hay or pasture subject to a yearly crop share to be delivered by the farmer. The Commission stated: "According to this assumption the crop share would equal $3.16 per acre." For grain and hay production the average yield-value per year should approximate $16.00 per acre. The value of the crop share is to apply to water rental or service tax, interest and to principal. Assuming that average water rental charges are $1.50 per acre per year, this leaves $1.66 to apply to interest and principal. This annual payment at 5 per cent interest would pay off a capital debt of $23.39 in 25 years. Where production is on a higher basis than wheat, oats, and hay, as in the case where sugar beets and canning products are a part of farm operations, the annual payment at a higher crop share value, would pay the capital cost in less period of years, or would pay a higher land value as may be required for higher land rating.

Under (b)—With respect to the value of land with water right, the Commission fixed a value of $20.00 per acre for land having a rating of 70 per cent. Rating is established by the relative merits of soil, topography, location and water-area factor and may naturally vary with each quarter section of land. The average rating of land and water right commonly considered as irrigable, as applied to existing or prospective projects in Alberta, will result in average prices from $16.00 to $25.00 per acre. This is the sum the farmer is expected to pay over a period of years.

In the figures given, relating to division of benefits, it is shown that 47 per cent of the ultimate sale price, of produce originating at the farm, is received by the farmer. This represents the value of raw farm products. The remaining 53 per cent of the ultimate sale price is the increased value brought about in the processing and distribution of the product. Of the total value it appears that 54 per cent of the money is used or spent locally and 46 per cent at outside places.

The theory of the author is that repayment of costs for total development may be allocated in the proportions of: the value of the primary product received by the farmer who also spends it, the amount spent in local and regional centres and the amount spent at outside points. These factors bear to each other in the ratio of 47 to 54 and 46 respectively. Reduced to the basis of 100 they would work out as follows:—

To be repaid by the farmer...........	32 per cent
To be repaid by local urban and regional interests through taxation by municipal and provincial governments.....	37 per cent
To be repaid by the public at large through taxes imposed by the Dominion government as represented in income taxes, excise duties, sales taxes, etc............................	31 per cent

The work of the Ewing Commission was thorough and exhaustive as related to the annual and total payment which the farmer was called upon to pay. The Commission also stated, specifically as before referred to, that the total costs for irrigation should not be charged to the lands immediately benefited. They were not asked under their appointment to go further than to allocate the amounts to be paid by the farmer.

If, however, the amount the farmer is required to pay, as determined by the Commission, is used to arrive at the value of benefits to other interests as hereinbefore set out, we have some measure in dollars of the amounts these other interests should pay and the sum of these figures will represent the total permissable outlay to provide irrigation. Using the percentages last mentioned and taking the farmer's payment at $20.00 per acre for irrigable land an average rating of 70 per cent we have:—

To be paid by the farmer	32 per cent	$20.00
To be paid by local urban and regional interests...........	37 per cent	$23.12
To be paid by the public at large......................	31 per cent	$19.38
Total permissable outlay per acre....................................		$62.50

Limit of Cost for Irrigation Works

On the premises preceding, the total outlay for irrigation development is stated at $62.50 per acre. A part of this sum is required for costs in meeting carrying charges arising from interest on capital indebtedness and from deficits in operation and maintenance of the canal system pending the time when settlement of lands by farmers is completed. There are also costs for colonization.

Irrigation systems require a large percentage of the total costs for works to be expended in initial development, viz: dams, reservoirs, main and branch canals and attending structures, etc. These must be built prior to any use of water and in the case of raw prairie lands, prior to settlement of the lands. A gradual transition takes place in the development, from the first settlers to the time when the project may be fully colonized. During the past, this has been a slow process as experienced particularly in early irrigation projects in Canada. This can be attributed to several reasons. Primarily the prairies had been settled, partially at least, by people who expected to carry on dry farming operations and by the encouragement of occasional wet years, they refused to admit drought conditions; also irrigation farming, where first started, was new and the prices for irrigated lands were high. These and other conditions delayed settlement in irrigation projects. Today a different viewpoint exists. Irrigation projects have shown their merits. It is generally recognized that parts of the prairies are not suitable for dry farming and there is now an urgent demand on the part of farmers themselves for irrigation. These conditions imply good prospects for rapid settlement but there is need, nevertheless, that some provision should be made for costs of various kinds, which will arise in the interval between the time when the irrigation works are built and the time when each acre in the project is contributing its share to the current and ultimate costs.

Past records of irrigation districts and private companies in Canada would show these costs to be very high but they were created under unfavourable conditions. With respect to future projects and in the light of present views on irrigation, these costs should be estimated for each project, having in mind availability of settlers and any special considerations for markets and general facilities for establishing the farmers on the land. Such determined cost, to be provided for by a carrying fund or development fund, should be deducted from the total permissible outlay to arrive at the permissible capital costs for irrigation works. It is apparent too that if development costs can be reduced, then a larger part of the total permissible outlay becomes available for irrigation works.

In the opinion of the writer, having in mind existing conditions and assuming works completed to enable relatively immediate use of all the land for irrigation farming of which a part may be already settled, such costs should not exceed $12.50 per acre (assessable to local and regional interests), thereby leaving in round numbers approximately $50.00 per acre as a permissible value for lands and cost for irrigation works.

This value is attributed to land requiring a full water right and not to lands where a partial water right is used as a supplement to dry farming operations.

(Signed) D. W. HAYS, M.E.I.C.

Medicine Hat, Alberta, December 4, 1940.

ESTIMATING PRODUCTION COSTS IN AIRCRAFT MANUFACTURE

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The following paper gives the author's idea of the way in which the estimated costs of aircraft production should be arranged and prepared by a manufacturing firm. It must be understood that the system here outlined is not in any way to be regarded as official or as describing the methods followed by any government costing departments. Without attempting to enter into complicated detail, the article suggests a method of estimating production costs which can be successfully used in present-day aircraft manufacture.

In the aeronautical industry the continual and rapid changes in design and manufacturing conditions, together with the fact that the large productive orders enjoyed by other branches of engineering are not yet experienced by aircraft manufacturers, are vital factors when considering a suitable basis to work on.

At the outset the difference between actual costs and estimated costs must be realized. In the former case, future costs cannot be ascertained until a batch of aircraft have actually been completed, whilst with estimated costs, an advance and fairly accurate schedule of costs can be compiled even before the building of the prototype machine.

The final cost of manufacture of any aircraft is advisedly based on the following main items:—

I. Labour—Direct and indirect.
II. Overhead—Development charges.
III. Material—This should be divided into:

1. *Raw Material*, i.e., sheet, bar, etc.
2. *Bought out items*, e.g., rivets, bolts, A.G.S. parts,* standard drawn or extrusion sections (not obtainable in the works), patent fasteners, pins, etc.
3. *Proprietary articles* such as coolers, pumps, oil separators, specialized equipment such as undercarriage and tail wheels not manufactured by the aircraft designer.
4. *Sub-contract work*, i.e., any parts of the aircraft which for reasons of delivery or lack of special plant, the firm decides to obtain from outside suppliers.

IV. Profit, usually a percentage based on the completed costs.

With regard to overhead (Item II), it is not necessary to go into detail, as the make-up of this item does not differ greatly from that usual in other branches of engineering industry, with the important exception that in aircraft work overhead is usually higher and involves a larger allowance for development and experimental work.

The labour charge is the most important factor and is best estimated as the total number of hours necessary to build the aircraft at an average hourly rate, e.g., 30,000 man-hours at 1/9.

After having obtained and checked a complete set of drawings and schedules for every part and assembly required on the aircraft, a breakdown scheme to simplify and expedite costing should be planned.

The most straightforward method of doing this is to divide the machine into self-contained constructional units under such headings as the following:—

(a) *Assembly* of all main structural units (already completely sub-assembled) comprising assembly of wings and tail unit to machine, final erection, connection of pipe lines and hydraulic systems, painting, flight, shed work, test flights, etc.

(b) *Wings*: Probably again divided into top inner and outer, bottom inner and outer. It is usually only necessary to plan either the port or starboard side, as in many cases they are identical; if not, any slight difference can be easily added or subtracted as required. Also included in the wing assessment will be flaps, ailerons and slots according to the design and type of aircraft.

(c) *Fuselage*. This can always be subdivided if necessary, especially if built in several sections or portions, e.g., front, mid and rear fuselage. The fuselage section will possibly include preparation for equipment, such as wireless and any other sub-section which is constructed or installed in the fuselage, such as armament, gun turrets, etc.

(d) *Empennage* comprising the tail unit: tail plane, elevators, fins, rudder and attachment tabs, etc.

(e) *Power unit* or engine installation which will include oil and fuel systems, hydraulic equipment and installation. Care must be taken that all these systems are subdivided as they will almost certainly occur in various sections of the machine.

(f) *Flying controls and engine controls*. These are self-explanatory.

(g) *Undercarriage* often made to special requirements and bought outside. This will include landing wheels, brake gear, and (nearly always) retracting gear which require assembling and embodying in the aircraft.

(h) *Engine mountings*. It is advisable to keep this distinct from Section E (power unit), as the engine mountings and attachment usually assume quite large proportions and may make the power unit section complicated if included in it.

(j) *Electrical services and installations*. This will include all electrical wiring and panels and equipment. It can be subdivided to apportion the amount of labour falling in any of the main units already mentioned, i.e., electrical wiring and installation in fuselage (Section C). It will also embody such items as electrical bomb release, navigation lamps and wiring, wireless, ignition starting and generator starting, etc.

(k) *Armament* comprising bomb mountings and gun turret and gun installation in fuselage or wings, together with any protective items such as armour plating, etc.

(l) *Miscellaneous and general equipment*. This will apply mainly to such matters as oxygen system, stowages for equipment, parachute and flare stowages, first aid outfit and other items of equipment depending on the type of aircraft being built.

(m) *Ground equipment*, which will include such items as trestles, trolleys, ladders, bombcarriers, covers, jacks, slings, or ancillary equipment.

The above sections (a) to (m) break down the machine advantageously for planning, production, and cost estimating, and also with regard to supplying spares. The costs of labour or material are easily calculated from these sections.

It is advisable to correlate the drawing number system with this sectional scheme, so that for instance the prefix b will immediately indicate a part or drawing on the wing

*Aircraft General Stores parts, in England, include such parts as rivets, Simmonds nuts, standard size split pins, cotter pins, turnbuckles, bolts, slotted nuts, all of which are common to almost every aircraft of English design.

Section "B" Complete

Item	Quantity per Aircraft	Drg. No. and Description	LABOUR		MATERIALS				
			Total Value Time at 1/9						
			Hrs.	Amount	Raw	Bought Out	Sub-Contract	Proprietary Articles	Total Material
1	1	Section "B" comprises Inner wings, Outer wings, Centre Section, Ailerons, Flaps, etc.	3000	£262.10.0	£75	£25	£ 2	£20	£122
2	1	B-707—Port Outer Wing......	750	£ 65.12.6	£45	£ 7	10/-	£ 3	£ 55.10.0
3	1	B-7071—Port Outer Wing Spar Assembly.	70	£ 6. 2.6	£6.10.0		...	.....	£6.10.0
4	2	B-7076—Port Wing Spar Web.	5	8/9	£1. 5.0		...	.....	£ 1. 5.0

section, or H725 would refer to a part on the engine mounting.

It then follows that for estimating and production purposes the cost of any part or unit of the machine can be individually assessed, or can at any time be easily found from the schedules, either for labour, planning, or material cost requirements.

The most suitable schedule system will be a master record of the sections already dealt with, first with the section complete and followed by a breakdown scheme. The above example shows how this would be done for Section B (wings)—

Thus a complete schedule, breaking down each section, is compiled.

Note that Item 4 cost is thrown back into Item 3 and again Item 3 is referenced into Item 2, so that we have all the details, then the sub-assembly, followed by the unit assembly and finally the complete section assembly as shown by Item 1.

Additional columns can be used to give the material breakdown costs so that almost any item on the machine can be extracted from the main costs in a few moments, obviously a very useful and desirable feature.

These breakdown schemes and the sectionalizing of the aircraft are the bases on which a correct estimated cost depends. In the hands of competent, experienced estimators there is no danger of any omissions or complicated overlapping of costs, and in this way a fairly accurate version of manufacturing cost can be arrived at sooner than by any costing system which is dependent on actual costs, and is subject to fluctuations.

Detail Costs

Perhaps a few words about detail costs and methods recommended for obtaining them will be advisable at this stage.

Firstly, dependent on the number of aircraft to be built on the contract, the jig and tool layout and production methods should be planned.

This is a vital factor in planning, production, and estimating cost, because the method used in making any particular part, or the time taken to assemble completely a unit depends on the jigs and tools available. Thus the number of aircraft to be manufactured and the binding delivery dates will govern the types of jigs and tools desirable, and these in turn will limit the methods or operational layout of the part or unit in question.

When estimating a contract, these points are of paramount importance as they determine the labour value of any particular job.

It will be found that when a full set of operational layout sheets has been checked and prepared in accordance with the system already described, the complete planned production cost can rapidly be arrived at.

Preferably all detail parts in any one section should be estimated first, followed by the sub-assemblies and then by the assembly of the unit, and in some cases possibly again followed by assembly of unit in the aircraft. Using this basis the estimator, having first completed details and sub-assemblies, when reaching the main assembly—naturally the most difficult part—will be familiar with the whole make-up of the unit, and will know exactly what is necessary to allow for in the main assembly cost. This sequence is regarded as of major importance. Unfortunately it is often neglected and its value not realized, yet its advantages in obtaining maximum accuracy of cost are undeniable.

Critics may say that this procedure is not possible or that it is uneconomical, especially in a large firm. Nevertheless, after years of experience and study of costing methods the author maintains that such a method is essential where accurate results are required at the early stages of a large contract.

With regard to the operational layout, on which estimated costs largely depend, a straightforward, complete layout is essential.

For example, to make a simple bracket the following would suffice:

	Material Cost	Material
1. Cut material to strip size.		
2. Blank and pierce.		
3. Open holes to finished size...	1.5d	3″ x 2″ of L.38
4. Burr holes and clean edges...		6 off required per aircraft
5. Part number..............		Ass. on B7071

This brief but complete summary is a history of all that is done, from start to finish, to make a part.

Notice that this combined planning and estimating sheet includes material required and its cost; also the number off per machine, but above all the indication where the part assembles, thus lining up with the breakdown scheme already described at length.

It is unnecessary to go into details regarding operational layouts for small component parts, because the estimates of experienced technical men for such work will not differ to any appreciable extent. After all, the amount of time required to face, turn, screw, radius, and complete a small machine component—given the plant and operational layout—does not present a difficult problem, and the margin of difference in a number of labour estimates will be exceedingly small.

This leads us to assembly unit estimates and costs. This is where many firms fail to realize exactly what is necessary in both operational planned layout, or to allow for unseen labour factors, i.e., time spent on the job which is not always obvious, even to an individual who after years of practical technical experience appreciates and foresees all the snags which occur in every workshop and may be described as "human elements" of time required.

It is important that a detailed operational layout on any assembly should be prepared. The author has been amazed at the number of famous firms who totally disregard this.

Such descriptions as "assemble all items, drill, bolt, rivet and complete" are sheer waste of time, besides being unsatisfactory and conducive to grave errors in costing.

Again, unless the whole job is visualized as it will be done by the mechanics in the shops, a reasonably accurate cost cannot be ascertained. Many experts forget that parts do not fly into place and that a certain amount of time is expended in preparation and on non-productive operations during assembly of a unit. Such operations as preparing and cleaning of the assembly jig, truing up, alignment of main members of the unit—such as spars, ribs, leading and trailing edges—often take longer than the actual operational time required to drill and rivet. Provision must be made for checking, stripping down for treatment, accessibility (another obviously important consideration, but too often not fully realized) and lastly, snags and rectification after normal completion. Thus for an assembly of an aileron one should begin:—

1. Obtain all details and parts required.
2. Clean down jig and check for truth.
3. Position and assemble front and rear spars (already sub-assembled).
4. Position main ribs on spars—check for centres and align before drilling.
5. Drill and temporary service-bolt ribs—and so on until the final stage of "Inspect, rectify inaccuracies and complete."

The assembly question has been discussed at some length as it is during assembly that high or varying costs always occur and where even a complete knowledge of the jigs and tools to be used will not reveal the true value of the labour required unless all details are given full consideration. In many cases the reverse occurs, i.e., through lack of correct planning and operational layout an estimated cost far in excess of an actual cost is arrived at. This is just as serious as underestimating, for it may lead to a firm's quotation being high or unreasonable, with consequent loss or perhaps valuable contracts.

Particularly is this true in regard to Section A, where the question of accessibility is of paramount importance. It should be noted that many jobs require two men and allowances must be made accordingly.

Consideration must be given to allowance for setting up or preparation, according to the batch of aircraft being manufactured on one order. Many experts compute this allowance at about 5 per cent of the total man-hours required for the aircraft, but the author does not accept this estimate, it would appear to be on the low side but is essentially dependent on the size of the order and number of parts manufactured at the same time in the shops. Possibly an allowance of 8 per cent will cover most types of aircraft.

Having completed all estimates and embodied them into their respective schedules and sections it is a simple matter to combine all the totals and obtain a complete figure in hours necessary to build a machine.

To do this must be added:

1. Setting up and preparation allowance (already mentioned, approximately 8 per cent.)
2. Contingency, or provision for labour difficulties.
3. Scrappage, varying according to design, type of machine and size of order.

Merely as a guide, the author, from actual experience, believes that in most cases Item 2 requires an allowance of 7 per cent and Item 3 of 5 per cent. These amounts can be added on to each section for the purpose of replacements or spares.

Similarly the material totals are obtained and allowances made for scrappage, handling charges of bought out proprietary articles and sub-contract supplies; the whole being combined into a total material figure.

It is then necessary to ascertain an hourly rate which will include bonus schemes, ability rates,* setting rates, in fact an all-in rate which will allow a small margin of safety against such events as future wage increases or inability to find suitable labour for jobs. This will naturally be decided in conjunction with the firm's cost accountants. Thus the price of an aircraft can be summarized (including all contingencies) somewhat as follows:—

Man-hours labour, 30,000 at 1/9 or	£2625
Overheads, 100%	£2625
Material (total)	£2125
	£7375
Profit, 10%	£737.10
	£8112.10

In a case like this the quoted price would possibly be £8250, including delivery and trucking charges within a reasonable area.

This article would not be complete without mentioning one or two other important matters, one of which is aptly described as the nightmare of the industry, i.e., modifications.

These are obviously impossible to assess with accuracy before installation, but, if economically planned, so as to be incorporated during production on a machine that has not advanced to an inconvenient stage, the cost can be ascertained with reasonable accuracy, and without the difficulty of complications resulting in overlapping and excessive costs.

Finally, tool costs, i.e., all fixtures, special tools and assembly jigs. This item is elastic, because the deliveries required and period allowed for completion govern the types and number of jigs required. On a small batch of aircraft the ratio of tool cost to production cost should fall between 1.4 and 1.6. In the case of the imaginary aircraft quoted above, the value of 50 off, at £8250 each, would be £412,500. The tool cost should approximate £68,750; or £1,375 per aircraft.

Jig and tool engineers will no doubt reflect that no comparison can be drawn between the various production labour costs of components and the "relative" tool costs. As in the case of engine mountings and undercarriage jigs, the tool costs are heavy and often exceed even the value of the completed component; but they are necessary to ensure accuracy, interchangeability, and accurate synchronization of components. As against this example, the jig and tool costs for ribs, formers, or attachment brackets are quite moderate and, in addition, they effectively reduce the production labour costs to a minimum.

These facts indicate that jig and tool costs present a problem peculiar to aircraft manufacture and must receive very careful thought and consideration when preparing the money and labour estimates as this in turn will favourably or adversely affect the final production cost of any aircraft. This applies particularly to main assembly and erection jigs.

Larger quantities will vary the relationship. While no attempt is made in this article to lay down definite ratios of cost, the foregoing remarks will indicate approximately what liability is likely to be incurred for the tool cost.

The author has purposely refrained from quoting operational times and dealing with statistics at length, because these might prove uninteresting and perhaps misleading, but he feels that the system and methods which have been described are essential as the basis for estimating production costs.

While there will no doubt be criticism and disagreement with many of the points raised, it is hoped that some of the ideas put forward will prove helpful and possibly present a fresh point of view.

*This refers to a special rate awarded to key men like shop mechanics who, by reason of their outstanding ability in speed, experience, and familiarity with the job, are awarded an additional amount, usually a penny or two over the standard shop rate, and are necessary to take charge of certain units or assembly operations. A fair average would be one ability man to eight normal mechanics. This is not to be confused with grades in labour, such as skilled and semi-skilled. It can rather be described as a super-skilled man who has a number of skilled men under him, and is often referred to in some labour categories as a "working charge hand."

DISCUSSION

Elizabeth M. G. MacGill, m.e.i.c.[1]

I have listened to the presentation of Mr. Wanek's paper with pleasure and considerable profit, but it is with misgiving that I accept the chairman's suggestion to comment on the paper, believing wholeheartedly that a shoemaker should stick to his last. My rôle, therefore, is that of questioner rather than of critic.

Such a method of estimating costs of production of an aeroplane as yet unbuilt but of which the design and drawings are completely finished, should be of particular value, I believe, to companies submitting tenders on aeroplanes designed at the instance of governmental bodies—such as the British Air Ministry. However, due to the different circumstances attaching to aeroplane designs prepared here, I believe that the emphasis must be shifted from estimated costs to actual costs before it would fill the need of the aircraft industry on this continent. Here, in general, for commercial and governmental work, the prototype aeroplane is produced simultaneously with the aeroplane drawings and is usually finished before them. This postulates that by the time the drawings have reached that state of completion demanded by the method, work on the prototype or first batch of machines has progressed to such a point that considerable information regarding actual costs is available, and hence estimates are not required. In such cases, however, the method proposed is still applicable, for I see no reason why *actual* costs rather than *estimated* costs should not be determined by the same procedure. Thus the breakdown system would be adopted as outlined, but actual cost figures obtained from shop timecards would be substituted for estimates in the portion of the table relating to labour.

In considering the work of grouping the airframe drawings preparatory to breaking down the costs, it is immediately apparent that the use of a numbering system for the airframe drawings which automatically groups the drawings would considerably simplify the task. Thus the common American numbering system by which a prefix letter in the drawing number identifies the drawing with its group (i.e. all wing drawings bear the prefix letter "W"; all fuselage drawings bear the prefix letter "F") is admirably suited to this work. Such a system groups the drawings regardless of whether they are introduced early or late into the drawing system.

In discussing the item labour, I should like to ask Mr. Wanek if he does not think that a more accurate cost estimate could be obtained, if each unit or group were allotted its own average hourly rate, i.e. one average hourly rate for wings, another for engine installation. Superficially at least, it would appear no more difficult to obtain an hourly rate for each unit than for the complete airframe, and the accuracy of the final results might be improved thereby.

Also, in estimating the cost of scrap, would it not be more direct to consider it as a percentage of material cost rather than to determine it in man-hours? The heading Scrap might be entered under Material in the table and the loss due to cutting waste be determined as a percentage of the material cost, the precentage varying with the material. Thus for electrical cable which is bought in rolls and cut to the desired length, the percentage of scrap would be small, whereas for rivets requiring heat treatment and handling the percentage waste would be large. Also the scrap due to errors and rejections might be considered as a percentage of the material, a higher percentage being taken for parts requiring a number of different and difficult operations than for those having few and simple operations.

Regarding tooling costs, I wondered if Mr. Wanek had on mind calculating them from the drawings of the jigs and tools in a manner similar to that which he suggests for the airframe drawings. Since the airframe cost estimate is commenced after the airframe drawings are completed, it is not unreasonable to suppose that the jig and tool drawings might be completed or well on the way to completion at that time, and hence be available for cost estimation.

Mr. Wanek has with good reason stressed the number of imponderables present—the size of the production order, the overhead charges due to costly experimental and development work, the recurring modifications to drawings.

In conclusion, I would like to express my appreciation to the speaker for his thought-provoking paper, and his particularly interesting presentation.

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Air Vice-Marshal E. W. Stedman, m.e.i.c[2]

The method of estimating production costs which have been described by Mr. Wanek can be used only when the complete drawings of all parts of the aeroplane, including the smallest detail, are available, and also when the scheme for tooling up has been completed and the process for the manufacture of each part has been worked out. This method of estimating may be of value in Great Britain where many orders are placed before the price has been determined, but in the usual methods of business on this continent it is necessary for the manufacturer to be able to estimate his costs before the aircraft is designed. For instance, bids may be asked for the production of a prototype aircraft and varying numbers of production aircraft of the same type ranging from 15 to 300, in peace time.

Therefore, the manufacturer must be in a position to know what his prototype is going to cost, and how much the cost of the production aircraft will vary with quantity. This variation of cost with quantity is a most important factor, which has been hardly touched by Mr. Wanek.

A recent quotation for bombers in the United States varied from $200,000 apiece for 15 to $75,000 apiece if the order was for 300.

The best method of taking into account these factors in the early stages before the design work has been completed appears to be that covered in a paper to the *Journal of Aeronautical Sciences* by Mr. Kendall Perkins of the Curtiss-Wright Corporation. This paper is entitled "Dollar Values in Aeroplane Design," and is published in the February, 1937, copy of the Journal. The estimation of manufacturing costs is dealt with on pages 140 to 142. In this method Mr. Perkins arrives at an approximate cost of labour per lb. of aeroplane, and at an approximate cost of material per lb. of aeroplane. In each case these costs vary with the type of aeroplane and the method of construction. He also uses a factor which has the effect of reducing the costs with increased quantities, thus allowing not only for the personnel becoming familiarized with the work, but also for the more complete tooling up, which is possible with large orders.

In Mr. Perkins' paper he suggests values that can be used for different types of construction, but owing to the increased costs since the war the values given in 1937 cannot be used at the present time. From my own experience in the analysis of a large number of quotations and orders I feel certain that with a continual check and changing the constants as a result of changing conditions in the industry it is possible by Mr. Perkins' methods to make a very accurate prediction of the cost of aeroplanes before the final details of the design have been completed, and before the method of tooling up has been determined.

A criticism of Mr. Perkins' method is that any estimation based upon weight is wrong because it places a premium upon heavy and bad design. This criticism is, however, groundless because aeroplanes that are too expensive become eliminated by competition, and, therefore, only the best designs survive.

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The Author

At the meeting, Miss MacGill commented on the difficulties experienced with material in regard to delivery and the difficulty of complying with the stringent Air Ministry specifications of materials.

The author considers that it is a planning and organization responsibility to ensure that material arrives well in hand for the manufacturing process; he also feels that any experienced estimator would provide sufficient allowance for these difficulties. But the author also realizes that the material factors today, during the war time conditions, are exceptional and therefore Miss MacGill's comments were justified and of particular importance.

Miss MacGill then mentioned the fact that comparative costs of any part of an airplane against, for example, an automobile, would be very much higher because of the accuracy, interchangeability and inspection requirements.

This is true, but the author would respectfully point out that this factor was referred to in the opening paragraph of the paper, where reference was made to the special manufacturing conditions experienced in the aircraft industry. Again, in the contingency and allowance section, Paragraphs 1, 2 and 3 are particularly applicable to this point. The author thinks that Miss MacGill's comments on these points were really covered in the paper.

Miss MacGill then commented on the effect of modifications and consequent delays and production difficulties.

Although these and other unforseen difficulties will arise, the author feels that, in most cases, a competent estimator, who must have had long experience in aeronautical engineering, will be able to fully cover these cases.

In later comments, which Miss MacGill kindly gave in writing, she suggested that the emphasis must be shifted from estimated costs to actual costs in order to fill the needs of the aircraft industry on this continent. This has serious disadvantages. One is, that actual costs do not necessarily give a true valuation of what the article should cost. Briefly, actual costs take no account of the competitive tender or the need to produce aircraft as economically as possible. I think Miss MacGill will agree that there can be no comparison between the value of aircraft where the cost has been planned and assessed, and where the management are aware to some extent of what it should cost, and the cost when the management simply sit back and await the routine completion of aircraft and then use the actual cost. Having estimated a cost, the manufacturing company and management are aware of the liability and make every possible effort to do the work economically. In some circumstances it is quite possible that the actual cost will soar to an unexpected height. The author does not wish to cast aspersions on any costing system or methods used by manufacturers during the present critical emergency period. The need, however, for the most economic and controlled cost during such a period is even greater than under normal conditions.

After years of experience, the author is opposed to accepting actual costs as a fair and reasonable basis, except in exceptional and special circumstances.

With regard to the comments suggesting that an accurate cost could be obtained if each unit or group were given average hourly rates, it has been demonstrated on a large range of types and quantities of aircraft contracts that this course is not necessary, and is subject to disadvantages which are not obvious at first sight. One of these is that even on each group or unit, so many types and grades of labour are used, that it would entail an enormous amount of detailed work to decide rates covering all of these categories.

Another point, nearly always overlooked, is the fact that the assembly labour, which is by far the largest cost in the complete manufacture, is also the largest in man-hours. Such assembly labour is always the highest paid and most difficult to obtain and control. If, therefore, an average rate, based on the assembly rate value, is used over all the aircraft, this will give the manufacturers and management added confidence and also provide a safety factor, inasmuch as they are covering lower grade labour with the highest rate of labour used.

The lowest paid grades of labour perform only a small percentage of the complete man hours necessary to build an aircraft.

These comments will, therefore, indicate the desirability of using an average rate over the whole aircraft.

With reference to Miss MacGill's comments regarding scrap, the author intended that scrap allowance would be covered in the estimated cost as follows:

1. Material:

(a) In the schedule shown, depicting the process manufacture of a detailed part, the material allowance given already allows for cutting waste and a small scrappage factor.

(b) In the complete material cost, an additional five per cent on top of the allowance made in paragraph (a), has been added.

(c) The material scrappage and waste have therefore been determined as a percentage, and only at the final stage have they been turned into monetary value.

(d) The allowance of scrappage to vary with the material has been included in the detailed planning allowances, as, of course, there should be more allowance for waste of materials such as "perpec's" and stainless steel than that of duralumin and mild steel plate.

2. Regarding scrappage on manufactured aircraft or labour, this has been allowed for as follows:

(a) In each unit, for example, the assembly of the aileron, duly quoted allowance was made for inspection rectification.

(b) Seven per cent allowance was quoted as contingency in the grand totals.

(c) Five per cent allowance was quoted for scrapping.

Thus consideration has been given to all the factors mentioned by Miss MacGill.

In practice it is not possible to allow different scrappage factors for different parts. On many units, such as assembling of aileron to wing, attachment of rudder to empennage, or attachment of main planes to fuselage, there cannot possibly be any scrappage. So that the scrappage allowance of five per cent on the complete man hours labour taken to build the aircraft, adequately provides for the scrappage factor. Statistics of costs over many years on various types of aircraft substantiate the author's opinion.

Remarks in the paper relative to tool costs were not intended to convey the impression that such costs should or could be calculated and estimated in detail. They were given merely as an indication of the probable liability for tool cost against production cost.

Summarizing this briefly, on a medium size order, i.e., from 300 to 500 machines, the ratio of tool cost to production cost should be 1 in 4 to 1 in 6. In other words, if the aircraft cost $6.00, the tool allowance should be $1.00 to $1.50. This cost ratio is, of course, per aircraft.

The author very much appreciates the discussion contributed by Miss MacGill. It is obvious that she has given the subject and paper considerable thought before writing these comments. He hopes that Miss MacGill will not consider his reply in any way a criticism; he feels that the subject covers a wide field and that many points which appear obvious prove on investigation to be more complicated.

Air Vice-Marshal Stedman's reference to Mr. Perkin's method of estimation of cost, which was published in the *Journal of Aeronautical Sciences*, February, 1937, is of interest. As far back as 1934 to 1935, discussions under the auspices of various aeronautical and production engineering societies took place relative to this particular subject. Acknowledged authorities from aircraft engineering plants from many parts of the world took part when this topic of cost of labour per pound and ratio of weight and cost factors was discussed. It was generally agreed that this principle could never be applied to the aircraft industry. Many engineers went so far as to openly condemn it as misleading, impracticable, and unsuitable for application in principle, in view of the extensive range of types of aircraft, both in weight and materials.

It is further pointed out that the changing manufacturing conditions, which are governed by the extreme range of many varied types of aircraft, would preclude the use of any static or constant factors which could be regarded as reliable and accurate.

The most important fact is, however, that should this method ever be attempted, it would be solely dependent on the use of data derived from previous and similar types of construction, which, in turn, would be based on actual costs. In other words, the constants or weight cost ratio factors to be used depend wholly on the availability of past technical costs data, without which no accurate estimate could possibly be arrived at.

Thus the cost per pound theory is entirely dependent upon previously estimated or actual costs from a similar type of aircraft.

With reference to Air Vice-Marshal Stedman's statement that the manufacturer is required to give an estimate before the aircraft is even designed, this is most unusual; the author has never heard of a case where any aircraft firm would be prepared to give a quotation on an aircraft that had not been designed and for which all the drawings were not available.

Valuations and assessments must not be confused with estimating production costs; the former procedures apply strictly to prototype aircraft, or for an order which is only for a very small number of aircraft. They can be regarded only as an approximate indication of costs or liability.

The author has no knowledge of any aircraft firm ever quoting a price for a prototype aircraft. It may be regarded as almost an impossibility. All available evidence indicates that where any firm has been asked to build a prototype aircraft, it has been on a cost-plus basis. If, however, a firm were requested to build a prototype aircraft, and also given a small order, for example, ten aircraft, the cost of the prototype aircraft would be spread over the cost of the ten aircraft. In no case would any firm risk giving a price on one prototype aircraft.

Based on these foregoing remarks, the author feels that it is correct to maintain that an estimate must be based on a complete set of drawings, because whatever the country where the aircraft is built, it must be manufactured to the specification and drawing requirements.

With regard to the remakrs that the variation in cost has not been considered, the author would respectfully draw Air Vice-Marshal Stedman's attention to the opening paragraph of the article which most emphatically refers to this factor. Another reference to this point occurs in the paragraph on detailed costs, where specific mention is made of the fact that the jigging, tooling and manufacturing costs will depend on the number of aircraft to be built, giving consideration to the binding delivery period. Further reference is made in the paragraph describing jig and tool costs, where the quantity factor is again emphasized.

With regard to the weight per pound theory, after discussing this point with leading American and Canadian aircraft manufacturers, both from technical and design staffs, the author finds that they agree that it is not applicable, nor is there any evidence of its being successfully used. In the main, they concur with the author's opinion on the subject.

ANTITANK AND ANTIAIRCRAFT GUNS

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(abridged)

The advent of the internal-combustion engine made the tank and the airplane possible, and these in turn made the development of counter weapons imperative.

Present European combatants seem to consider that the prime necessity in overcoming a tank is armour penetration. Any projectile or sizable fragment of a projectile which gets inside a tank, together with the fragments broken from the armour plate, will do sufficient damage to the mechanism and the crew to put the tank out of combat. Tank armour is remarkably resistant to the effects of high-explosive shell bursting outside the tank, and there is no point in trying to secure bursts inside, since a solid projectile gives better penetration than a shell and will as certainly put the tank out of action. Consequently, the present trend is toward solid projectiles.

The caliber .30 armour-piercing bullet is almost ineffective against any recent tanks, and even the caliber .50 bullet soon may lose its value relatively. The larger calibers which have been considered for antitank use are the 20-mm., the 37-mm. and the 75-mm. In our service to date, principal emphasis has been on the development and utilization of the 37-mm. gun.

The methods of fire control used by anti-tank weapons apply the principles previously in use by our land services. Ranges are comparatively short—generally not more than a few hundred yards. The targets are moving with whatever rapidity possible. No great refinement of apparatus is possible under battle conditions. Telescopes are single power and are fixed with their axes parallel to the bores of the guns. They are provided with graduated reticules by means of which the gunner can adjust his fire by observation. Tracers are provided in the projectiles to make observation easier.

The problem of attacking aircraft is quite different. The airplane presents an entirely new kind of target, moving in three dimensions at speeds of 350 to 400 miles an hour.

After a period of cut-and-try development, the director system of fire control has been evolved. The problem involves three co-ordinates, for the gun must point in the proper direction, it must be laid with the proper elevation, and the fuse must be set so that the projectile will arrive and burst at the position which will be occupied by the airplane several seconds after the gun is fired.

Two principal and numerous auxiliary devices contribute to this end. To solve a triangle we must know the length of at least one of its sides, and our first device obtains this information by means of a complex optical instrument known as a "height finder." This is simply a military-type range finder with an added mechanism to translate automatically the rapidly changing actual slant range to the target into terms of the slowly changing height at which the target is moving. At the height finder we have two observers, each of whom follows the target through a telescope in the instrument; as long as they are accurately on the target and a third observer keeps the instrument adjusted to the distance of the target, the instrument gives a continuous reading of the height of the airplane above the ground. The reading is set on an electrical data transmitter on the height finder, which causes the data to be transmitted to the next principal device—the "director"—where an index or pointer is caused to move to correspond to the height of the target. Here, no one actually has to read the data. An operator by turning a small handwheel causes a second pointer to move and keeps it matched with the one which brings the data from the height finder to the director.

With numerous planes in the air, it would be easy for the observers at the height finder and those at the director to become confused and to take observations on different airplanes. To obviate this, a device on the director automatically "repeats back" to the height finder the direction and the angular elevation of the target on which the director is set. These are registered electrically at the height finder and serve to keep the two groups of observers on the same target.

Several tasks must be performed by the director before the data necessary to set the gun to hit the target in its future position are available. Allowance must be made for the speed of the airplane. Corrections must be made for wind, for the density of the atmosphere, for any variation in the muzzle velocity of the gun from standard, etc. The rapid movement of the target is allowed for and its future position computed by observers at telescopes attached to the director, one of whom keeps a vertical cross hair on the target by rotating the whole instrument about a vertical axis. Another keeps a horizontal cross hair on the target by rotating the telescopes about a horizontal axis and in doing so sets into motion a train of mechanism inside the director.

The result of all of this is that the machine computes continuously and with high accuracy the three co-ordinates needed at the gun. No one has to read these data, however. They are sent to the gun automatically where three operators, by the same "follow-the-pointer" system mentioned above, set them off. The gun is thereby continuously kept pointed in the proper direction and laid at the proper elevation for hitting the target. The setting of the fuse for the time of flight from the gun to the target, however, offers more difficulty. No satisfactory device has yet been produced for setting the fuse with the projectile actually in the gun. The best that can be done at present is to set it outside the gun in a device known as a fuse setter. A certain time is required to take the round of ammunition from the fuse setter, insert it in the gun and pull the lanyard. This is known as "dead time." The figure from the director which sent to the fuse setter allows for the time it takes the projectile to travel from the gun to the future position of the target plus an estimated allowance for "dead time." This would be good if the "dead time" could be kept uniform. But inevitably this time will vary from round to round—gunners are human and their timing is not uniform. When it is seen that a difference of one second, with the target travelling 250 miles an hour, means a difference of over 350 feet in its position in space, it is apparent that the elimination of "dead time" is greatly desirable.

The question of locating an aircraft target at night is immensely more difficult than in daytime. The principal method of doing this has been by means of an instrument known as a sound locator. This instrument consists, in effect, of two pairs of horns which conduct the sounds of an approaching aircraft to the ears of two observers, one of whom can turn the instrument about a vertical axis and the other about a horizontal one. This instrument operates upon the principle that, for a person with normal hearing, a sound affects each ear with equal intensity when it appears to come from a position directly in front. Each observer moves the instrument until he appears to be directly facing the source of the sound. It is to be remembered, however, that sound travels at a velocity of roughly 1,100 feet per second, and with an aircraft 20,000 feet away, the direction from which the sound appears to come will be very considerably behind the actual position of the aircraft. In order to compensate for this the data from the sound locator is fed into another instrument known as an "acoustic corrector" which makes the necessary corrections for the travel of the aircraft during the time it takes the sound wave to reach the ground and then gives the instant position of the target. The aircraft having been thus located, the battery is ready to open up its searchlights and get it within their beams. This having been done, the problem of fire control is the same as in daylight.

The classic time fuse is the powder-train fuse, but a newer and more accurate type is the clockwork fuse. This consists of a small watch movement mounted in the nose of the projectile. It is arranged to start when the gun is discharged and runs for a predetermined time, set by the fuse setter at the gun, at the end of which it causes the projectile to burst.

There is still another branch of antiaircraft activity which has not yet received anything approaching a stabilized solution. This is defence against low-flying aircraft such as the so-called hedgehopper and the dive bomber. Here we have very high speed targets flying so as to arrive with the least possible warning. A method of individual sight control has given fair results at times and is still being developed. Another method depends on tracer ammunition. This would seem to be easy, since the line of flying bullets is visible like a stream of water from a fire hose. Unfortunately, it is practically impossible for the observer on the ground to tell what part of the trajectory is nearest the airplane and hence in what direction to move his sight. This difficulty is made worse because the brightest part of the tracer path is closest to the gun. The method does have the advantage, however, that it requires no apparatus and is instantly available.

A further development is the central-control tracer method, in which the sights of several guns are controlled by an observer placed where he can best observe the fire. A small control box is provided into which vertical and lateral estimated deflections are set off while observing the tracer, and these leads are transmitted by flexible shafts to the sights of the several machine guns in the group. The gunners then concentrate on aligning the sights directly on the target against which they are firing. This method yields considerably better accuracy than individual tracer control since the control box is not directly back of the guns, but it sacrifices the greater advantage of individual tracer control which requires no apparatus whatsoever. Because of the apparatus required, it is not available on the march, but can be used only for firing in position. A fourth method that is now in the development stage is that of central control with computed leads. This is the most accurate of all methods under discussion when circumstances are such as to permit its use. Here leads, instead of being estimated, actually are computed by suitable apparatus.

Low-flying aircraft are available as targets only for a very short time. It is necessary, therefore, to have extremely flexible guns to meet them. Guns such as our 3-inch and 90-mm. antiaircraft cannon, although entirely satisfactory to meet bombing airplanes, are entirely too slow and cumbrous to engage such targets. In addition to the smaller caliber machine guns, we have developed an automatic 37-mm. gun and are developing a semiautomatic 75-mm. gun for this purpose. The standard projectile for attack of low-flying aircraft is a high-explosive shell with an impact fuse.

COMPLACENCY IN CONFUSION

ROBERT E. DOHERTY

President, Carnegie Institute of Technology, Pittsburgh, Pa., U.S.A.

An address delivered to students at the Carnegie Institute of Technology, Pittsburgh, Pa., on "Carnegie Day," November 26, 1940, and printed simultaneously in the publications of the members of the Engineers Council for Professional Development

Most people live in a state of complacent confusion. College students and graduates are no exceptions. How many of them, for instance, have only a vague and confused notion of the fundamental principles of their professional study or practice; how many of them are content to live without a clearly thoughtout philosophy of life; how many of them are inclined to think with their emotions instead of with their minds; how many, disillusioned by events of the past decade, are intellectually lost and assume the role of the cynic; how many, I ask, thus bear their own evidence of confusion? I believe you will agree with me that the number is discouragingly great.

The consequences of complacent confusion are serious. If these consequences were personal only—if they were merely the unrewarded personal careers, or the travail of minds that see no way out of new and trying situations, or the sterile satisfactions that go with intellectual poverty —they would be serious enough. But the consequences do not end there. They become national in scope when confused minds decide matters of destiny, for our democracy rests full-weight upon the proposition that the people are competent to determine their destiny. If they depend upon leadership, as they must, and leadership is confused, the consequences in national and local community life must be devastating, and indeed they have been devastating. By leadership I do not mean federal leadership alone. It is only a part of the whole. I mean every policy-making body or policy-making person in the country, whether in business, industry, education, or government. The general direction of flow of national and community life depends upon the general policy pattern constituted of all the individual policies of these agencies, and the people must accept that flow of life. Hence the consequences of confusion may strike you on two serious counts. They may strike you personally and professionally if you elect to join the large ranks of the confused, and then you may continue to be the victims with all the rest of us of confused leadership. You thus have a definite and direct personal interest in this matter, and also a very important interest as a citizen, even if this may appear to you less direct. My purpose here is to help you to recognize your interest and to encourage you to do something about it. I realize that the immediate, direct personal interest is, from your point of view, probably a more convincing basis for my appeal to you, but since the general social interest is not less important to you, I wish to pursue it further.

In the confused and demoralized world in which we now live, and which certainly will become more confused and more demoralized, there is a great challenge to the college students of America. It is the challenge to become intellectually prepared to deal with such a world, to meet with intelligence, courage, and confidence the new and trying situations which rapid changes are now bringing about. In such a world, which will be the world of your generation, life in America must be profoundly affected. National life will be difficult. Individual life will be difficult. The formulas of day-to-day contemporary life will not suffice because many of them will not apply to the new situations. New formulas must be thought out, and in this thinking there must be a return to the very fundamentals of science and living. There must be a clarification of basic philosophies —personal, professional, social. There must be clear, straight thinking. And to have these there must be genuinely educated people. Walking encyclopedias and handbooks will accomplish little. College graduates who have learned only the routine skills and formulas of their work will be intellectually lost in a world of new problems and thus will be ineffective in determining either social or individual destiny. There must be an intellectual renaissance, and that is your challenge.

I have mentioned confusion and its consequences and how I find these related to your own interests. I wish now to consider the question why in a nation of incomparably great educational opportunity there should be such pervasive confusion; why it is that the experience of 16 or 18 years of formal study, especially the period of college study, does not cultivate in more students a deeper understanding and a greater intellectual competence? After I have considered this question, I shall indicate more fully the nature of the task you will face if you set out in earnest to cultivate your own mind to its full capacity.

Does the habit of confusion and superficiality among so many college graduates stem from an inherent lack of intellectual capacity? Many times I have heard this given as the reason. But my personal experience with students and large numbers of young graduates does not confirm this defeatist view. Now I know it is a long hard struggle for most of us really to learn the art of constructive thought, but I know, too, that many of us have more capacity for understanding and for intelligent thought than we are given credit for having. In college we may be slow in getting our thinking gears into mesh; and if while we are trying to get them into mesh the external machinery of classroom procedure moves too fast, the gears get stripped. Then disorder and confusion result. However, with a little more patience and a little more emphasis at the right points, more of us might have got our mental machinery into gear and successfully made the shifts until we got into high gear. No, I do not accept the view that inherent limitations of mind fix the intellectual achievements of college graduates at their present levels. We all have our own limits, of course, and these are not the same for everybody; but I am convinced that there is still good leeway between actual and potential intellectual achievement. So we must look elsewhere for the trouble.

I have already hinted at it. We strip the gears. The trouble is that too much is undertaken in the time available. In the modern curriculum there is so much subject matter to be covered that in the time available few, if any, students can cover all of it with understanding. The result is that they do not understand much of what they have covered, or only partly understand it. They come to depending more and more upon memorizing, and less and less upon understanding. This process of racing through, with one eye on the next quiz, pages of words and formulas with half understanding or no understanding is utterly demoralizing. It is repeated in American colleges day after day, month after month, year after year, until superficiality becomes a habit, until confusion becomes accepted as a normal state of mind. With such a habit firmly established in college, it naturally persists afterward; and thus confusion and superficiality mark the minds of too many graduates.

It is therefore a deplorable fact that the college diploma is usually not a certificate of a cultivated mind. Rather it may signify only that the graduate has acquired the requisite number of credits by meeting the course requirements of grades, lessons, and attendance. And the meeting of these requirements is no guarantee of intellectual competence in the sense that I am stressing. The work may have been fully done and good grades received, and still the diploma might not be a certificate of a cultivated mind. I mean a mind that can cope with new situations—a mind that intelligently can find its way out of perplexities, whether these be professional, personal, or social—and that has the capacity of humane appreciation. The test for identifying a cultivated mind is to face it with perplexities—to face it with new situations not in the books but involving principles and knowledge which that mind has studied. Then see how it behaves. Does it grab for straws, does it become emotional, is it evasive, does it give up ? Or does it try to anchor to principle, does it have a philosophical base for its thought, has it essential knowledge, however limited, that will give meaning to its principles and to its philosophy, and can it think logically in applying all of these to the understanding and solution of the new situations with which it is faced ? I might state the point in still different words. An educated person is one whose intellect has been cultivated in the processes of understanding, of thinking, of appreciating, of solving perplexities; and the only way yet found that I know of to cultivate these processes is actually to engage in them, to experience them, and to keep on experiencing them at increasing levels of difficulty. Thus, the question whether at commencement you, and indeed all other college graduates, will have achieved the status of educated persons will not, I am afraid, be answered completely by the fact that you and they have received diplomas. Moreover, neither will the extent to which you have approached that status be necessarily measured by the number of courses you have taken, nor yet infallibly indicated by our grades. But you can measure it. You can tell whether you understand thoroughly what you have studied, whether you have grasped great truths and worked them into your thinking so that as time goes by you can think your way out of situations and problems of increasing difficulty. You can know your own mind. Do not rest upon the assumption that a college diploma tells the whole story. It does signify that you have completed a college programme and it may also be a ticket to a job; but it is not a ticket to the ranks of intellectual competence or to a successful career.

I am trying to have you grasp what I consider to be the most important thought in your educational career. It is this: that genuine education—the only kind of education that will help you to advance professionally and that will help you to live a life of service and satisfaction in a changing world—is not to be achieved merely by memorizing large quantities of miscellaneous information; it is not to be achieved merely by learning formulas, important as many of these may be; still less is it to be achieved by memorizing the words or the symbolisms of such information without understanding what they mean. It is to be achieved only by the acquisition of fundamental knowledge that is thoroughly understood and by the development of a purposeful attitude of mind and of a competence in thinking your way out of perplexities.

I realize I am on delicate ground. I run the danger of suffering your judgment that I indulge in pedantic counsel to you, and the faculty's judgment that my appraisal may be too pessimistic. I hope that I may not deserve such judgments; but if I seem to, may I ask that before the judgment becomes final, you at least think over carefully what I say and place it against the background of the world changes you see on all sides.

In any case, do not misunderstand me. Memorized information and formulas are of course important, indeed they are essential, but only so if they are thoroughly understood and furthermore are related *in your own mind* to a definite intellectual purpose. Then they cease to be miscellaneous information and become knowledge. For instance, it is futile to learn, however perfectly, the language of Newton's laws of motion unless the significance of the language is clearly comprehended in its relation to the tangible physical facts which these laws correlate; in other words, unless one can visualize and interpret a physical situation involving these laws.

Let me be more specific regarding the nature of genuine education as I conceive it. I will discuss four essential elements which I have already mentioned in passing. The first is the acquisition of fundamental knowledge; that it to say, the learning and understanding of great basic truths and of a sufficient background of related fact to give definite and constructive meaning to those truths. As great truths I include those in the physical world, in the social and economic world, and in the realm of the human spirit. There are not many. I refer to such principles as the law of conservation of energy; the law of diminishing return, the principle underlying the golden rule. There are of course hundreds, perhaps thousands, of principles and formulas derived from such basic truths, much as the numerous theorems of geometry are derived from a few fundamental premises; and then there are perhaps a few hundred more based upon somebody's opinion. But it would be both hopeless and futile to undertake to learn all of them. One must discriminate between these and the great truths that form the bedrock of intelligent thought.

A second element is the development of a philosophy of life. This is a long process. It is settling upon basic purposes and attitudes in life and the reasons for them; it is placing the indispensable underpinnings of faith and courage and self-confidence. It is a continuing building process—the process of testing against the experience of your own life and the recorded lives of others, those purposes and attitudes that are tentatively adopted and of thus selecting and fitting in, piece by piece, the structural units of a life purpose. For instance, one important and immediate unit in this structure with which you are now presumably concerned is professional purpose. I do not mean the specific details and place of your future work, but the broad lines of professional activity that now seem to offer the greatest promise of those satisfactions which, after careful thought, you have come to cherish.

Next I mention humane appreciation. A mind or life that shuts itself off from an understanding of man as a human being; that shuts itself off from an appreciation of the desires and disappointments, the yearnings and satisfactions that motivate human activity; that shuts itself off from an appreciation of the literature and arts through which the human soul has attempted to express itself—such an isolated mind or life is only half human, and therefore not genuinely educated.

Finally I come to intellectual competence. Without this competence the other elements I have mentioned—fundamental knowledge, a philosophy of life, and humane appreciation—would represent merely passive satisfactions. Such satisfactions are of course important fruits of education. But they do not constitute a whole; they are complementary to another fruit—the fruit of constructive thought. And to achieve this competence in thinking one's way out of perplexing situations is to round out that genuine education which I am urging upon you.

Do you want that kind of an education ? Do you wish to prepare for keen competition ? Do you wish to preserve your precious liberty of thought, speech, and worship ?

If you want these things you can have them, provided you pay the price. I doubt that the price is any higher than you are now paying, for I know most of you are already working hard. But it is a different kind of price. it is the price of *taking the initiative* in your educational work. This demands of you greater resolution than does merely *following* the regimen of class-work. It requires greater devotion to purpose.

No one can possibly do this educational *job* for you. The assumption that the instructor can do it for you is the basis for more educational confusion than any other I can think of, save one, namely, the assumption that education is achieved by memorizing a lesson merely in order to report it back on a quiz and get a grade. A recent definition, if I may be facetious, is that education is the process by which the instructor's notes get into the notes of the student without passing through the brains of either. No, the kind of education I am proposing cannot be given to you; you must *win* it by hard intellectual struggle in which you take the initiative. The faculty may inspire you to intellectual effort, but you must exert it; the faculty can help you to understand, but you have to do the understanding; the faculty can coach you in the art of logical thought, but you must do the thinking; and the faculty can help you to cultivate good taste and humane appreciation, but you have to do the cultivating. Every time you struggle with a new concept and *master it*—for instance, a physical law, or an economic theory, or a concept of art—you will have made an educational advance, you will have added to your intellectual stature. Furthermore, every time you make *use* of such a law or theory or concept to think your way out of a perplexity or to experience a new appreciation, you will have achieved another and further intellectual advance But in both cases you must do the job. You, not the coach, must carry the ball.

So I urge you to take the initiative and learn to use your heads. In the first place, dig yourself out of confusion. Insist on understanding! Do away with superficiality! Stop memorizing words and formulas that you do not understand, merely for a grade. Do not go on cultivating a habit that will cripple your mind for the rest of your days—the habit of superficiality, the habit of accepting confusion as a normal state of mind, the habit of playing on words that carry no meaning. You know when you understand and when you do not; when you grasp a point that is clear and clean cut and when, instead, it is blurred and confused. With all the emphasis in me I repeat: Insist on understanding! Then, under the guidance of the faculty in your regular class programmes, but under your own initiative, you will be in position to go forward more effectively and more rapidly with the acquisition of great truths, the evolution of a philosophy of life, the cultivation of humane appreciation, and the development of intellectual competence—in other words, a genuine education gauged to the demands of the changing world in which you will live.

DISCUSSION ON ENGINEERING TRAINING FOR NATIONAL DEFENCE[1]

A. R. Cullimore[2]

In dealing with the tremendous defence programme in the United States from a production standpoint, it was soon realized that the problem could not be met by industry alone without some help as regards technical or vocational and, on the top, engineering training.

The engineering training programme, it seemed to me, was conceived on a threefold basis. It was easy enough to get in boys if they were available, or young men from plants on the outside, and teach them to operate a machine. But in order to get production, there had to be something more specific or definite than that. So a plan of training was prepared in Washington, in collaboration with Dean Potter and his Advisory Committee and the United States Department of Education, taking into account three factors.

One was training at the vocational school level. For this, men were recruited largely from the local State Unemployment Bureaux, the United States Unemployment Commission, and the W.P.A.

This training, of which Dean Potter speaks, and to which $66,000,000 has been given, was really a pre-service, as well as an in-service training.

In addition there is a very definite in-service training as such, or training within industry, which is in charge of two of our ablest men in the States, Mr. C. R. Dooley of the Standard Oil Company, and Mr. Walter Dietz of the Western Electric Company.

The United States Department of Education have charge of all this vocational training.

In addition, it was evident that the engineer had a part to play and before we got very far in the spending of dollars we must have more men on what might be called the engineering level.

So, Congress provided money for that, and they named Dean Potter as Consultant and Chairman of the Advisory Committee on Engineering Training for National Defence. While his paper covers only a part of the whole picture, we in engineering believe that it is a very important part.

It has been a pleasure to present Dean Potter's paper. As my contacts have been particularly in the New Jersey area, and as I was more or less familiar with the basic philosophy of the programme, Dean Potter suggested that I might attempt to answer questions arising during discussion. Please note, however, that the answers or opinions are mine, not his.

We in our America, as you in your part of America, are very sensitive as to our autonomy, as regards educational institutions.

The situation was that our engineering colleges throughout the country were not able to finance short courses of intensive training without financial help. Probably those of you who are in educational work will appreciate that difficulty. So it was decided to have the institutions responsible directly to the United States Government, without any attempt at supervision, except direction as to the broad general lines of the endeavour.

Thus the institutions became custodians of certain general public funds to be spent upon courses which were outlined and definitely laid down by the institution, and not by the United States Government, with the help of advisers, of whom I happen to be one.

Sometimes as educational adviser I have wished I could tell all the colleges in any neighbourhood exactly what they ought to do and when they ought to do it, and get something started, but that comes perilously near the sort of dictatorship which is repugnant to our ideals.

This brings in the great problem which we face today. How can we make the best of existing conditions and get efficiency ?

The question has been asked whether the United States of America is doing all possible to help the war. My reply is "No, not all possible, but all that is humanly possible."

The problem then becomes one of gearing up a plan of this kind to meet the human needs, the human factors and the human criteria which bear upon it, and in my opinion, Dean Potter and his committee did an outstanding job in that respect.

Take the case in our own industry, which had its own specific needs, in some cases quite vital, in other cases not so vital. At the start, contracts were coming in at the rate of one billion, three hundred million in six months. A man

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[1] Paper prepared by A. A. Potter, Dean of the Schools of Engineering, Purdue University, Lafayette, Ind., and Chairman of the Advisory Committee on Engineering for National Defence, at Washington, for presentation at the Annual Meeting of the Institute and published in the February, 1941, issue of *The Engineering Journal*. Owing to the pressure of work in the defence programme, Dean Potter was prevented, at the last moment, from coming to the meeting at Hamilton. Fortunately one of the members of his Committee, Mr. A. R. Cullimore, was able to present the paper and tell of his own experience in organizing the State of New Jersey.

[2] President, Newark College of Engineering, Newark, N.J., U.S.A.

the day before he had his contract had no needs in the way of staff or production engineering. The day he got the contract he did not know what it was all about.

Thus the whole picture changes from day to day. The plant with no needs yesterday has overwhelming needs today, and the plant that has no needs today may have over whelming needs tomorrow. In order to meet the specific needs in engineering training, it was necessary to build up a reserve of engineering personnel, based on the experiences which we gathered in trouble shooting.

The thing that seemed to us the most necessary in that particular area was the question of production engineering and production supervision. And if we could only get the heads of our concerns production-minded we would have accomplished a great deal.

Next to that was the subject of engineering drawing, not necessarily from the standpoint of draughtsmanship, although there was great need for instance in the aeroplane industry for draughtsmen, but because drawing is the universal language of engineering, and it is difficult to picture any man going far in the engineering field unless he knows something about the language with which one engineer could talk to another.

Another thing which became and still is extremely important is the inspection and testing of material.

These three matters in our area, and probably in most regions of the United States, stood foremost in our immediate wants.

I think something ought to be said about the type of men—they are not all young men—coming in for this work. When we started in New Jersey at Newark College, we had four engineering courses, but did not give the matter much publicity. We had a few posters in the vicinity of Newark in plants, and a few newspaper articles appeared.

In our own institution there were some 3,500 applications within the first two weeks. They were studied to see what class of men were applying, and to find whether these men were really wanted by industry, or just boys who wanted to get a little tuition free and of course get a little more money in connection with the defence programme. In other words, how many really came with the backing and blessing of their own industrial concern. At least 35 per cent of them came with this support.

One of the reasons why industry was not asked to name these men was because we thought this programme had very definite value as a recruiting agency. After all, what we wanted to get a hold of was a group of men who not only held defence positions of some consequence and who would be directly benefited by a programme of this sort, but we wanted to find, if we could, if there were any other men in any non-essential plants who had the capacity of getting into defence industry, as such. Actually, there was a very considerable group of such men. About 75 per cent of our applications were from college graduates, engineering college graduates. Quite a few men had had two, three or four years work in engineering college, without graduation.

Some of the men had one, or two, or even four years in the college of arts, majoring in science or mathematics.

It is felt that to gather together those people, to give them a course, to test them in that field, to make them available for industry, was in itself a very considerable contribution.

Now, that, in a word is perhaps a very sketchy outline of some of the things that we have been trying to do. At the present time, out of the total of 3,500 applicants in New Jersey, we have in training there, by the 10th of the month, 1,089 young engineers, and none of whom have had less than two years of engineering training.

Concerning the capacity of the vocational schools and the technical institutes, we found we would have to adopt the farming out method, taking care of about 565 men more than we have any business to take care of, and doing it very largely by utilizing laboratories on Saturday afternoons, when they were free, and holding classes in the junior colleges, art classes—anywhere we could get space within the limits of Newark.

We have to do with education production as with other production—farm out a good deal of material where we can.

As regards the relation of vocational training to training in the plant, I am heartily in sympathy with plant training, but believe that if higher education plant training or vocational training, separately or together, can turn out a man who can step in and immediately take his place in a productive capacity, the problem is being solved.

For instance, in talking with a man in charge of one of the large arsenals the other day, he said, "We give them a good course of about sixty hours when they get into the arsenal."

Of course they do. We could not possibly give a course in our college or any vocational school which would teach a man how to be a powder inspector in a certain particular arsenal, testing a certain particular powder. We could give enough of the background of powders—the technology, metallurgy and chemistry—and then they could take that engineer as an assistant and jump him from that to a junior, finally a senior, and finally an inspector.

So the vocational problem and the school problem in engineering is only a part of the whole frame, and I think that should be definitely realized.

E. P. Muntz, M.E.I.C.[3]

Dean Potter has shown us very clearly how the United States Office of Education, for which he is consultant, is coping with the shortage of technical and skilled manual workers. The plan he outlines is impressive and its results should once again emphasize the effectiveness of analysis and execution of the solution of many such problems from the engineering point of view.

As the war progresses we are becoming more and more accustomed to thinking in sums over seven figures. A plant valued at over one billion dollars, and composed of over one thousand public vocational schools, is something to conjure with when an increase in manual workers is required. I wonder if Dr. Potter would give us the approximate capacity of these schools. He mentions that "it is expected that during the present fiscal year the skills of more than five hundred thousand people will be increased through this vocational educational programme of 'less than college grade'." The figures given indicate a high average—over five hundred per unit—at least high to us in this country.

It is most impressive to learn from Dr. Potter's paper that up to December 30, 1940, a total of four hundred and forty-four engineering defence training programmes had been approved to be administered by ninety-one engineering colleges in forty-four states, the District of Columbia and Puerto Rico.

In this country also, there is an acute shortage of engineering specialists in many lines. Our new war industries are reported as requiring one hundred thousand workers this year, between four and five thousand of whom must be technically-trained people.

A similar supervising agency for technical education is required here. There should be the closest co-operation between such an agency and the most efficient placement agency that can be devised.

Our potential reservoirs of technically-trained workers lie undoubtedly in:

1. Refreshing and re-establishing those previously qualified and presently engaged in non-essential industries.
2. Giving to those already proficient in mathematics and physics sufficient additional instruction along practical lines to permit them to take over certain specific technical work and thus release those with a broader technical training.

[3] Foundation Company of Canada, Limited, Montreal, Que.

Our regular supply of technically-trained workers comes from our engineering schools of course and must be augmented to the limit of the capacity of staffs and facilities.

The best trained and most efficient man in the world is not much good if placed in the wrong job.

I wonder if it is too early to ask what results are indicated under the United States system and what difficulties are encountered in placing the people trained? A principle which has been advocated here is that training in vocational schools, while desirable to a point, should be carried on only to supplement a much larger proportion of training within industry itself. The chief reasons are: (1) that the actual contact with, and orientation to, industry is made by the individual during schooling, considerable time and wastage thus being saved; (2) that in a vocational school a whole class is too often retarded by one or two drones to an extent out of all proportion to its numbers, the result being a longer period of training for the majority or less proficiency in a given time.

It would be interesting to know if the Office of Education in the United States is attempting to bring about any considerable increase in schools within individual industries.

Dr. Potter notes that "Present world conditions demand that technology operates at full speed." We will all agree absolutely. Once again our profession is called upon to create newer and newer articles for offensive and defensive warfare far in advance of our normal peacetime development and at the same time to develop the most stupendous industrial production of all time.

However, it would be neither good engineering nor common sense (and the two are really largely synonymous) to disregard where we are going. True, the paramount concern of every one of us is to contribute all our energy to winning the war—but how much more sensible to have a definite plan for after the war, and, as the opportunity occurs, so mould our actions without impairing the effectiveness of our war effort, that the birth pains of peace may be endured.

We as a profession will be accused once again of having developed processes and increased productions without a thought to the distribution of the increased products of our brain children. This accusation will not appear during time of war—but it will thereafter. The last Great War is so fresh in the minds of so any of us, and the aftermath, too, that there should be little doubt that winning the peace is equally as important as winning the war, or even more important. Therefore, I plead that just as soon as our various technical educational programmes show that the war demand is being fulfilled, attention must be given to after-the-war requirements, so that we may not lag behind the requirements.

We who have been largely responsible for our technical advances may develop by engineering approach to, and analysis of, these requirements, a plan for the future which will have some prospect of avoiding the unemployment and resulting hardships of the decade previous to the present war, as well as much of the unrest immediately following the last.

Already Great Britain has a Ministry of Reconstruction, one of its chief duties being adequate preparation to meet post-war problems. Great Britain will have vastly more physical reconstruction to contemplate than we are likely to have. It is becoming increasingly evident as time goes on that she has solved many social problems that we still have to face. Mismanagement of these is much more likely to lead to disorder and chaos, than if all our physical possessions were battered by bombs.

Everyone will agree that after the last war we tried to get back to a so-called normal altogether too quickly. This time the problems are much greater and the time required to readjust will be considerable. Such educational programmes as Dr. Potter has outlined will be of the greatest benefit if continued and moulded to help realign us to peaceful occupations.

I would like to compliment Dr. Potter on his paper. It is a most valuable contribution at a very crucial time.

Ernest Brown, m.e.i.c.[4]

The central thought in the scheme of engineering training described by Dean Potter is expressed by that paragraph of his paper which reads as follows: "The leaders in the engineering profession as well as in the Army and Navy of the United States of America are insistent that the engineering schools of this country should maintain during the present emergency the strongest possible programmes of undergraduate and graduate instruction and should increase their research efforts so that an adequate supply of well trained and creative engineers is assured."

A meeting of this kind hardly needs to be assured of the special responsibilities of those in charge of our engineering schools during war time. The difficulties in the problem of training are probably not realized so fully. Two main factors are of paramount importance—the staffing of the schools, and the state of mind of the student body. Members of staffs have withdrawn wholly, or in part, from teaching duties in our schools to serve in the active forces, to act as instructors in the air-training scheme, to work on special problems in association with the National Research Council, or in numerous other forms of war effort. Replacements are in many cases impossible in existing conditions, and the teaching burden of those who remain has increased greatly. Many young graduates who normally would be doing post-graduate work are engaged in industry, and are therefore not available as demonstrators. As a result of all this, teaching resources are heavily taxed.

A condition of unrest exists in our student body. Under an agreement made between the universities and the Government they have devoted six hours per week to military training, in addition to the regular course of study, and have been immune from call for training during the college year. It is difficult, however, to keep their minds centred on the idea that in thus continuing professional training they are doing their part fully and serving a necessary purpose in the war effort. There is the strong and ever present pressure towards enlistment, or towards work in some war industry. The latter condition, particularly in the final year, frequently involves the question of a student leaving before completion of his studies, or in the extreme case a drastic shortening of the period of study leading to a degree in the case of all students. The student does not wish to leave without his diploma. The diploma, as a certificate of professional training, loses some of its value if that training is seriously curtailed, or itsefficiency impaired. Only those who are in close touch with such a situation can realize the full effects of it, and the difficulties which it creates. It is a long way removed from the ideal outlined by Dean Potter. It results from our being at war.

A survey of the careers of members of a class which graduated about five years ago, showed that a considerable number are on active service. Enlistment, or withdrawal for war service from the earlier years of our courses is already appreciable, and shows a tendency to increase. The numbers graduating in the next two or three years will thereby be reduced, and it seems likely that the needs of industry and of our active forces will increase. These facts show the need for intelligent effort to establish a proper balance. The Engineering Institute of Canada, the Canadian Institute of Mining and Metallurgy, and the Canadian Institute of Chemistry took early steps to provide for the Government a register of their memberships, and of their special qualifications, in the hope that the best use might be made of our technically trained men in the war effort. The results have been disappointing. It is rumoured, however, that a proper control will soon be set up, in which the bodies named will be asked to take an active part, so

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that better use may be made of our resources. This should tend to ease the situation in the schools by enabling industry to appeal confidently to such an organization to fill its needs, rather than to seek partially trained men from the schools. A favourable reaction on the state of mind of the student should follow—an important matter where his education is concerned. The industries themselves, and our technical schools, can continue to train effectively the large numbers required in the sub-professional groups such as machinists, welders, junior draftsmen, etc.—a service for which the engineering schools are not equipped. Their true function, as Dean Potter has said, is to "maintain during the present emergency the strongest possible programme of undergraduate and graduate instruction . . . so that an adequate supply of well trained and creative engineers is assured."

C. R. Young, M.E.I.C.[5]

The outline of the personnel activities being carried on in the United States in connection with the great defence programme of our neighbour indicates a very comprehensive and a very thorough enterprise.

I fancy that those here present who, like myself, are particularly concerned with engineering education are most interested in training on the engineering college level. As Dean Brown has clearly pointed out, there are great difficulties associated with the carrying on of a war-training programme as we might wish to carry it on.

At the outset of the war a very helpful letter was addressed by Lieut.-General MacNaughton to the presidents of the universities of Canada, suggesting, on behalf of the National Research Council, that training in engineering and in scientific courses should follow normal lines, that it would be inadvisable for men in such courses to enrol in any large numbers in the armed forces immediately, particularly so for those in the upper years, and that it would be much better for them to continue their courses and be thoroughly prepared and ready for the call when it should come.

At the University of Toronto we have carried on in accordance with that policy. In the session of 1939-40 no great numbers of men left their courses for the armed forces or for war industry, but during the present session we have found a very considerable unrest. The symptoms reported at McGill are duplicated at Toronto.

It had been known almost from the beginning of the session that considerable numbers would wish to enter the armed forces long before the session had ended and, late in December, when we were besieged by urgent requests on the part of war industry, in some cases from governmental corporations, it became necessary to adopt special measures to deal with the situation. We consequently released a number of men, especially in chemical engineering, at the end of the first term with the assurance that they would receive their degrees in June if they presented certificates of having been suitably employed in war industry for a defined period. These were picked men whose success in the year's work was assured, and who therefore might very reasonably be allowed to go without doing any violence to the standards of the institution.

Since then further withdrawals have taken place. Out of a fourth year of 186, over 30 (43 on March 8th) have withdrawn for the armed forces or industry, and I have no doubt more will withdraw before the end of the session.

In the third year unrest was also evident, and in order to do something to stabilize the situation it was decided by the Council of the Faculty of Applied Science and Engineering that in the national interest we should curtail the fourth year, at least so far as the examinations were concerned, and free the men of this year by the middle of March with all examinations and tests completed. The third year is being freed by the first of April, with examinations and tests also completed. These measures will, I think, have some effect in quieting the unrest. The curtailed examinations or tests will be as simple as it is possible to make them in order to discover the qualifications of the men for graduation or for undertaking the work of the next higher year.

We are not curtailing in the slightest the work of the first two years and the normal examinations will be held for them.

That is merely one contribution that we are trying to make to the national war effort at the University of Toronto. Another one has been the selection from the fourth year of a number of men of particularly high qualifications to take an intensive special course in radio and communications. It is believed that these men, along with others from the final year in the Faculty of Arts, will be most useful in connection with certain activities with which you are already familiar.

We could wish that we had a little more direct leadership from governmental authorities as to the lines which our endeavour might profitably take in the Faculty of Applied Science and Engineering at Toronto. It seems probable that as a result of the newly announced federal activity in marshalling the technical personnel of this country we may have direction in the framing of our programmes very shortly. I am quite sure that at Toronto, as at all of the other engineering colleges in Canada, we are prepared to do anything that may be practicable and in the national interest, despite the fact that our staff is overworked due to the absence of several senior members of it on war service.

It is a very difficult thing, as Dean Brown has suggested, to find at this time the teaching personnel required for special war courses. Unless we can attract additional men of sufficiently high qualifications, I do not believe that we could undertake additional courses of the kind to which Dr. Malcolm has referred.

Someone in authority might very well point out at this time the great need of holding in the engineering colleges those men who are especially qualified to teach technical subjects. The lure of the armed forces is very great, but it should be pointed out that the duty of many of these men distinctly lies in teaching work in the engineering colleges.

I was very much pleased to read some time ago a recommendation of the National Academy of Sciences and the National Committee on Education and Defence of the United States to the effect that deferment of military training under the Selective Service Law be granted for those who are required to replenish depleted instructional staffs. We ought to be thoroughly aware of the fact that to allow teaching personnel to go off to war industry, or to the armed forces is tantamount to eating our seed grain. You cannot possibly carry on the grade of training that is essential in these days without having a skilled and competent teaching staff.

We should like to carry on graduate work to a much greater degree than we are able to do it at the present time. There is here, again, the problem of staff, but at the same time there is to some extent a disposition amongst students to look for something that is quick and direct; in other words a demand for the *ad hoc* type of training. Training for the armed forces is, of course, very much of that variety. It is necessarily training in a narrow specialty, intensive and direct, with a view to doing some particular job in a particular way. Such is not sound engineering education, but, after all, the conduct of war is not a normal engineering enterprise such as you would ordinarily advocate for the people of any country. It is a disagreeable task that must be done in the shortest possible time and in the most effective way that can be discovered.

I fancy that as time goes on we shall be asked to undertake some narrower and more intensive training than we now give and to fit it in somehow or other with our existing programmes. If we are asked to do so we must be aided in some manner in the obtaining of the necessary staff and

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the necessary funds. Under the existing budget it is impracticable at the University of Toronto to carry out any large programme of specialized training. Additional funds would need to be provided from some governmental source.

Whether courses of this kind should be carried on simultaneously with the regular courses, or whether they should be given at night or given during the summer months has not yet been determined. At Toronto there is a Committee of the Faculty Council now giving careful study to the whole matter and I feel quite sure that when the policy is laid down for us and we are able to work to a definite pattern, we shall not fail in doing our duty.

Lindsay Malcolm, m.e.i.c.[6]

It seems somewhat preposterous for me to discuss a matter brought up by Dr. Cullimore of Newark College, but I am probably in the position of being a platoon commander, rather than a general, or the general's aide, whom Dr. Cullimore represents.

We have been up to our necks in this kind of training since last September. Cornell University, due to the exertion of our Dean, saw the opportunity of doing some work to help the aeroplane industry, more particularly in Buffalo, and in September last he organized there a course at graduate level to help this industry.

This was not under the Defence Training Plan, as this plan was not then constituted. We had in that first course about 125 students from the aeroplane industry who were graduates of some university or other. To teach this group we released one man from the School of Mechanical Engineering, and one from the School of Civil Engineering, (both assistant professors).

The assistant to the Dean, Dr. Adams, was placed in immediate charge, so that these three men were there to to do the work. They carried on until the Defence Training Plan came into being.

Immediately following the organization of the Defence Training Plan there was set up at Buffalo an additional course at the undergraduate level for those who had graduated from high schools or had an adequate period of training in the industry itself. We had about 400 students apply and about 350 are carrying on at the present.

The Curtiss plant and the Bell plant, if I may speak particularly, were so much impressed that they have continued this work and have asked for an additional school in mechanics at a higher level then even the graduate level. Dr. Goodier, who was formerly connected with Toronto University, is in charge of that work. He is the head of the Mechanics Department in the School of Mechanical Engineering. He goes to Buffalo every Friday. Peculiarly enough, where we expected 30 we have 70 students taking this very advanced course in aeronautics.

We have three very flourishing courses at Buffalo. Now, we were not able to release any more than two members of the staff, without counting Dr. Adams, to this Buffalo work. We had to go out in the open market and obtain engineers who were capable of teaching, and we now have four additional members of staff there, making seven in all for the training programme in Buffalo.

I suppose you might call them special courses, although the instructors are for the present permanently there.

Professor Moynihan, of the School of Mechanical Engineering, and Professor Chamberlain, of the School of Electrical Engineering, were sent to the southern and western part of New York State to canvass all industry. They came home with the most surprising amount of information concerning the industries who wished their employees to take advantage of this opportunity, so they could speed up their work from the engineering point of view.

In Elmira, N.Y., the chief industry is the American Bridge Company, and the officials asked that courses be set up for their men. This has been done, but we did not limit the courses to those men. Anybody in that district capable of doing the work can come. We have students there from about eight or nine industries. The courses we have set up are handled from the School of Civil Engineering at Cornell.

In the structural field on Friday last we started an advanced course in structural draughting, at the request of the American Bridge Company. We had no instructors that we could spare, so we obtained from the chief engineer of the American Bridge Company in Elmira, one of his men, who he thought was capable of doing the work. This instructor is proving a very satisfactory man indeed.

The elementary course in structural engineering and elementary design, and the advanced course, could not be handled in any other way than simply to detail two of our staff. As we have had some deaths in the past year in our staff, we could not overload the new men coming in, so one of the members of the Structural Department and I are teaching these two courses.

In Ithica itself, because we draw from such places as Corning, Elmira, Bath, Sidney, on the south, Geneva on the north, and Courtland on the east (we cannot go too far to the east because Syracuse University is in the picture there), we have organized five different groups in Ithaca, largely in the industrial field. The courses which we have in Ithaca, are: Materials Testing and Physical Metallurgy, Electronics, Machine Design, Tooling and Design, Production Management and Supervision, specifically related to industry.

In all we have eleven courses set up. (There are three others in contemplation, at the request of people who are interested.) This has put a great strain on the staff. Our staff members normally have been, as in most universities, doing all that they could at any one time, sometimes being overloaded (although our friends in the open always want to tell the professors how little they do). We have thirty members of staff actually teaching these courses. The courses have from seven to fifteen students in any one particular course. We try to keep the classes as small as possible in order to provide supervision—on design and draughting and personnel work. We try to limit attendance in any one course to about twenty per teacher per evening. Normally the length of these courses is three hours each night. In order to get around and see that everyone is following the work, the classes should be limited in size.

I was impressed by Dr. Cullimore's statement about the ages of these men. In the class of which I have personal charge, there are three boys whom one industry has just taken in the draughting-room. These have had high school training and have graduated from the high school. They are just youngsters, keen, fairly well trained in their mathematics, and seem to follow the work all right.

I have four men in that same class that I would say were fifty years of age. These men have been in highway engineering, in sales department work, etc., and are anxious to get back to the technical side of the work. It is surprising how keen both these boys and men are. They are anxious to get ahead with their work, and they show that they intend to go to it and stick it out.

Another point that Dr. Cullimore suggested was the recruiting for these courses. We have used the newspapers and two radio stations in the district, that I know of. There is one other that I do not think we have used yet. Cornell University has its own radio station, and we have used that rather extensively to cover the district. We have also used the radio station in Elmira, and we have had surprisingly good results. It is not a very highly industrialized area, but we are drawing from the industries that we have. These industries give us their support and the managements in many cases are intensely interested. For example, last Friday and Monday nights, the chief engineer of the American Bridge Company at Elmira attended all the sessions, just to show his interest in this worth-while problem.

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NEW AMERICAN TONNAGE

From *Trade and Engineering*, (London), November, 1940

In the programme undertaken by the U.S. Maritime Commission for the rebuilding of the mercantile fleet are 18 cargo-passenger liners. A number of tankers and many pure cargo ships have been completed as part of the programme, but none of the cargo passenger ships have yet run trials. These are, however, in many ways the most interesting of all the vessels. Some of them are equipped with steam machinery and others with Diesel engines. The first steamer will be placed in service in the course of the next month or two, and the first of the oil-engined vessels will run trials next spring. According to present arrangements, the motorliners and some of the steamers will trade between New York and East Coast South American ports. The remaining steamers were intended to operate on a round-the-world service, or between New York and London. These routes will have to be modified while the war is in progress.

The hulls are standardized in most respects, in spite of the installation of different classes of machinery, and it may be noted that the high-pressure boilers and steam turbines are to be installed in a machinery space equal to that occupied by the Diesel engines. The range of action of the steamers is, however, less. The length overall of the ships is 492 ft., the moulded breadth 69 ft. 6 in., and the draught 27 ft. 3 in. The gross register is 7,800 tons, and in normal service a speed of 16½ knots is to be maintained.

In the motor-ship two Sun-Doxford engines will be installed, each developing 4,500 b.h.p. The installation will be entirely different from that of any British-built Doxford-engined ship, since the two units will be geared to a single shaft. They are designed to run at 180 r.p.m. which is a much higher speed than has hitherto been adopted with Diesel machinery, and the propeller will turn at 80 r.p.m. The drive is taken through Westinghouse gearing and electric couplings, which receive their excitation at 240 volts from the main generators. The total cargo capacity is 560,000 cu. ft., including 60,000 cu. ft. of refrigerated produce.

The cost of each of the ships at normal rate of exchange is in the neighbourhood of £800,000, which, at the time the order was placed, was probably about double the expenditure involved in building a similar ship in this country.

REPORT ON CONSULTING ENGINEERING PRACTICE AND FEES

From *Mechanical Engineering* (New York), March, 1941

The problems facing the consulting mechanical engineer in setting fees for his services, in defining the scope of his activities, and in determining the cost to him of rendering service have been before The American Society of Mechanical Engineers for some time. Early in 1940, President McBryde initiated an investigation of these problems and in August appointed a Committee on Consulting Practice to analyze them in the light of the greatly increased use of consulting mechanical engineering services in the national-defense programme and also in relation to the broad aspects of rendering consulting services in the fields which are predominantly of a mechanical-engineering nature.

Subsequent meetings brought forth a preliminary draft which was reviewed carefully by the committee members and Mr. Davies and then sent to a number of representative engineers (in all parts of the country) fully conversant with consulting engineering problems as they relate both to rendering and to using such services. The finished draft was presented to the Executive Committee of the Council in November, together with the written comments of this large informal "board of review."

An abstract of the report has been prepared and is included with this article for the benefit of all A.S.M.E. members. Where members or organizations contemplate using consulting mechanical-engineering services, it is recommended that a copy of the complete report be studied.

The report has been divided into ten sections: (1) General principles for consulting work; (2) classification of consulting services; (3) designation of mechanical-engineering projects; (4) cost of rendering consulting service: (5) types of service on design projects; (6) recommended bases for making charges; (7) repetitive work; (8) drawings and designs; (9) patents; and (10) confidential data.

The report defines the various types of consulting service and classifies them into two broad groups:

(a) Personal Service, Reports, Investigations, etc.

1. Individual service.
2. Appraisals, valuations, rate studies, reports.
3. Management and production engineering services.
4. Inspection or testing of apparatus, equipment, etc.

(b) Design Projects:

1. Machinery or equipment consulting services.
2. Consulting services on complete projects or sections of projects.

For per-diem rates covering personal service, reports and similar activities a minimum rate of $50 per day for each day or fraction thereof, with a minimum charge of $100 for each engagement is recommended. Where special technical knowledge or skill is involved, charges from $100 to $250 per day are considered reasonable.

When long-term engagements are required, a reduction of 25 to 50 percent from these minimum rates is justified providing the term of engagement is in excess of one week to ten days. Variations of the per-diem rate such as billing at three times pay roll or cost-plus-a-fee, and cost-plus-a-percentage are also recommended.

Recommended Minimum Fees based on Net Cost of Work, Designed by Consulting Engineer, expressed as a percentage of cost of work.

	A	B	C
	Mechanical equipment of Bldgs.		Complete Mechanical engineering projects percents
	With supervision percent	Without supervision percent	
Net cost of work, dollars			
25,000 or under.......	10	8½	14
50,000...............	8¾	7½	12¾
100,000...............	7¼	6¼	10½
200,000...............	6¼	5¼	9
300,000...............	6	5	8
500,000...............	6	5	8

Where the scope of services can be determined in advance with some degree of accuracy and where the total cost of the work does not exceed $500,000 the method of evaluating fees as a percentage of the cost of the work has been recommended.

The detailed description of the various items included under this service is set forth in the complete report. It should be noted that these percentage fees do not include reproduction or communication costs, living or travelling expenses incurred on account of the work, nor do they include resident inspection or supervision at the site. Such items are billed in addition to the percentage fee as are field surveys, etc.

TRUCK CARRYING-CAPACITY RATING

Report of S.A.E. Motor Truck Rating Committee

From *Journal of Society of Automotive Engineer*, March, 1941

The carrying capacity of a motor truck is the end product of the almost innumerable elements of its design and construction. It is the integration of the carrying capacities of the tires, wheels, bearings, axles, springs, stearing system, brakes, frame, engine, etc., and the many parts of these major components. Ideally it would be desirable to rate carrying capacity by means of an engineering criterion, or formula, which would integrate this multitude of complex elements and give an answer entirely objective in character. Unfortunately no such criterion is available and, if an acceptable one could be developed, it would be exceedingly complicated. It consequently would not have the requisite characteristics of simplicity and understandability, and thus would be without practical usefulness.

Lacking such a criterion the Rating Committee believes that the most satisfactory alternative is for the manufacturer to rate the carrying capacity of his own products and that, for the worth-while benefits to be derived from uniformity, the form of rating should follow a standardized pattern. This would require each manufacturer to provide the same information about the carrying capacity of his trucks. This information, however, would not necessarily be entirely comparable because of the variations in the bases on which different manufacturers rate their products as determined by their own design and selling policies.

With this background, the Rating Committee presents its recommendations for a uniform method of rating the carrying capacities of motor trucks.

The carrying capacity should be rated by the following terms:

1. Maximum Gross Vehicle Weight............pounds.
2. Maximum Gross Combination Weight.......pounds.
3. Maximum Gross Carrying Capacity.........pounds.
4. Maximum Authorized Tire Equipment........
5. Structural Chassis Weight..................pounds.

The above terms which, taken together, give the capacity rating of a truck, are defined as follows:

1. Maximum Gross Vehicle Weight is the weight in pounds of a truck chassis with lubricants, water and full tank or tanks of fuel, plus the Maximum Gross Carrying Capacity as defined below.

2. Maximum Gross Combination Weight is the Maximum Authorized Gross Weight in pounds of a tractor truck and any combination of trailers. It is made up of the sum of the weights of all chassis (including tractor-truck and trailer), cab, lubricants, water, full tank or tanks of fuel, all bodies, special chassis and body equipment, attaching parts and payload.

3. Maximum Gross Carrying Capacity is the maximum authorized weight in pounds which may be superimposed upon a truck chassis when equipped with the maximum authorized number and size of tires. It is equal to the sum of the weights of cab, body, special chassis and body equipment, and payload.

4. Maximum Authorized Tire Equipment means the size, number of plies and number of tires on the load carrying wheels of the prime mover which, in accordance with Tire and Rim Association Standards, is the maximum in capacity authorized by the manufacturer.

5. Structural Chassis Weight is the weight in pounds of a truck chassis without lubricants, water and fuel, less the weight of tires, radiator (including shell and grille), engine, clutch, transmission and propeller shaft assemblies.

Relation of Capacity Rating to Ability Rating

The information conveyed by the five factors used as a basis for the capacity rating, taken in conjunction with the information required for the ability rating, gives a complete general idea of the capabilities of any given truck chassis.

In addition to the capacity factors, the maximum certified horsepower and the r.p.m. at which it occurs are necessary to evaluate the all-around ability of a truck and to compute the ability factor.

It is recommended that this information at least be presented by means of a plate upon which the six factors required for both ability rating and capacity rating are shown.

WHAT U.S. AID MEANS

From *Aeronautics*, (London), February, 1941

While during the last two decades many practical demonstrations of British progress in aviation were being made, year after year, the United States was running us close and sometimes outpacing us in technical development. This was noticeably so in the production of commerical landplanes and, until the Short Empire boat was designed, it seemed as though the lead in flying boat construction which Britain had held was to be eclipsed by the strikingly advanced designs of American manufacturers. It has always been a characteristic of aircraft constructors in the United States that they never shrink from breaking away from the orthodox, and it is largely due to this that we have to thank them for such standardized features as the retractable undercarriage, the metal variablepitch airscrew, for it was in America that these were brought to practical form in the first place. To-day the American aircraft industry with its immense research and manufacturing resources is making great strides in substratosphere flying technique. It is pushing ahead with petrol injection systems and exhaust-driven supercharging designs. It is solving icing-up problems, and it is doing much in evolving pressure cabins and new aerofoils for high-altitude flight. Progress is being achieved, too, in new aircraft alloys, plastics and fuels.

There is no doubt that America will be able to teach England quite a lot and England in return will pass on a great deal to America in the way of new ideas, developments, and discoveries in the near future. This close Anglo-American co-operation and joint effort without a doubt will result in the R.A.F. and the U.S. Army Air Corps having the finest aircraft in the world before this war is over. Not only that, but we shall have them in tremendous numbers, and quality and quantity are the factors that are going to count.

LIGHT WEIGHT CONCRETE

From *Civil Engineering* (London), November, 1940

Notes on the production of vermiculite are given in *Mineral Trade Notes*. The raw material is crushed, dried and screened before being expanded in an oil-fired vermiculite kiln, after which it is separated into three sizes. A great many fines are rejected at the mine, so a ton of dried material yields 700 lb. of house-fill that passes ¼ in. but remains on 10 mesh and 900 lb. of minus 10 plus 30 mesh, which is used in plaster and concrete products. The product used for house-fill weighs only 5½ lb. per cu. ft. The finer sizes, which bulk 6 to 7 lb. to the cu. ft., are made into plastic insulation, plaster and concrete products. Experiments are being made with insulation brick, which may be sold at $80.00 a thousand. The latter appear to be blended with bentonite and amphibole asbestos fibre, thus differing from the plastic insulating material only in that they are pressed after being moulded.

Col. Ellis C. Soper has designed a pre-cast concrete slab for floor, roof or wall construction that weighs 35 to 40 lb. per cu. ft., and carries at least 200 lb. per sq. in. in compression. A 7 ft. slab support near the ends will bend as much as 1½ in. under a 150 lb. load at the middle and then come back to its original shape. In addition to their light weight and heat-insulating properties, it is said that these slabs are easy to install. If necessary they can be sawn, cut with a knife, drilled or nailed, in much the same way as wood lumber.

THE QUEEN ELIZABETH WAY

Abstract of paper by A. L. MacDougall, delivered before the Sault Ste. Marie Branch of the Engineering Institute of Canada, March 21st, 1941.

The Queen Elizabeth Way, the first four lane highway in Ontario, is being built to relieve congested traffic conditions between Toronto and the Niagara Peninsula. It has now been completed from Toronto to Niagara Falls, a distance of 73 miles and the remaining 18 miles to Fort Erie, directly opposite the Peace Bridge over the Niagara River has been graded and will probably be paved this year.

The completion of the highway will provide adequately for the heavy tourist traffic from the United States. It is estimated that 50% of the United States visitors to Canada enter at border points in the Niagara District. It will provide transportation facilities for materials and finished products to and from a large number of industrial plants now engaged in the production of war supplies. It will also be valuable from a military standpoint; recent troop manoeuvres demonstrated that motorized units could maintain on it a speed of from 45 to 50 miles per hour as compared with a speed on ordinary roads of from 25 to 30 miles per hour.

A traffic census taken during the Labour Day period last year showed that from 17,000 to 38,000 vehicles were handled daily and it is estimated that a traffic of 60,000 vehicles per day would be no inconvenience.

The road is being built to the highest modern standards of both safety and stability. Grades are limited to a maximum of 3% and curves to 2 degrees. The pavement is of cement concrete four lane construction, the driving lanes being 11 feet in width and passing lanes 12 feet. Separating the motor ways is a grassed boulevard of varying widths but generally 30 feet. Slopes are being sodded and trees planted. Grade separations are being installed at all intersecting heavily travelled roads and railways, and clover leafs constructed at entrances and outlets to Towns and Cities. Separated bridges have been built accommodating traffic in each direction.

The highway is being lighted as an added safety measure, 14 miles already having been done. All crossings and junctions are being marked with sodium vapour lamps which glow a bright yellow in contrast with the incandescent lights elsewhere. Another safety measure is the banning of bicycles from the highway. There are parallel roads nearby which can be used by cyclists and horse-drawn vehicles.

One of the rolls of film shown deals more particularly with construction work carried out last year between Burlington and Niagara Falls. As time was an important factor the 41 miles to be built were divided into eight contracts. The most up-to-date type of equipment was used and the whole pavement was laid in 44 working days. The highest individual daily production of concrete by one contractor was 4,000 feet of 11-foot wide strip in 16 hours. The highest total daily production for seven contracts was the equivalent of 2.33 miles of 23-foot-wide pavement.

All mixes of concrete were determined by trial in the field, trial mixes being based on a cement content of 6.6 to 6.75 sacks of cement per cubic yard of concrete; slump limited from 1 in. to 3 in. and a water cement ratio of four imperial gallons per sack of cement.

Daily tests of samples of concrete, job cured, showed an average compressive strength of 4,500 lbs. per square inch.

The pavement section adopted has a uniform thickness of 9 in. as compared with the 10-7-10 adopted heretofore. Adjacent slabs are keyed together by a key formed in the side of the slab 3 in. deep and 1 in. wide. Transverse expansion joints of creosoted wood were installed at 300-ft. intervals.

After the concrete was poured, finished and broomed, it was cured by the customary method of covering with wet burlap kept continuously wet for 24 hours, then by ponding for 8 days.

RAILWAY DIFFICULTIES

From *Trade & Engineering*, (London), December, 1940

After 15 months of war and three months of intensive air attacks train speeds and punctuality are suffering. The main reasons are the redistribution of the population, greatly increased freight traffics, black-out and weather conditions, the immediate and after effects of enemy action, and air-raid warnings. Longer trains are being run to carry all who desire and have to travel. More passengers are making longer journeys than in peacetime. Men and women in uniform, evacuee children, their parents and relatives, all make long, individual journeys. The running of longer trains at times involves double stopping at stations and delays to main line trains react on services in other parts over wide areas. During air-raid "alerts" train speeds of 25 miles an hour are necessary for safety reasons during non-black-out hours, a restriction which has undoubtedly reduced the severity of casualties in railway accidents, apart from saving rolling stock, engines, carriages and wagons which are not now readily replaceable. It is perhaps overlooked that the railways have not endless supplies of locomotives, carriages, rails and sleepers, and the renewal of rolling stock requires men and material urgently needed elsewhere.

All kinds of commodities, coal, munitions, shells, guns, war equipment and essential food supplies are being moved in greater masses on the railways than in peace-time. As a nation we are becoming more and more self-supporting. Evacuation has meant that small stations now deal with three and four times more freight than hitherto, and evacuation also means that supplies of clothing, foods, fuels, mails, newspapers and all other commodities for the upkeep of the new homes of the people require transport. Home-grown timber is being loaded at country stations, branch lines are busier, and local produce is being moved in quantities to feed the nearest large towns and cities. Heavy freights have also to be handled when the convoys arrive at the docks and there has been such diversion to the railways of freights which formerly were carried by coastwise steamers. New unusual traffics, such as the leaves of bushes and plants for medical supplies, are being dispatched to wholesale chemists, and the urgent tonnages for the war effort are being moved by freight trains which are slower than passenger trains and take much longer times on their journeys.

Much of the freight traffic in peace-time was handled during the night. To-day the position is that during the black-out hours freight movements and shunting are slowed up, and the time available for loading and unloading in daylight is restricted. Winter-time weather also affects the rapidity of freight operation. Throughout the railway system control staffs are constantly watching and regulating the flow of traffic, both passenger and freight, to keep the railway wheels turning. Although railwaymen remain at work during air raids, air raid warnings affect the collection and delivery of goods, and although extremely rapid repairs are carried out to bombed tracks, stations, bridges, and tunnels, it is often necessary for speed checks to be instituted at particular points on the railway lines until more permanent restorations can be effected. The running of more and faster passenger trains is said to be impracticable in present conditions when priority must be given to the movement of freight traffics for war production. Every passenger train provides regular communication for as many places as possible, and while there is no restriction on travel by train, essential freights must get through. The railways have stood up well to the effects of enemy action, and although there does not seem much prospect of an immediate return to the regularity and punctuality of peace-time passenger trains, railwaymen are determined that the trains shall be kept running and the essential services maintained.

A ROLE FOR ENGINEERS

From *Mechanical Engineering*, Easton, Pa., April, 1941

Engineers should find some way to pluck William E. Wickenden out of his administrative duties as President of the Case School of Applied Science and from his important services at Washington in the cause of national defense and send him around the country for a few months at least, to carry to all engineers and their well-wishers the message he delivered on February 7th to The Engineering Institute of Canada. The reading of it will start many minds off on a track of wishful speculation and, it is hoped, pious resolve to work for the advancement of the engineering profession, and it should also help to crystalize in the minds of readers some of the basic principles of professionalism. Probably Dr. Wickenden cannot be spared from either of his important posts at this time, but one wonders if he might not at some future date speak on this subject to many groups and bring within the influence of his personality men who, awakened to the high purposes his address sets forth, would immeasurably raise the level of the profession in which they find themselves and coincidentally make a better world for their fellow men.

It is a satisfaction to direct attention, for the purpose of emphasis, to a portion of Dr. Wickenden's address that covers a point frequently urged in these pages. This refers to the strategic position held by engineers as managers of enterprises, in whole or in part, where their intermediate position between owners and employee vests them with responsibilities to both and equal responsibilities to the public served by these enterprises. Few thinking men doubt the inevitable social and economic changes that the future, conditioned by world-wide upheaval of which the war is a horrifying witness, may hold in store. The industrial era of modern civilization is working toward its climatic phase, during which the pattern of economic, social, and political life will either be woven into a strong fabric of more wholesome relationships or be replaced by one that is alien to most of us.

Just as engineers hold the key position in respect to the military conflict that is spreading so rapidly over the globe, so also they may occupy the position of determining influence in the unpredictable events that inevitably will accompany peace. But to exercise to beneficial purpose the influence that may be theirs, engineers must rapidly assume a habit of intellectual maturity in the chaotic field of human relationships. They alone cannot insure the character of the pattern of things to come, but, aided by thousands of men of sound judgment and intelligent understanding of the rapidly developing history of our times, they afford the most hopeful instrumentality by means of which a better world may be built.

NATURE LED THE WAY TO INSULATION

From *Refrigeration and Air Conditioning* (Gardenvale, Que.) November, 1940

In Spain, Portugal, Southern France, and Northern Africa are heavily wooded areas which are subjected to a scorching sun and hot, parching winds. During the summer, when practically all other vegetation is dried up, you see certain flourishing trees unaffected by the heat.

These are cork oak trees. They survive because they are heavily sheated with an outer bark of such peculiar structure that it insulates the living cork tree from the heat and from the drying wind.

This outer bark is cork. From it is obtained the commercial cork which finds its way into a thousand and one nooks in our daily life.

The commercial cork is obtained by "stripping." The "sap bark" lying next to the woody growth carries the life-blood of the tree and under no circumstances should be disturbed. This in turn is covered by a thick layer of multi-celled bark, highly resilient and compressible. It is this bark which is used for insulation and other purposes. A shaggy outer bark encases the whole, this last having no commercial value.

When stripped from the parent tree, the bark is naturally curved, as it conformed to the trunk or large branch. These slabs are piled high on a cradle arrangement and the huge bundle is picked up by a hand crane and swung over and into a vat of boiling water. After being immersed for a short time the bark becomes pliable and can be readily flattened out. At the same time the coarse outer bark is softened and is easily scraped off.

After being trimmed to size and thickness, the slabs are carefully wrapped and packed for transportation.

The large companies operating in Canada and the United States have their own factories in the cork growing districts and do their own processing and packing. Arrangements are made for shipping to the American continents where the majority of the world's supply is consumed. Usually, freighters are chartered to make the trip from a Spanish or Portuguese port across the Atlantic. These runs are scheduled to keep the market supplied without maintaining too large stocks on this side.

However, the present war has considerably interrupted the even flow of supplies. The two greatest export countries are situated on the more dangerous trade routes and shipping, even when not commandeered, is irregular. This situation has caused Canadian and American manufacturers and importers to build up as large stocks as possible in order to handle the regular volume of business and to take care of war demands. Naturally, munitions have to receive first consideration, but supplies have been ample to meet all demands from every quarter.

BOILER OIL FOR MOTOR-SHIP ENGINES

From *Trade & Engineering*, (London), November, 1940

It was mentioned in these columns some time ago that all the motorships, numbering over 40, which are being, or have been, built under the U.S. Maritime Commission's programme have to operate on a heavy grade of residual oil. The results of the performance of some of these vessels in service are now available. It appears that the oil is known as a modified Bunker B, that its specific gravity may be anything up to unity, and that it contains a maximum of one per cent of sulphur. The new vessels—there are four of them—are cargo ships of about 11,600 tons deadweight capacity, with geared two-stroke machinery of 8,000 b.h.p. driving a single shaft. Four engines are employed and they run at 225 r.p.m. The shaft speed is about 90 r.p.m.

The results indicate that the total fuel consumption with this boiler oil in service on fairly long routes is 0.42 lb. per b.h.p. hour for all purposes. This figure seems somewhat high, even bearing in mind the large amount of electric power generated by Diesel machinery, required on board ship. It is, moreover, expected that the cylinder liner wear will be greater, and these two factors have to be taken into account when the question of the economy of utilizing boiler oil is under consideration. In a corresponding European ship with a single engine direct-coupled to the propeller, a fuel consumption of about 0.38-0.39 lb. per b.h.p. hour for all purposes would be expected. Thus, the increased consumption with the heavier oil, to the extent of 10 per cent, and the cost of more frequent liner replacements have to be set against the economy affected by burning oil which is, roughly speaking, 30 per cent cheaper.

From Month to Month

News of the Institute and other Societies, Comments and Correspondence, Elections and Transfers

HONOURS FOR THE PRESIDENT

It is a matter of general satisfaction and pleasure to all engineers that Dean Mackenzie is to receive this month, not only one but two honourary degrees. On May thirteenth, at Halifax, his own alma mater, Dalhousie University, gives him a Doctorate of Laws, and on May twenty-ninth, McGill University confers upon him a Doctorate of Science.

While there is more than one justification for paying these tributes to Dean Mackenzie, members will feel that his presidency of the Institute may have been a contributing factor, and engineers in general may be excused if they see in these acknowledgments of merit and attainment, a tribute to the profession.

The profession will be proud to have him speak for it as well as for himself on these two significant occasions. Engineers throughout Canada join wholeheartedly in congratulations and wish him unlimited success in his important field of usefulness.

THE PRESIDENT VISITS THE MARITIME BRANCHES

It has been admitted that the importance and urgency of the work being done by President Mackenzie in his capacity as Acting President of the National Research Council, would make it difficult, if not impossible, for him to visit the branches of the Institute. Therefore it is a matter of much satisfaction that he has been able to arrange to visit at least some of the maritime branches in conjunction with his trip to Halifax for the convocation of Dalhousie University.

A schedule of visits follows. From this it will be seen that a regional meeting of Council is to be held in Saint John, N.B., as a feature of the short tour. It is expected that councillors from all maritime branches will be present, and that additional representatives will come from Ontario and Quebec. This will make the third meeting of Council this year away from Headquarters.

(All times are Standard. Either Eastern or Atlantic)

Sat.,	May 10—Leave Ottawa......	4.00 p.m.	C.N.R.
Sun.,	May 11—Arrive Halifax......	8.00 p.m.	C.N.R.

Meeting with Branch, Monday night, May 12th

Convocation, Dalhousie University, Tuesday, May 13th

Wed.,	May 14—Leave Halifax......	8.25 a.m.	C.N.R.
Wed.,	May 14—Arrive Moncton.....	1.50 p.m.	C.N.R.
OR			
Wed.,	May 14—Leave Halifax......	4.00 p.m.	T.C.A.
Wed.,	May 14—Arrive Moncton.....	4.50 p.m.	T.C.A.

Meeting with Branch, Wednesday night

Thu.,	May 15—Leave Moncton.....	5.15 a.m.	C.N.R.
Thu.,	May 15—Arrive Saint John....	8.40 a.m.	C.N.R.

Meeting of Branch, Friday night, May 16th

Meeting of Council, Saturday afternoon, May 17th

Sat.,	May 17—Leave Saint John....	7.00 p.m.	C.P.R.
Sun.,	May 18—Arrive Montreal.....	10.25 a.m.	C.P.R.
OR			
Sun.,	May 18—Leave Saint John....	5.15 p.m.	C.P.R.
Mon.,	May 19—Arrive Montreal.....	6.50 a.m.	C.P.R.
OR			
Sun.,	May 18—Leave Saint John....	11.20 a.m.	C.N.R.
Mon.,	May 19—Arrive Montreal (via Moncton)....	6.50 a.m.	C.N.R.

A COMMITTEE REPORTS

For seven years the Institute's Committee on Western Water Problems has been at its task. The work has gone on quietly, continuously and methodically. Not many members of the Institute were aware of its existence or its purpose, and some wondered at its tenacity and longevity. All these can now satisfy themselves that the Committee and Sub-Committee were doing a great work. It is recommended that the report of the Committee appearing in this number of the *Journal* be read and studied as an example of the usefulness of such groups and of the purposes by which the Institute can render a useful service to the public.

This report has been submitted by Council to the Prime Minister of Canada. It is felt that leadership in this important problem of combatting drought and preserving international water rights will be welcomed by the provincial governments concerned, as well as by the federal authorities. The report certainly provides that leadership as it makes clear and specific recommendations based on the findings of experts, representing a non-political, non-prejudiced Canadian-wide professional organization.

The situation is urgent. Early action is necessary if certain benefits of national importance are not to be lost in perpetuity.

REMISSION OF FEES

At the April meeting, Council accepted without hesitation the recommendation of the Finance Committee that fees of members of the Institute resident in the United Kingdom be remitted. It was felt that as such persons are undergoing extraordinary experiences of privation, suffering and disturbances to normal living, any reduction in ordinary business obligations would be helpful. In all there are about fifty members so affected.

This modest gesture of sympathy and support will receive the unanimous approval of all members on this side of the Atlantic.

WARTIME BUREAU OF TECHNICAL PERSONNEL

There is little additional progress that can be reported at this time. The basic work is well underway and many additional developments are under discussion. The mechanics of the proposal are rather formidable, and care is being taken to check each item thoroughly before the body of technical personnel is approached. The quantities are so large that only careful planning and preparation will prevent confusion and waste motion from developing to a disturbing degree.

The questionnaire will be mailed to every person who, on his national registration last September, declared he was then practising engineering, or that his normal occupation was engineering. The mere photostating of the original records runs into a tremendous task. It is estimated that the list will be in the neighbourhood of a thousand feet long, and will contain approximately thirty thousand names and addresses.

With this number thirty thousand in mind it is possible to grasp some idea of the amount of detail involved. It means thirty-thousand envelopes to be addressed, the same number of covering explanatory letters, questionnaires and classifications lists. Upon their return, the information has to be indexed, sorted and filed. The resultant file system will have in it from sixty to seventy thousand cards of one kind or another, all of which will have to be kept up to date.

Certain interesting information on demand and supply has been obtained, which indicates that the Bureau has a real work to do. At a meeting of the Advisory Board held in Ottawa in April, approval was given to the work already done and to plans for the future. Discussions brought forth indications that the usefulness of the Board might go much farther than was originally contemplated.

At present the main task is to get the forms out to the engineers and chemists. This is a larger undertaking than was at first contemplated, but the extra time taken now in more detailed preparation will facilitate the working of the system later when it goes into action.

CORRESPONDENCE

The Institution of Electrical Engineers,
18th March, 1941.

L. Austin Wright, Esq.,
The Engineering Institute of Canada,
2050 Mansfield Street,
Montreal, Canada.

Dear Mr. Wright,

Your letter of the 3rd February inviting the Institution of Electrical Engineers to undertake the presentation of the Sir John Kennedy Medal to General McNaughton did not reach me until the 10th March, when I immediately consulted the President, who greatly appreciated the opportunity you have afforded us in England to do honour on your behalf to General McNaughton.

Accordingly, after ascertaining a date that would be convenient to General McNaughton and to the High Commissioner for Canada, I telegraphed you as follows:

"Yours 3rd February just received stop delighted arrange presentation medal to General McNaughton at Kelvin Lecture meeting May 8th when Presidents other leading Institutions usually present stop have ascertained date convenient General and High Commissioner stop telegraph or air mail further instructions and suggested guests advisable post medal early with details recipients career and conditions award."

On account of the general situation here and also the pressure at which the majority of our members are working, meetings have not been held in London during the present Session, but a few weeks ago it was decided that on the occasion of the Annual General Meeting which, being a statutory meeting, would have to be held, the Kelvin Lecture should also be delivered. This occasion would seem to be one which would be appropriate, and one on which we could hope to do justice to the presentation ceremony.

We are honoured that General McNaughton is a member of this Institution, and, in welcoming him on his arrival in this country, we placed our resources at the disposal of himself and his officers. More recently, on learning of the award of the Sir John Kennedy Medal, we wrote congratulating him. From this you will appreciate why, at a meeting of my Council on the 13th March, pleasure was unanimously expressed at your proposal and at the decision our President had taken.

If the time your letter has taken in reaching here is typical, we shall not have much opportunity for further interchange of views before the 8th May, and it was for this reason that I suggested your sending me as soon as possible full details of the award and the names of distinguished Canadians and others whom you would wish to suggest might be asked to the presentation.

Before the meeting there will be an informal luncheon for members of the Council and to this General McNaughton and the High Commissioner understand that they will receive an invitation.

I sincerely hope that no circumstance will interfere with the arrangements for a ceremony to which we are looking forward with pleasure.

Yours sincerely,
(*Signed*) W. K. Brasher, *Secretary.*

E.C.P.D. ANNUAL REPORT

Engineering, in many and obvious ways, is growing as a profession. The quality of that growth is largely governed by activities in accrediting curricula, in improving the admission of suitable students to the profession, and in securing the proper appreciation of all that it means to be an engineer. These activities are described in the Eighth Annual Report of Engineers' Council for Professional Development, just published.

The Chairman of E.C.P.D., John P. H. Perry of New York City, records not alone the affiliation of The Engineering Institute of Canada, in October 1940 with E.C.P.D., but stresses the remarkable progress in accrediting engineering curricula. He reports also the petition from a group of technical institutes that some such plan of accrediting be evolved by E.C.P.D. for the technical institutes of the country, thus giving more effective recognition to their sphere in technical education.

The Committee on Student Selection and Guidance, Dean Emeritus R. L. Sackett of Pennsylvania State College, *Chairman*, reports further progress in the study of aptitude tests and, especially, advance in the promotion of proper selection of engineering as a career by high school boys. This committee's report contains excerpts from summaries of activities, submitted by local groups of engineers, in New York, Omaha, Detroit, Iowa, and Canada, whose aim was not to recruit to engineering but to give boys of high school age an opportunity to learn the qualities and aptitudes essential to success. Thus, those with decided engineering talent will continue in their ambitions for this field while those without sufficient aptitude will not undertake a career in engineering if they will be more likely to succeed elsewhere.

Dean A. A. Potter of Purdue University, for the Committee on Engineering Schools, discusses the problems of accrediting and gives statistics on the subject since the initiation of the accrediting programme.

The Committee on Professional Training, Dean O. W. Eshbach of Northwestern University, *Chairman*, reports further efforts to discover what is being done by and for junior engineers in their immediate post-graduation period, and includes as an appendix a questionnaire used to gather information, on this subject. This will be used, then, as the basis of a programme to be developed for use among the various organizations.

The Committee on Professional Recognition, Professor Emeritus Charles F. Scott of Yale University, *Chairman*, probes the matter of engineering as a profession, and an appreciation of it as such. He strongly urges the various constituent organizations of E.C.P.D. to encourage emphasis on ethics, the teaching of ethics, and the professional spirit among engineering students, in order that they may acquire a full conception of the profession as early as possible.

Founded in 1932, E.C.P.D. is an organization representing the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers, Society for the Promotion of Engineering Education, National Council of State Boards of Engineering Examiners, and The Engineering Institute of Canada. The purposes of E.C.P.D. is to enhance the professional status of the engineer. Its Eighth Annual Report evidences definite progress toward this objective.

MEETING OF COUNCIL

Minutes of a regional meeting of the Council of the Institute held at the Royal York Hotel, Toronto, Ontario, on Saturday, April 19th, 1941, at two o'clock. p.m.

Present: President C. J. Mackenzie in the chair; Past-President J. B. Challies (Montreal); Vice-Presidents K. M. Cameron (Ottawa), McNeely DuBose (Arvida), and J. Clark Keith (Border Cities); Councillors A. E. Berry (Toronto), D. S. Ellis (Kingston), J. G. Hall (Toronto), E. M. Krebser (Border Cities), J. L. Lang (Sault Ste. Marie), A. Larivière (Quebec), W. R. Manock (Niagara Peninsula), H. Massue (Montreal), W. L. McFaul (Hamilton), C. K. McLeod (Montreal), W. H. Munro (Ottawa), H. R. Sills (Peterborough), C. E. Sisson (Toronto), J. A. Vance (Woodstock), and General Secretary L. Austin Wright.

There were also present by invitation: Past-President C. H. Mitchell; Past-Councillors W. E. Bonn, A. U. Sanderson, J. G. R. Wainwright and R. B. Young; Branch

Chairmen C. H. McL. Burns (Niagara Peninsula), W. A. T. Gilmour (Hamilton), and R. L. Dobbin (Peterborough); H. E. Brandon, chairman, W. S. Wilson, vice-chairman, F. J. Blair and R. F. Legget, members of the executive, and J. J. Spence, secretary-treasurer of the Toronto Branch; and H. F. Bennett, chairman of the Institute's Committee on the Training and Welfare of the Young Engineer.

After each person was introduced to the meeting, the President extended a cordial welcome to all guests, and asked them to feel free to take part in any of the discussions.

The general secretary reported briefly regarding the James Watt International Medal, which is the senior award of its kind in the Old Country. The final decision is made by a committee appointed under the auspices of the Institution of Mechanical Engineers, sixteen national engineering societies being asked to submit nominations. At the last meeting of Council a letter was read from one of our members in London, Colonel C. G. DuCane, suggesting that it would be very suitable if the next award could be made to some one from one of the Dominions. It is likely that Mr. A. G. M. Mitchell, M.C.E., F.R.S., will be nominated for the next award by the Institution of Engineers of Australia, and supported by the Institution of Engineers of South Africa. It is suggested that if the Engineering Institute of Canada would support this nomination it would probably insure Mr. Mitchell's success. At the last meeting of Council it was decided to leave the matter open to see if anyone had any other names to suggest. Since then the general secretary had been in correspondence with several outstanding members in the mechanical engineering field, all of whom had endorsed this nomination. Following some discussion, on the motion of Mr. McFaul, seconded by Mr. Sisson, it was unanimously resolved that Mr. Mitchell's nomination be supported by the Engineering Institute of Canada.

At the request of Dr. Challies, the President vacated the chair, which was then taken by Past-President Mitchell.

Dr. Challies drew the attention of Council to the two honorary degrees which are shortly to be conferred upon the Institute's worthy and much respected president. On May 13th his Alma Mater, Dalhousie University, will confer upon him the honorary degree of Doctor of Laws, and on May 29th McGill University will confer an honorary degree of Doctor of Science. Dr. Challies moved, and Mr. Larivière seconded a motion that Council record its pleasure and satisfaction that these timely and deserved distinctions had come to Dean Mackenzie, and that the congratulations of this meeting be presented to him through the acting chairman. This proposal was greeted with enthusiastic applause, and Past-President Mitchell graciously conveyed the greetings and good wishes to the president.

In reply, on retaking the chair, President Mackenzie expressed his sincere appreciation of the honours which are to be conferred upon him and of Council's congratulations. He did not consider the conferring of such degrees as entirely a personal matter. He felt that the office of president of The Engineering Institute of Canada, to which he had been graciously elected, was mainly responsible for these awards. Recognition, on the part of the universities, of the position the engineering profession in Canada holds, is shown in this very tangible way, and is something in which all engineers should take pride.

The president reported that during the morning a meeting had been held with the Ontario councillors to discuss means by which the two vice-presidencies for Ontario could be arranged so that every branch would have a fair share of the honour. The outcome of the discussion was that it was agreed that the best results would be obtained if the province were divided into two circuits with Ottawa, Toronto, Peterborough and Kingston in one, and the remaining six branches in the other. Subject to the approval of the branches in the first group, a gentleman's agreement could be arrived at whereby one vice-presidency would go from Ottawa to Toronto, to Kingston, then back to Ottawa, Toronto and Peterborough, this circle repeating regularly. Such an arrangement would give Ottawa a vice-president two years out of six, with Toronto in the same proportion. Peterborough and Kingston would have a vice-president two years out of every twelve years. In the other circuit, the vice-presidency would rotate regularly, thus giving every branch in that group a vice-president two years out of every twelve.

The advantage that this gives to Ottawa and Toronto was thought by all councillors to be equitable. It was expected that the branch which had the privilege of naming nominees would put up more than one name for election. The president explained that the proposal could not be any more than a recommendation to the chairman of the Nominating Committee each year, but thought such an arrangement should be satisfactory as it was already followed in the other zones.

The president also reported that at the morning meeting there had been considerable discussion about ways and means by which the Institute might expand its programme of promoting co-operation within the province of Ontario. The discussion revealed the fact that in the councillors' opinions there was nothing special that should be done at this time beyond following out the established policy of promoting at every opportunity frank and friendly co-operation with all engineering bodies.

Another matter which was discussed was the possibility of establishing additional branches in the province. Some of the councillors suggested that certain areas had developed to the point that the Institute could render a better service by establishing branches in those areas. It was left with certain councillors to investigate conditions locally and to report back to Council.

It was noted that the financial statement to the end of March had been examined by the Finance Committee and approved.

In view of the privation, and the sacrifice which is being made by Institute members resident in the United Kingdom, and the difficulties attendant upon remission of money to Canada, the Finance Committee recommends that Council agree that the fees of such members for the year 1941 be remitted. The Secretary reported that this would affect the Institute's revenue by about $700.00 a year, but it was the unanimous opinion of the councillors that this sacrifice should be made in view of the circumstances.

Upon the motion of Mr. Hall, seconded by Mr. Massue, it was unanimously and enthusiastically agreed that this policy should be followed, and the secretary was accordingly instructed to communicate with all members who will be affected by the ruling.

The secretary reported that an interim statement from the Hamilton Annual Meeting Committee indicated that the deficit on local events usually paid by Headquarters was being met by the Branch out of their own funds. This would make it possible to keep the total cost of the meeting to Headquarters down to a very reasonable sum. As a part of the motion approving of the Finance Committee's report, it was agreed that Council should express its appreciation of the action of the Hamilton Branch.

Dr. Challies, chairman of the Institute's Committee on Professional Interests, reported briefly on the progress being made towards co-operation with the various provincial associations. The co-operative agreements in Saskatchewan and Nova Scotia, completed in 1938 and 1939 respectively, and the recently completed agreement in Alberta, are working very satisfactorily. Discussions are under way in Manitoba and New Brunswick, and it is hoped that substantial progress will be made this year.

Mr. H. F. Bennett, chairman of the Institute's Committee on the Training and Welfare of the Young Engineer, reported that definite progress was being made in the preparation of the Canadian booklet for distribution to high school students. The final draft will be submitted to Council, and it is expected that the booklet will be ready for distribution in the early fall. This was noted, and the president commented on the valuable work that is being done by Mr. Bennett's committee.

On the motion of Mr. Vance, seconded by Mr. Massue, it was unanimously resolved that a vote of thanks be tendered to the Toronto Branch executive for their kindness and courtesy in entertaining the councillors at lunch.

Two councillors referred to two specific cases where Institute certificates were being displayed by engineers who were no longer members. In their opinion this was an undesirable condition, and they inquired to see if any means were available whereby such certificates could be returned to the Institute.

In the discussion which followed, it was pointed out that the by-laws of the Institute require certificates to be returned when membership ceases, but that it had been found impossible to carry this out in practice. The meeting agreed that it was desirable to have the certificates returned, and the secretary undertook to include such a request in any correspondence having to do with resignations or removals from the list.

The secretary was also instructed to write to the two individuals specifically mentioned after a further check was made to see if the certificates were still on display.

The president pointed out that in conjunction with the presentation of his honorary degree at Halifax on May 13th, it might be possible for him to visit some of the other maritime branches at that time. He suggested that if any other members of Council could find it convenient to accompany him, it would be very much appreciated by the branches. Speaking from his own experience in the west, he realized how much such visits meant to the smaller branches, and how they stimulated interest in Institute affairs. He would be very glad to hear from any councillors who could make the trip.

A number of applications were considered and the following elections and transfers were effected:

Admissions	
Members	17
Students	26
Transfers	
Junior to Member	5
Student to Member	1
Student to Junior	13

It was left with the President to decide on the date and location of the next Council meeting.

The Council rose at four o'clock p.m.

ELECTIONS AND TRANSFERS

At the meeting of Council held on April 19th, 1941, the following elections and transfers were effected:

Members

Agnew, Ellis A., B.A.Sc. (Univ. of Toronto), vice-president i/c engrg., Livingston Stocker Co. Ltd., Hamilton, Ont.

Danks, Cyril Norwood, Diploma, S.P.S. (Univ. of Toronto), Ontario District Engr., Canadian Ingersoll-Rand Co. Ltd., Toronto, Ont.

Duncan, Wm. Archibald, B.A.Sc. (Univ. of Toronto), manager, Process Service, Dominion Oxygen Co. Ltd., Toronto, Ont.

Dyer, Frederick Frank, B.A.Sc. (Univ. of Toronto), general engrg. dept., Imperial Oil Limited, Sarnia, Ont.

Folger, Collamer Coverdale, (Queen's Univ.), general manager Public Utilities Commission of Kingston, Ont.

Hole, William George, B.Sc. (Univ. of Alta.), heating engr., T. Pringle & Son, Montreal, Que.

Johnson, Edwin Lewis, B.Sc. (McGill Univ.), works mgr., Canadian Industries Ltd., "Dominion" Ammunition Divn., Brownsburg, Que.

Leheup, Charles Samuel Henry, (Leyton Tech., Woolwich Polytechnic London), member of United Kingdom Technical Mission to Canada, Montreal.

Noonan, William Fleming, B.Sc. (Queen's Univ.), Divn. engr., Dept. of Highways of Ontario, Kingston, Ont.

Rawlins, James Walter, B.Sc. (Queen's Univ.), 27 Ava Rd., Toronto, Ont.

Wood, Elvin Morley, B.A.Sc. (Univ. of Toronto), planning engr., H.E.P.C. of Ontario, Toronto, Ont.

Transferred from the class of Junior to that of Member

Bonnell, Alexander Robertson B.Sc. (Univ. of N.B.), road engr., Trinidad Leaseholds, Ltd., Pointe-a-Pierre, Trinidad, B.W.I.

Gray, Harry Alden B.Sc. (Univ. of Man.), res. engr., Quebec Roads Dept., Knowlton, Que.

Smith, Carl Clifford, B.Sc. (Queen's Univ.), Elec.engr., Canadian Westinghouse Co. Ltd., Hamilton, Ont.

Spriggs, Robert Hayward, B.Sc., (McGill, Univ.), div. plant engr., Bell Telephone Co. Ltd., Toronto, Ont.

Taylor, Franklin Thomas, B.A.Sc., (Univ. of Toronto), dftsman. Richard Wilcox Canadian Co., London, Ont.

Transferred from the class of Student to that of Member

Tassé, Yvon Roma, B.A.Sc., C.E. (Ecole Polytechnique), apparatus sales engr., Canadian General Electric Co., Quebec, Que.

Transferred from the class of Student to that of Junior

Adams, Jack Douglas, B.Eng. (McGill Univ.), inspr., Dominion Bridge Co. Ltd., Montreal, Que.

Baldry, George S., B.Sc. (Univ. of N. Dakota), 810 Wolsley Ave., Winnipeg, Man.

Bellamy, Keith Lacy, B.Sc. (Queen's Univ.), electrical contractor, Niagara Falls, Ont.

Brooks, Joseph Warren, B.Sc. (Queen's Univ.), lecturer, civil engrg., Queen's Univ., Kingston, Ont.

Forsythe, Marshall Anthony, B.Sc. (Univ. of Alta.), elect'l dftsman., Shawinigan Engineering Co., Montreal, Que.

Howe, Harold Bertram, B.Sc. (Queen's Univ.), engr. dftsman., Canada Cement Co., Montreal East, Que.

McIntosh, William Gardner, B.Sc. (Univ. of Man.), Flight Lieut., R.C.A.F., engrg. branch, Ottawa, Ont.

Oliver, James, B.Sc. (Univ. of Alta.), 1407 First St. N.W., Calgary, Alta.

Racicot, Jacques, B.A.Sc., C.E. (Ecole Polytechnique), res. engr., Quebec Roads Dept., Montreal, Que.

Wardrop, William Leslie, B.Sc. (Univ. of Man.), instructing at University of Manitoba, Winnipeg, Man.

Students Admitted

Bateman, Leonard Arthur, (Univ. of Man.), 508 Carlaw Ave., Winnipeg, Man.

Callaghan, James Francis, (Univ. of N.B.), 543 Brunswick St., Fredericton, N.B.

Copping, Edward E., (McGill Univ.), 49 St. Thomas St., Joliette, Que.

Cunningham, Robert Auld, (Queen's Univ.), 151 Second Ave., Ottawa, Ont.

Dubé, Jean Thomas, (McGill Univ.), 174 St. Jacques St., Grand'-Mere, Que.

Gaudreau, Marcel, (Ecole Polytechnique), 3527 Evelyn St., Verdun, Que.

Hiseler, Ronald Percy, B.E.E. (N.S. Tech. Coll.), Canadian General Electric Co. Ltd., Peterborough, Ont.

Kippan, James Alexander, (Univ. of Man.), 129 Arlington St., Winnipeg, Man.

Lentz, Claude Peter, (No. 1 Wireless School, Montreal), Gander, Nfld.

McCorkindale, Donald Harvey, (Queen's Univ.), 75 Lower Alfred St., Kingston, Ont.

McDowell, Creighton Joseph, (Queen's Univ.), 437 Elm Ave., Windsor, Ont.

McKay, William Gordon, B.Sc. (Queen's Univ.), 1940, 382 Earl St., Kingston, Ont.

Pasquet, Pierre Auguste, (Queen's Univ.), 25 King St. W., Kingston, Ont.

Pierce, John Gourley, (Queen's Univ.), 492 Homewood Ave., Peterborough, Ontario.

Pue-Gilchrist, Alfred Conde, (McGill Univ.), 3437 Peel St., Montreal, Que.

Remus, Frank Richard, (Queen's Univ.), 141 Agnes St., Oshawa, Ont.

Savory, John Alfred, (Queen's Univ.), 10 Lumsden Ave., Hamilton, Ont.

Seymour, David Llleyellyn, (Queen's Univ.), 87 Cartier St., Ottawa, Ont.

Stopps, F. Sidney, (McGill Univ.), 3506 University St., Montreal, Que.

Trout, Ross Gregory, (Queen's Univ.), Estevan, Sask.

Personals

News of the Personal Activities of members of the Institute, and visitors to Headquarters

Dean C. J. Mackenzie, M.E.I.C., president of the Institute and acting president of the National Research Council has been given the honorary degree of LL.D. by his Alma Mater, Dalhousie University, at the Convocation held on May 13th.

McGill University will also be conferring a degree of Doctor of Science on Dean Mackenzie at the Convocation to be held this month.

J. M. R. Fairbairn, M.E.I.C., past-president of the Institute and former chief engineer of the Canadian Pacific Railway Company has been appointed director of works and buildings, Naval Service, Department of National Defence, at Ottawa.

Geo. A. Walkem, M.E.I.C, past president of the Institute, is president and managing director of the Gulf of Georgia Towing Company Limited, Vancouver, B.C. In the January number of *Harbour and Shipping*, a monthly magazine published at Vancouver, a very interesting account is given of the beginning of the company, 32 years ago, with five small scows. The company has now progressed to a point where it owns five diesel tugs and sixty scows, and is the most prominent towboat company operating out of the largest city in British Columbia.

H. E. Brandon, M.E.I.C.

H. E. Brandon, M.E.I.C., is the newly elected chairman of the Toronto Branch of the Institute. He was born at Cannington, Ont., and was educated at the University of Toronto where he was graduated in 1907. Upon graduation he went with the Manitoba Bridge and Iron Works at Winnipeg, and in 1910 joined the Vulcan Iron Works of Winnipeg. From 1911 to 1915 he was chief engineer with this firm, and from 1915 to 1919 he was overseas in active service. In 1919 he joined the Hydro Electric Power Commission of Ontario as a structural and mechanical engineer, and is still with the Commission.

W. H. Munro, M.E.I.C., director and general manager of the Ottawa Light Heat and Power Company Limited was elected president of the Rotary Club of Ottawa last month. He has also been elected to the vice presidency of the Industrial Accident Prevention Association of Ontario. Mr. Munro is a councillor of the Institute representing the Ottawa Branch. It is interesting to note that the present president of the Rotary Club of Montreal, Mr. DeGaspé Beaubien, is also a member of the Council of the Institute being vice-president for the province of Quebec.

Major W. L. Thompson, M.E.I.C., has recently been promoted to that rank and appointed to be second in command of No. 2 Army Field Workshop, R.C.O.C., which is stationed in England. Born near London, Ont., Major Thompson received his education at the University of Toronto, graduating in mechanical engineering in 1927. Since then Major Thompson has been with the Bailey Meter Company Limited, of Montreal, where he specialized on the automatic control of steam power plants. Shortly before the outbreak of war he was appointed manager of the company at Toronto. An officer of the Non-Permanent Militia unit of No. 2 Army Field Workshop before the outbreak of war, Major Thompson proceeded overseas in January, 1940, and has served with the unit in England since that time. Major Thompson is the brother of Lieutenant-Colonel H. G. Thomspon, D.F.C., M.E.I.C., who originally commanded the unit.

G. H. Kirby, M.E.I.C., has recently been appointed chief engineer of the Canadian Car Munitions Limited, Montreal. He had been with the company since early last fall. Previously Mr. Kirby was with Price Brothers and Company, Ltd., at Kenogami, Que., as electrical superintendent of the Riverbend mill.

J. A. Ouimet, M.E.I.C., has been appointed assistant chief engineer of the Canadian Broadcasting Corporation. Born at Montreal in 1908, he was educated at the College Ste-Marie and obtained his B.A. degree from the Université de Montréal in 1932. He received his engineering training at McGill University where he was graduated in electrical engineering, with the highest honours, in 1932. After graduation he was employed as research engineer with the Canadian Television Limited and the Canadian Electronic Company until 1935 when he joined the staff of the Canadian Radio Broadcasting Commission, now the Canadian Broadcasting Corporation. He was employed in development work until 1937 when, as operations engineer, he was put in charge of the operation and maintenance of all C.B.C. stations. In 1939, he was made general supervising engineer and was given full responsibility for the engineering organization of the royal visit broadcasts. In his new position Mr. Ouimet will continue to supervise all technical facilities of the C.B.C. and will be responsible for the administration of the engineering division under the direction of the chief engineer.

Lieutenant Trevor C. Thompson, M.E.I.C., is now in England with the Royal Canadian Ordnance Corps. Before enlisting last fall, he was with the Bell Telephone Company of Canada, at Montreal.

T. R. Bell, M.E.I.C., is now acting as resident technical officer for the Department of Munitions and Supply in the General Electric Company's works at Peterborough, Ont. He was previously with the Jaeger Machine Company Limited, and was located in Toronto.

J. A. Creasor, M.E.I.C., is now located at Port Colborne, Ont., with the Canada Cement Company Limited. Lately he had been located at Kilmar, Que., with the Canadian Refractories Limited.

H. B. Montizambert, M.E.I.C., has been granted a commission in the Royal Canadian Airforce with the rank of Flying-Officer, and has been appointed Works and Building Engineer at No. 13 Service Flying Training School, at St. Hubert, Que. Flying-Officer Montizambert has been connected with several large construction projects during his professional career, and is well known in the Montreal Branch where he has been particularly active.

R. A. Sara, M.E.I.C., has been appointed managing secretary of the Industrial Development Board of Manitoba at Winnipeg. Mr. Sara is an alderman for the City of Winnipeg.

J. A. Ouimet, M.E.I.C.

W. H. Munro, M.E.I.C.

Noel N. Wright, M.E.I.C.

Noel N. Wright, M.E.I.C., has recently been elected president of the Young Men's Canadian Club of Montreal. He was born in England and educated at the University of Illinois where he was graduated in 1928. He has been with Ferranti Electric Limited as a sales engineer since graduation, covering eastern Canada. He is chairman of the electrical section of the papers committee of the Montreal Branch.

Léon A. Duchastel, M.E.I.C., has been appointed Officer Commanding the Collège Jean de Brebeuf contingent of the C.O.T.C. at Montreal. Major Duchastel is power sales engineer with Shawinigan Water and Power Company. He is also the secretary-treasurer of the Montreal Branch of the Institute.

A. M. Reid, M.E.I.C., who was district engineer with the Department of Public Works of Alberta at St. Paul, has been transferred to Grande Prairie.

H. R. Younger, M.E.I.C., former superintendent of the Kettle Valley Division of the Canadian Pacific Railway Company at Penticton, B.C., has been appointed district engineer at Calgary, Alta. He has been with the company since his graduation from McGill University in 1910.

Donald A. Forbes, Jr.E.I.C., has joined the staff of Price Brothers & Company Limited, at Kenogami, Que. He was graduated in civil engineering from the University of Saskatchewan in 1934. For a few months after graduation he worked with the Canadian National Railways at Saskatoon, and in 1935 he was employed on a geographical survey with the Department of Mines and Resources of Canada. Since 1936 he had been with the Consolidated Paper Corporation at Port Alfred, Que.

R. V. Anderson, Jr.E.I.C., left the Imperial Oil Company in August, 1940 after returning from five-years' service in the tropics and has since been employed by the Chemical Construction Corporation at Niagara Falls, Ont. He was graduated from the University of British Columbia in 1931.

F. M. Booth, Jr.E.I.C., has joined the staff of the Canadian Pacific Railway Company, Air Service Department, in Montreal. He was graduated in 1938 from McGill University in mechanical engineering and upon graduation joined the staff of Trans-Canada Airlines in Winnipeg. He was engaged in the design and testing of aircraft structures and equipment, as well as development work, until he left to accept his new position.

A. Mead Wright, S.E.I.C., has been commissioned as sub-lieutenant in the R.C.N.V.R., Engineers' Special Branch, and upon his graduation from McGill University in electrical engineering last month, left for Halifax, N.S., to follow a training course. Sub-Lieutenant Wright is the son of the general secretary of the Institute.

Jacques Belle-Isle, S.E.I.C., is now employed as field engineer in the Plant Department of the Bell Telephone Company, Montreal. He was graduated from the Ecole Polytechnique in 1938 and has since been employed with the Quebec Roads Department. Lately, he was division engineer at Plessisville, Que. Mr. Belle-Isle was the winner of the Ernest Marceau Prize of the Institute in 1938.

James O. Dineen, S.E.I.C., is now employed as an instructor in the War-Emergency Radio Classes at the Westdale Technical School, Hamilton, Ont. He was graduated in electrical engineering from the University of New Brunswick in 1940.

J. S. Hubley, S.E.I.C., has returned from Trinidad where he has been employed for the past year and has joined the staff of the McColl Frontenac Oil Company Limited, in Montreal. He was graduated in chemistry from Mount Allison University in 1939.

A. D. K. Laird, S.E.I.C., is now employed with Fraser Brace Engineering Company Limited, at Winnipeg, Man. He was graduated in mechanical engineering from the University of British Columbia in 1940, and upon graduation joined the staff of Defence Industries Limited in Montreal.

D. L. Rigsby, S.E.I.C., is employed with the British Air Commission at Canadian Car and Foundry Company in Montreal.

A. M. Swan, S.E.I.C., has been transferred from the Peterborough works of the Canadian General Electric Company Limited, to the Toronto district office. He was graduated in electrical engineering in 1939 from the University of Manitoba.

VISITORS TO HEADQUARTERS

A. D. Fish, S.E.I..C., from Nobel, Ont., on March 24th.

H. M. Howard, S.E.I.C., Metallurgical Sales Engineer, E. Long Limited, from Orillia, Ont., on March 28th.

M. J. McHenry, M.E.I.C., Director of Sales Promotion, Hydro-Electric Power Commission of Ontario, from Toronto, Ont., on March 31st.

H. G. Stead, Jr.E.I.C., Chief Draughtsman, E. Leonard and Sons, from London, Ont., on April 3rd.

H. I. Mulligan, M.E.I.C., Newfoundland Pulp and Paper Co., from Corner Brook, Nfld., on April 4th.

J. H. Johnson, M.E.I.C., Chief Engineer, The Borden Company of Canada, from Tillsonburg, Ont., on April 8th.

Marcel Papineau, S.E.I.C., from Noranda, Que., on April 16th.

Professor J. A. Van den Broek, University of Michigan, from Ann Arbor, Mich., on April 17th.

F. S. Hutton, Jr.E.I.C., from Hamilton, Ont., on April 18th.

J. M. Fleming, M.E.I.C., President and General Manager, C. D. Howe Company Limited, and Councillor of the Institute representing the Lakehead Branch from Port Arthur, Ont., on April 21st.

L. C. Dupuis, M.E.I.C., Division Engineer, Canadian National Railways, and Chairman of the Quebec Branch of the Institute from Levis, Que., on April 22nd.

Obituaries

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Charles George Du Cane, O.B.E., M.E.I.C., died at St. Albans, Herts., England, on March 4th, 1941, after a short illness. He was born at Willingale, Essex, on March 20th, 1879, and was educated at Winchester College and Cambridge University, where he was graduated in 1900. He served his engineering pupilage with Messrs. Crompton and Company of Chelmsford, where he was engaged in the construction of electric locomotives and in general mechanical work, and also received training, as an assistant to Messrs. Sir John Wolfe Barry and Partners, in general parliamentary work and in the design and construction of bridges, docks, and reservoirs. He served as assistant engineer to the firm on the dock extensions at Middlesbrough, and in 1905 was appointed resident engineer. Later he was engaged for the firm on parliamentary work, chiefly in connection with the London Outer Circle Railway. In 1910 he became chief engineer to Messrs. Norton Griffiths and Company Ltd., of Vancouver, B.C., and his activities included the design and construction of reclamation works at Vancouver. In 1912 he practised as a consulting engineer in the firm of Messrs. Du Cane, Dutcher and Company, at Vancouver, and was responsible for the design and construction of the hydro-electric plant at Kamloops, and for water supply, electric lighting, irrigation, and land drainage in Canada, including complete surveys and estimates for the Calgary-Fernie Railway.

After the outbreak of war in 1914 he was appointed a superintending engineer, being gazetted with standing as a Commanding Royal Engineer. In 1915 he went to Russia on reconnaissance and negotiations for the Murman Railway, and in the same year was commissioned in the Royal Engineers and after road construction work with a Labour Battalion became water-supply officer to the Third Army. He formed and commanded the 352nd Electrical and Mechanical Company, Royal Engineers, and later served on the staff of the Engineer-in-Chief, at General Headquarters, as water-supply officer for laison with the five armies. He was demobilized in March, 1919, with the rank of Lieutenant-Colonel, and in April travelled to India as the representative of Messrs. Sir John Wolfe Barry & Partners to report on harbours for the Madras and Mysore Governments. In 1922 he became a partner in the firm.

The most recent individual work carried out by his firm was as engineers to the London & North Eastern Railway for the New Fish Dock at Grimsby and its equipment at a total cost of over £1,700,000.

Colonel Du Cane was one of the consulting engineers and agents for the Bombay Port Trust and Aden Port Trust and was also a partner in the firm of Messrs. Fox and Mayo, consulting engineers. In 1918 he was awarded the honour of Championship of the Order of the British Empire.

He was elected an Associate Member of The Institution of Civil Engineers on the 4th December, 1906, and was transferred to the class of Member on the 14th December, 1920. He served on the Council of the Institution from November, 1938 until his death. He was a Member of the Institution of Mechanical Engineers, a Member of the Smeatonian Society of Engineers and a Member of the Association of Consulting Engineers being chairman of the latter in 1939.

Colonel Du Cane joined the Institute as an Associate Member in 1912, and he transferred to Member in 1931. He had represented the Institute last January at the presentation of the James Watt International Medal to Professor Stodola, in London.

Frederick Bowles Fripp, M.E.I.C., died in the hospital at Victoria, B.C., on April 14th, 1941. He was born at Ottawa, Ont., on February 18th, 1867, and educated at the Ottawa Collegiate Institute. In 1884 he became engaged with the Ontario Pacific Railway and a few months later entered the office of P. K. Hyndman, civil engineer, Montreal, where he studied for a year. In 1885 he joined the staff of the Department of Railways and Canals as a draughtsman. From 1887 until 1890 he worked as assistant engineer on the construction of the Cape Breton Railway. In 1891 he became connected with the Canadian Pacific Railway Company as an assistant in charge of work at Outremont, Que. From 1894 to 1898 he worked as a leveller in the surveys of the Trent Canal. During the years 1898 and 1899 he worked on the canals at Sault Ste. Marie, Williamsburg and Cornwall. From 1898 to 1913 he was engineer in charge at Sault Ste. Marie for the Department of Railways and Canals, and from 1913 until 1919 he was engineer in charge at the Prince Edward Island Railway Car Ferry Terminals. In 1919 he was appointed harbour engineer with the Canadian National Railways at Moncton, N.B. He retired on pension in 1932.

Mr. Fripp joined the Institute as an Associate Member in 1892. He became a Life Member in 1933.

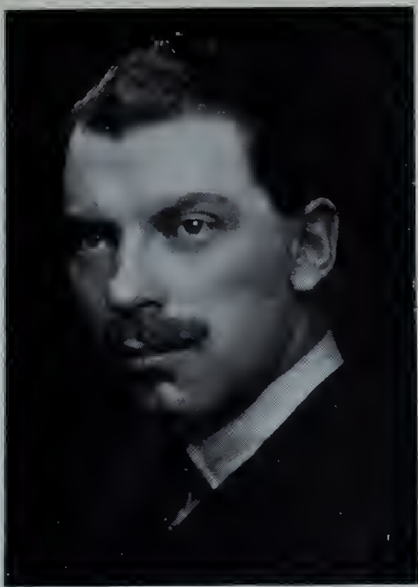
Gaston Lalonde, S.E.I.C., died at his home in Montreal on April 10th, 1941, after a few months' illness. He was born at Montreal on May 15th, 1915, and received his early education at the Mount St.-Louis College, Montreal. He entered the Ecole Polytechnique in 1938 and was in his fourth year at this institution when he died. Several of his classmates gave of their blood for transfusion during his illness. Gaston was the nephew of J. A. Lalonde, M.E.I.C., general manager of the Highway Paving Company, and the cousin of Flying Officer Jean A. Lalonde, killed in active service last summer.

Mr. Lalonde joined the Institute as a Student last fall.

James Grant Moloney, M.E.I.C., was killed in an accidental explosion on March 20th, 1941, while on military duty with the Royal Canadian Engineers in England. He was born in London, Ont., on June 1st, 1908, and was educated in the public schools of that city and at Tri-State College, Indiana, where he was graduated in civil engineering in 1935. Returning to London, Ont., after graduation, he was employed for six months by the City Gas Company in surveying and appraisal work. He then spent three years with a construction company, six months with a firm of consulting engineers in Buffalo, a year with Watt and Blackwell, architects, assisting in the steel design of the Huron & Erie Building at London, and two years with Archibald & Dillon, consulting engineers, London. In 1936 he became designing engineer for the Dominion Road Machinery Co. Ltd., Goderich, Ont., which position he resigned on February 1st, 1938, to join the editorial department of The Canadian Engineer Publications.

He joined the militia as a lieutenant in the Canadian Fusiliers at London in 1935. When he moved to Toronto he secured a transfer to a Toronto regiment. Last June he enlisted for active service, and after three months' training at Petawawa he went overseas in September with reinforcements for an engineering unit.

No details have been received in regard to the explosion that caused Lieut. Moloney's death, but it was known that he had been engaged in the construction of gun emplacements along the south coast of England.



James Grant Moloney, M.E.I.C.

Lieutenant Moloney joined the Institute as a Junior in 1936 and he was transferred to Associate Member in 1939.

John William Morrison, M.E.I.C., died suddenly at his home at Haileybury, Ont., on February 22nd, 1941. He was born at Oldham, N.S., on January 21st, 1880, and was educated at Dalhousie University and Nova Scotia Technical College, where he was graduated in 1912. Upon graduation he went with the Lucky Cross Mines Limited at Swastika, Ont., and later went with the Miller Lake O'Brien Mines, at Gowganda, Ont. From 1914 to 1918 he was manager and engineer with the Lake Shore Mines Ltd., at Kirkland Lake, Ont. From 1919 to 1925 he was with the Argonaut Gold Limited at Dane, Ont., first as manager and later as general superintendent. In 1925 he went to Haileybury, Ont., and inaugurated a consulting practice in mining engineering which he still carried at the time of his death. He was also manager and director of Albany River Mines.

Mr. Morrison joined the Institute as a Member in 1919.

James Weir, M.E.I.C., died at his home at Outremont, Que., on April 16th, 1941. He was born at Miami, Man., on May 8th, 1883, and was educated at McGill University where he was graduated with the degree of B.Sc. in civil engineering in 1913. He acted as assistant in the Department of Surveying before graduation and remained with the University as a staff member. During his career as professor, he successively taught surveying and geodesy. At one time Professor Weir was superintendent of the McGill Observatory. He gave invaluable service during the Great War in determining the exact time from the stars and sending it out over Canada by telegraph. Troop movements from eastern Canadian ports were regulated on these signals. At the time of his death he was associate professor of geodesy in the Faculty of Engineering.

Professor Weir joined the Institute as an Associate Member in 1921.

News of the Branches

Activities of the Twenty-five Branches of the Institute and abstracts of papers presented

BORDER CITIES BRANCH

W. P. Augustine, M.E.I.C. - *Secretary-Treasurer*
J. B. Dowler, M.E.I.C. - *Branch News Editor*

The February meeting of the Border Cities Branch was held on February 14th at the Prince Edward Hotel. After a short business session the chairman, Mr. George Medlar, turned the meeting over to Mr. C. G. R. Armstrong who introduced the speaker of the evening. The speaker, Mr. H. Lloyd Johnson, is a member of our own branch and a Lieutenant of the Veterans Civil Guard. He is also warden of Division No. 4 of the Civilian Defence Committee of Windsor. His subject was **The Warden System of the Civilian Defence Committee.**

Civilian defence is now a national undertaking and committees are being formed in the cities and towns of Canada. Under the Defence of Canada Regulations the Dominion Government has constituted an air raid precautions committee. Under this the provincial governments have sponsored the effort to have each community form local air raid precautions organizations based on the organization now functioning in England.

Early in December, 1940, the Windsor Board of Control and Council met and formed the Civilian Defence Committee of Windsor. The committee as formed has followed closely the suggestions contained in literature on the organization of the committees in England where they are operating so successfully.

The objective of the Civilian Defence Committee is to be ready to combat all forms of attack including attack from the air and attack from within. Some people think that the committee exists solely for the purpose of controlling damage that may be caused by attack from the air. This is not so. The impression is prevalent for the reason that, at the present time our sister organization in Great Britain devotes most of its time to air raid work. In broad terms the function of the Civilian Defence Committee is to assist the authorities to combat any and all forms of attack.

In Windsor the mayor is chairman of the Civilian Defence Committee. There are five auxiliary services, namely, public utility services, police services, fire services, medical services, transportation and communication services. Under the police and fire services come the warden services. Other auxiliaries can be added as found necessary.

Reporting to the police and fire chiefs is the chief warden, under him are five divisional wardens in charge of five divisions of the city. Each division, according to population is divided into two or three districts each in charge of a district warden. Each division is divided again into groups in charge of group wardens. Each group is divided into posts in charge of post wardens. The post area comprises approximately 500 people. Each post warden organizes the people in his post who will volunteer to serve in the organization. Thus the warden service covers the entire city.

One of the very important functions of the wardens system is to assist in exposing and combating subversive activities. Many people will not take the time and trouble to give bits of valuable information to the police but they will pass along information when they belong to a voluntary organization.

In Canada we are fortunate in being able to copy the British A.R.P. organization, an organization that was planned so brilliantly that basically it has not been changed. The development is similar in many ways to the development of an organization for carrying out an engineering project. First a small staff is formed and then gradually expanded and authority delegated to the various branches. Work of almost any magnitude can be undertaken. Each branch functions independently and yet co-operates closely with the other branches. Any part of the organization may be expanded quickly to handle any amount of work necessary.

In Great Britain the A.R.P. organization was started in 1935. In 1937 the Air Raid Precautions Bill was passed by parliament and local organizations started. By the time the war started, four years of thought had been given to the development of the A.R.P. system and for two years the organization had been in existence. The civilian population of Britain was prepared.

The veterans civil guard is a voluntary organization of veterans which forms the mobile unit of the Civilian Defence Committee. It comprises five companies corresponding to the five divisions into which the city is divided. It is so organized that it can be called out to any part of the city where trouble arises in a very few minutes.

After Mr. Johnsons' talk a vote of thanks was moved by Mr. Wm. Fletcher.

Our new councillor, Mr. E. Krebser, was introduced to the members and spoke for a few minutes.

Mr. P. H. Jenkins, the retiring councillor, then gave a brief report on the annual meeting at Hamilton. He reviewed for a few moments the papers and the procedure of the meeting. This branch was represented at the meeting by Messrs. P. H. Jenkins, J. C. Keith, C. M. Goodrich, P. E. Adams, E. M. Krebser, G. C. Henderson, J. G. Turnbull and J. H. Bradley.

The meeting was then adjourned.

The March meeting of the Border Cities Branch was held on March 14th at the Prince Edward Hotel. G. E. Medlar, the branch chairman, presided over the dinner and the meeting afterwards. C. M. Goodrich introduced the speaker of the evening, Mr. J. A. McCrory, vice-president and chief engineer of the Shawinigan Engineering Company. Mr. McCrory's subject was **La Tuque Power Development.** The paper was published in the February issue of the *Journal.*

After an interesting discussion period, J. Clark Keith moved a vote of thanks to the speaker.

The branch was privileged to have two visitors from London, Ontario, J. A. Vance, councillor, and H. F. Bennett.

CALGARY BRANCH

P. F. Peele, m.e.i.c. - *Secretary-Treasurer*
F. A. Brownie, m.e.i.c. - *Branch News Editor*

The February 27th meeting of the Calgary Branch was devoted to a paper by Mr. R. M. Watson of Canadian Industries Limited on the subject, **Commercial Explosives and Their Application in Fill-Settlement Operations.**

Mr. Foster outlined briefly the history of explosives, stressing the great debt owed to Alfred Nobel, not merely because he invented dynamite and the blasting cap, but because of the high place he occupied among the great minds of all time. He also pointed out the fact that explosives fall into two distinct classes, military and commercial, and that explosives of one class are not well adapted for use in the other.

When a road is constructed across a swamp or muskeg, it will gradually settle until a firm foundation is reached. This results in the continual necessity of repairing and building up the road surface. If explosives are available, the fill may be completed to its ultimate depth on top of the swamp and landed on firm material by blasting out the muck underneath it.

The annual general meeting of the Calgary Branch was held following a luncheon at the Palliser Hotel on March 8th, 1941.

Mr. Boese, councillor for the Calgary Branch, reported at some length on the recent annual meeting of the Institute held at Hamilton, Ontario. Reports of the various committees were read and adopted following which the results of the election of officers were announced. Before adjournment the meeting was turned over to H. J. McEwen, newly elected vice-chairman in the absence of the new chairman, J. B. de Hart.

EDMONTON BRANCH

B. W. Pitfield, Jr.e.i.c. - *Secretary-Treasurer*
J. F. McDougall, m.e.i.c. - *Branch News Editor*

The Edmonton Branch held a mixed dinner and meeting at the Macdonald Hotel on the evening of April 1st. Chairman E. Nelson was toastmaster. Mr. Julian Garrett proposed the toast to the ladies and Mrs. R. M. Dingwall responded.

After dinner the Belasco Players, a local comedy troupe, entertained the members with several songs and skits. They were extremely gifted artists and kept everyone laughing.

Later, a motion picture dealing with the manufacture of household silver articles was shown.

Twenty-six members and their wives were present. All agreed that the evening was a great success and that a mixed dinner should become an annual feature of the branch. The meeting adjourned at 11.00 p.m.

HALIFAX BRANCH

S. W. Gray, m.e.i.c. - *Secretary-Treasurer*
G. V. Ross, m.e.i.c. - *Branch News Editor*

A technicolour talking picture entitled **Friction Fighters** was shown to the members of the Halifax Branch and the Professional Engineers of Nova Scotia, at the March dinner meeting. Presented by R. L. Dunsmore, superintendent of the Imperial Oil Refinery, the picture is a story of the development of lubricating oils in keeping pace with the high speeds and pressures in present day motor cars.

Several senior students of the Nova Scotia Technical College were guests of the branch. The Institute award to the student outstanding in scholastic and extra-curricular work, was made by Ira P. Macnab to Wallace A. MacCallum of Amherst, N.S., a senior mechanical.

S. L. Fultz presided at the meeting which was attended by about fifty members and their guests.

LONDON BRANCH

H. G. Stead, Jr.e.i.c. - *Secretary-Treasurer*
A. L. Furanna, s.e.i.c. - *Branch News Editor*

The regular monthly meeting of the Branch on March 13th, 1941, was addressed by J. A. McCrory, the vice-president and chief engineer for the Shawinigan Engineering Company of Montreal. He described the **La Tuque Hydro-Electric Development.** The paper was published in the February issue of the *Journal.*

The many questions asked of Mr. McCrory after he had given his paper indicated the keen interest taken by those present. The speaker was introduced by Mr. Buchanan.

NIAGARA PENINSULA BRANCH

Geo. E. Griffiths, m.e.i.c. - *Acting Secretary-Treasurer*
C. G. Cline, m.e.i.c. - *Branch News Editor*

A dinner meeting of the Niagara Peninsula Branch was held on March 21st, 1941, at the Reeta Hotel, Welland. Mr. H. B. Chambers, metallurgist of Atlas Steels, Welland, spoke on **Some Fundamental Steel Characteristics of Special Interest to Engineers.** He stated that the metallurgist has been able to produce a range of steels that can cover all ordinary requirements, but the engineer does not always use them to the best advantage. With the aid of slides, the speaker showed the chemical basis of all steels. He showed the relation of carbon content to application in the case of plain carbon steels. These steels must be hardened in water and this tends to cause warping and cracking. He showed the effect of mass on the mechanical properties and how an increase in size causes shallow penetration of hardness. It is these shortcomings of water-hardening steels that have led to the introduction of alloy steels, which may be hardened in oil or even in air, thus reducing hardening strains. In some cases it is possible to improve the design, from a metallurgical point of view, by balancing the cross section, thus reducing hardening stresses and making it possible to use plain carbon steel. Where the design is so intricate that this cannot be done, an alloy steel, either oil or air hardening, should be used.

The speaker was introduced by A. N. Conklin and the vote of thanks was tendered by Paul Buss. A. L. McPhail, vice-chairman of the Branch, presided. There was an attendance of thirty.

OTTAWA BRANCH

R. K. Odell, M.E.I.C. - *Secretary-Treasurer*

At one of the most largely attended luncheon meetings in the history of the Branch, held at the Château Laurier on March 13th, Flying Officer H. T. Mitchell, D.F.C., of the Royal Air Force, gave an address on the **Activities of a Fighter Squadron.** In simple language and in unassuming manner he told of the activities of the Hurricane Fighter Squadron to which he had been attached from the beginning of the war, first in France and then in England.

At the commencement of the war the squadron was located in the vicinity of Rouen, France, though at first there was not a great deal to do. The first German plane shot down was a Heinkel 111, of which some interesting photographs were taken from the moment it was attacked until it fell to the ground. Other moves of the squadron were to Amiens and to Verdun. While at the latter place the blitzkrieg started in real earnest and the squadron was moved to Lille before it was forced to return to England. In twelve days of fighting, five of the R.A.F. squadron pilots were shot down to 73 enemy planes.

The return to England had to be made on ten minute's notice, and each pilot was told to land on any English field available. Two weeks were then taken to get reassembled and re-equipped and for this reason the squadron missed action at Dunkerque, most of the action there being taken by home defence squadrons. When the German air raids on England commenced in real earnest the squadron was located at the south coast.

Flying Officer Mitchell outlined the course of action on a typical day against the enemy from the time the first telephone call came from the "operations room" that an enemy formation was massing for attack over the west coast of France until the action was over. He stated that ordinarily it took 2½ minutes for the squadron to get into the air and from five to ten minutes after that before contact was made with the enemy. In a real fight there may be as many as 500 aeroplanes in the air at the same time and the pilot himself does not get a clear impression of the fight as a whole, being concerned more with his own individual action and that of his immediate enemy.

In answer to a question from the audience he stated that the most vulnerable part of a plane is the pilot himself and then the gas tank. In the Messerschmidt 109 there is a gas tank immediately behind the pilot. It is not armour plated and if a direct hit is scored upon it the plane and pilot are quite likely to both be put out of action. He also gave it as his personal opinion that no matter how speeds are increased the pilots will be able to stand up to them. In some dive bombing actions, speeds in the region of 600 miles per hour are obtained with no effects upon the pilot except perhaps "blackout," but this is something that experience overcomes.

The most dangerous enemy plane, the speaker believed, was the Heinkel 113 fighter, especially when it followed the practice of rushing in, attacking quickly, and then flying off. This with the Messerschmidt 110 twin-engined fighter or fighter-bomber constitute the two most dangerous enemy planes, he believed.

Asked to give his opinion regarding the relative merits of manoeuverability and speed he believed the former will win over the latter in the end. The Hurricane fighter is the most manoeuverable of the English planes and it has shot down more than any other, even though it is not the fastest. The Spitfire he believes is the best interceptor fighter but in a big fight the Hurricane is best.

Flying Officer Mitchell is at present in Canada on instructional duties connected with the air training scheme.

At the noon luncheon on March 27th, L. A. Hawkins, executive engineer of the General Electric Company, Schenectady, New York State, gave an address on **Research and Security Now and Later.** T. A. McElhanney, chairman of the Branch, presided.

Mr. Hawkins commenced his address by paying a tribute to the work of the National Research Council at Ottawa which he said was "as fine a research institution as is to be found anywhere." He also referred to the loss sustained through the recent death of Dr. Banting, a man whom history would accord a high place in his own field alongside, for instance, of such men as Osler in medicine and Rutherford in physics. Research actually has no national boundary lines with its products of benefit to everyone.

Regarding the onset and trend of the present war and its threat to democracy, Mr. Hawkins stated that his country was all too slow in recognizing the emergency. "The United States was bound in a strait jacket of official neutrality," he said, "although we know how the vast majority of people felt in that country."

To-day there is little left of that official neutrality with the passage of the Lend-Lease Bill and the country "to the limit of its ability will not only produce all the materials that Great Britain needs but will see that they get there."

When the United States at last woke up to the emergency facing it, the president of the General Electric Company made it quite clear that they would do all they could to help the war programme. Now about 75 per cent of the technical staff are working intensively on war projects, working hours per week have been extended and the staff increased. "All of us are convinced," he said, "that if the role of the United States in this war is to be the arsenal of the free nations then we should do all in our power to see that the stock going into that arsenal is the best possible."

The speaker related some of the research results achieved during the first Great War, particularly in the development of submarine detecting devices, wireless apparatus, and portable safe X-ray outfits, for use of the military forces. To-day, he added, "war is becoming mechanized beyond belief," the problems are far more complex, much different from 1917, and "we have a real job to catch up." It is a war of ships, tanks, aeroplanes, and other machines, he said, and the efforts of the research laboratories in England "first class in every particular" as well as those in the other free countries are all needed.

Mr. Hawkins stated that in peace time there should be some kind of consolidation of the powers of the English-speaking nations for their own protection and advancement. Several steps along this line have already been taken, including the formation of the Joint United States Canadian Mission for defence as well as the agreement relating to the transfer of United States destroyers to England and the use of naval bases by United States in return. This general policy has been advanced and "crystallized" under the Lend-Lease Bill.

If the consummation of such a policy, he declared at the conclusion of his address, can afford to our children and to our children's children a full measure of peace, liberty and prosperity then the sacrifices called forth by the present war will not have been made in vain.

At a largely attended evening meeting held at the National Research Laboratories on April 10th, A. E. Davison, transmission engineer of the Hydro Electric Power Commission of Ontario, gave an address illustrated with motion pictures on **Dancing Cables and Bridges.**

Mr. Davison has devoted considerable thought in the past fifteen years to the subject of vibration and remarked that everything was not yet known about it. So far as cables and bridges are concerned, vibration gives rise to the phenomenon known as "galloping" or "dancing" which may become so pronounced as to cause damage. Cable conductors and supporting structures have been brought to the ground in severe cases and bridges have collapsed, as in the recent case of the Tacoma Narrows Bridge.

One contributing cause to the dancing of cables, stated the speaker, is the change in cross section due to the formation of ice on one side. The cross section, then, instead of being a circle, approaches that of an ellipse or even that of an aeroplane wing. While temporarily of this shape, moderate gusty winds will cause the cable to assume an undulating or rolling motion that becomes more severe as the wind increases in velocity. The central portion of a cable, as suspended between two supports, will travel upward as well as downward through the action of the wind and will also move from side to side in a remarkable manner.

This characteristic was revealed by motion pictures exhibited at the meeting. They showed the action of wind on cables partially encrusted with ice and damage done to transmission lines under such conditions. In one case, due to the galloping action, cables were detached from the supporting cross arms and newly erected wooden poles were snapped off at points several feet from the ground.

A most interesting event of the evening was the showing of a remarkable coloured film of the galloping of the Tacoma Narrows Bridge preceding its collapse and the actual collapse itself.

T. A. McElhanney, chairman of the Branch, presided and the speaker was introduced by W. H. Munro, past chairman of the Branch, and present councillor of the Institute.

PETERBOROUGH BRANCH

A. L. Malby, Jr.E.I.C. - *Secretary-Treasurer*
E. Whitely, Jr.E.I.C. - *Branch News Editor.*

The evening of March 20th was a noteworthy one for members of the Peterborough Branch. In the first place it was the night when the Junior and Student Section provide the programme, an annual affair. This year, under chairman F. Athey, a new programme was tried, with evident success. The dinner was followed by a student paper and entertainment in the form of some very interesting moving pictures.

Student engineers are guests of senior members of the Branch at this meeting and are introduced to the members during the meeting. It has been found that this helps the membership committee a great deal. The event was remarkable this time in the presence among the student engineers of a young lady. Miss E. Rabkin graduated from the University of Alberta in electrical engineering and is now taking the student engineering course with the Canadian General Electric Company. This event introduces a new note into the activities of the Branch.

Mr. H. R. Sills, our councillor, was also present and gave his impressions of the annual general meeting, recently held in Hamilton, especially the things that would be of interest to the junior engineers. The meeting must have been inspiring when even the story of it was enthusiastic.

The speaker of the evening, J. M. Mercier, graduated from the University of Montreal, Ecole Polytechnique, in 1940 and is now in the Test Department of the Canadian General Electric Company. His paper, **Some Aspects of Railway Signalling,** was based on a study made for his graduation thesis with a background of life-long association with and interest in railroads.

Beginning with the simple track circuit Mr. Mercier showed the fundamental components of modern signal systems and how they operate. This is one of those things everyone comes in contact with but few people know how they work. As described by Mr. Mercier it is all very simple. The development of the various systems was traced historically, and quite completely as far as fundamentals go. The complicated details were omitted which is as it should be when such things are first described to laymen. The story was not without its thrills too, a rare thing in technical papers. It was quite evident from the discussion afterwards that the speaker's description of two trains meeting on a single track at a siding, the trains passing without stopping, with their position being indicated on a remote control board from which the track switches are operated stirred many to imagine themselves doing the switching. All kinds of difficulties were imagined, but Mr. Mercier was able to convince everyone the feat is not only feasible but a common occurrence. Our railway signal systems are much bigger and more important than the average person might suspect. They are apparently extremely efficient.

At a meeting of Peterborough Branch on February 27th, 1941, Mr. C. L. Sherman, metallurgist for Phillips Electrical Works Limited, Brockville, Ontario, presented an excellent paper on **Processing of Copper.** The paper covered the metallurgy and processing of copper from mine to copper wire, one of its finished products.

Canada is fortunate in having large copper ore deposits containing about 1 lb. of copper, in the form of copper sulphide, per ton of ore. The ore is picked over to remove obvious waste, crushed in rod or ball mills and the wet powder agitated in an oily solution. This last process known as flotation, gives a 20 to 40 per cent concentrate. The next step is smelting in reverberatory furnaces where the concentrate is melted and a slag or matt of iron-copper-sulphide is skimmed off. The molten matt is put in converters where air is blown in and a siliceous flux is added. The resulting reaction removes most of the sulphur and iron leaving a charge that is cast in cakes, called blister copper because it is very porous.

Beyond this point there are alternative methods of treating the copper—by electrolysis in copper sulphate solution, or by further melting in furnaces. Electrolytic copper is very pure but unfortunately in present processes it is remelted for casting into rods and thereby picks up gases and loses some of its desirable purity.

Small amounts of impurities have a marked effect on the electrical conductivity and mechanical strength of copper.

Rod for wire is produced from the standard bars by hot rolling alternately oval and square sections. This breaks up large crystal structures and refines the grain size at the same time as the section is reduced. Water cools the rolls and cracks off oxide scale which forms on the rod. It is important that surface defects are not put on the rod at this stage as they will persist to the final wire and may lead to slivers.

The wire is drawn from rod thus made, the amount of cold working being adjusted to suit the temper required in the wire, which may be hard, medium or soft. Annealing will reduce the hardness produced by cold working. Carbide dies are used for larger sizes, and diamonds for smaller sizes. There seems to be no limit to the speed at which wire can be drawn except the purely mechanical difficulties in high speed machines. Speeds of a mile-a-minute are common.

Quite a lively discussion followed Mr. Sherman's talk which was illustrated by slides and a motion picture "The Mining, Smelting and Refining of Copper-Nickel Ores."

QUEBEC BRANCH

Paul Vincent, M.E.I.C. - *Secretary-Treasurer*

Lundi soir, le 17 février, avait lieu une représentation de films à la fois instructifs et récréatifs présentés par l'International Nickel Company of Canada Limited.

Cette séance marquait l'inauguration d'une série de films documentaires sur les activités des ingénieurs dans le domaine du génie civil en général. Les dames et le public étaient admis à cette soirée d'éducation technique.

Le programme se composait de cinq films parlants et semi-techniques sur **l'Industrie du Nickel au Canada.**

Les méthodes récentes d'exploitation des mines de nickel et de cuivre au Canada y furent montrées et tous purent constater le rôle important que ces deux métaux jouent dans la vie économique du pays.

Au début de la séance, le secrétaire Paul Vincent souhaita la bienvenue à un auditoire d'environ 200 personnes. Monsieur J. Alex. Larivière, régisseur de la Régie des Services Publics de Québec, remercia l'assistance de son encouragement et il annonça que d'autres séances semblables suivraient.

Le 28 février, les membres de la section de Québec de l'Institut furent invités à un déjeuner-causerie au Château Frontenac.

L'Honorable T. A. Crerar, Ministre des Mines à Ottawa y donna une conférence des plus intéressantes sur les **Contributions Minières du Canada dans la Guerre.**

Cette causerie était sous les auspices des Clubs Canadien, Rotary, Kiwanis et de l'Engineering Institute of Canada. Monsieur L. C. Dupuis, président de la Section de Québec et le secrétaire-trésorier Paul Vincent représentaient l'Institut à la table d'honneur. Plusieurs membres assistèrent à ce déjeuner.

On Monday, March 10th, the Quebec Branch held a very interesting meeting in the theatre room of the Palais Montcalm.

The **Engineer and the Hydroelectric Developments on the St-Maurice River** was the subject which captivated the interest of the members accompanied by their wives. The public was also invited, so that some 500 people listened to Huet Massue and Guy Rinfret, who were the guest speakers. Five films were presented to illustrate their talk. A local orchestra played some winning music pieces while the silent films were being shown on the screen.

Mr. Huet Massue, engineer with the Shawinigan Water & Power Company, gave a short, but a masterly and well illustrated talk, on the **Hydroelectric Industry in Quebec** and the **Hydrology of the St. Maurice River.**

A forty-minute programme of silent films was then presented on the Shawinigan Power and especially on the Construction of the Rapide Blanc Power Plant.

Mr. Guy Rinfret, then presented a short talk on the **Construction of the Rapide Blanc and La Tuque Power Plant.**

Mr. E. D. Gray-Donald, vice-chairman of the Branch introduced the speakers and Mr. R. B. McDunnough moved a vote of thanks to the lecturers and to the large audience for their encouragement to engineering activities.

SAGUENAY BRANCH

T. A. I. C. Taylor, Jr.E.I.C. - *Secretary-Treasurer*
B. E. Surveyer, Affil.E.I.C. - *Branch News Editor*

The first meeting of the Saguenay Branch, for the year 1941, was held on 14th January at the Arvida Protestant School. The speaker was A. T. Cairncross, of the Aluminum Company of Canada, Limited. The subject of his talk was **Experiences of an Engineer in China.** Mr. Cairncross was engaged for quite a number of years on engineering work in China. With the help of slides he took the meeting through an imaginary trip in the interior of that country. He showed what an engineer had to cope with in his work over there, some of the difficulties encountered and some of the methods used in solving these. He blended his talk with some of his own personal experiences all of which made for a highly interesting and educational evening. After the presentation of the paper a meeting of the executive of the Branch was held.

The second meeting of the New Year was held on the 21st February at the Arvida Protestant School. The guest speaker was W. H. D. Clark, chief engineer of the Combustion Engineering Corporation. He entertained his audience with an illustrated talk on **Combustion Boiler Installations.** He spoke on modern boiler designs and described the different types of boilers now in use showing the improvements reached in recent years. He pointed out in detail the problems solved by the designers stressing the fact that improvements and new designs were based on past performances rather than any set formula. His subject was timely, as in this district an increased use of combustion boilers has been made in the last eighteen months, and the active discussion which followed served to demonstrate the interest felt by everyone at the meeting.

The following meeting of the Saguenay Branch was an unusual one, unusual in the way that it was a mixed meeting and that all attendance records were broken. It was held on 28th March at the Arvida Protestant School. The speaker was Jean Flahault, of the Aluminum Company of Canada, Limited, and his subject, highly up to date, was **Engineering in the Battle of France.** Mr. Flahault, a graduate of the Ecole Polytechnique of Montreal, has just recently returned from France where he was taken prisoner of war while serving with the French Army. After making his escape to unoccupied France he obtained passage to Canada and he is now a resident of Arvida. He discussed some of the methods used by the German Army in their conquest of western Europe and emphasized the engineering basis on which the German High Command had developped their new modes of offensive warfare. He gave examples on the workings of some of the weapons used and showed how field and air strategy can efficiently co-operate when based on engineering principles. He flavoured his topic by relating some of his own personal experiences and adventures injecting the right amount of humour at the right time. That the evening and the lecture were such a huge success stand as a tribute to the talents of Mr. Flahault as a speaker.

SAINT JOHN BRANCH

V. S. Chesnut, M.E.I.C. - *Secretary-Treasurer*

A supper meeting was held at the Admiral Beatty Hotel on March 21st. The attendance was 16.

A four reel sound film, loaned by the International Nickel Company of Canada Limited, was shown. The film portrayed the various operations involved in producing nickel and copper at the Company's plants in Sudbury and Port McNicoll, Ontario, from the mining of the ore to the refining of the metal.

A proposal by President Mackenzie to ask all members and juniors to contribute $1.00 towards the expense of underpinning the Headquarters building was unanimously approved.

The Tacoma bridge film was presented at a meeting of the branch on April 18th.

There were twenty present at our meeting, all of whom found the film most interesting. After the showing of the film, considerable discussion took place, led by Mr. Sidney Hogg of the Saint John Drydock and Shipbuilding Co., Ltd.

The programme was then rounded out by Mr. H. P. Lingley who presented a colored film of his own, showing fishing scenes and scenes of wild life in New Brunswick, and a view of the recent Emerson fire in Saint John.

A motion of thanks to Institute Headquarters and to Mr. Lingley was passed for a very enjoyable programme.

SASKATCHEWAN BRANCH

Stewart Young, M.E.I.C. - *Acting Secretary-Treasurer*

The regular monthly meeting of the Saskatchewan Branch, of the Institute was held jointly with the Association of Professional Engineers and the Saskatchewan Section of the American Institute of Electrical Engineers at the Kitchener Hotel, Regina, on Friday evening March 21st, with 52 members and guests in attendance. The speaker of the evening, Flight Lieutenant G. Thornber, gave an outline of the theory of **Air Bombing and Gunnery** progressively illustrating his lecture by lantern slides showing graphs of the several aspects of his subject. Considerable discussion followed the address after which a hearty vote of thanks, moved by W. E. Denley, was tendered the speaker.

SAULT STE. MARIE BRANCH

O. A. Evans, Jr.E.I.C. - *Secretary-Treasurer*
N. C. Cowie, Jr.E.I.C. - *Branch News Editor*

The third general meeting for the year 1941 was held in the Windsor Hotel on Friday, March 21st, when 19 members and guests sat down to dinner at 6.45 p.m.

The business portion of the meeting began at 8.00 p.m., with Chairman E. M. MacQuarrie, presiding.

A letter was read from President C. J. MacKenzie, asking the branch to solicit funds from the members for the work done on Headquarters building last year, caused by settling due to changing soil conditions under the building. J. S. MacLeod and N. C. Cowie, moved that the secretary circularize the members in the branch asking for a donation of $1.00 for this cause. K. G. Ross and W. S. Wilson moved an amendment to the motion that the necessary funds be taken from the branches' funds provided a proportionate amount is raised from the other branches. The amendment was carried.

The chairman then introduced the speaker of the evening A. L. MacDougall, district engineer for Highways, who gave a short address on the **Queen Elizabeth Highway.**

On the conclusion of the address the members were shown two technicolour reels on the Queen Elizabeth Highway. The first showed the construction of the highway, while the second was the highway from Toronto to Niagara as seen from the air.

At the conclusion, C. Stenbol moved a vote of thanks to the speaker for obtaining this fine film for the branch. E. M. MacQuarrie thanked Mr. MacDougall on behalf of the branch.

ST. MAURICE VALLEY BRANCH

Gordon B. Baxter, Jr.E.I.C. - *Secretary-Treasurer*

The annual dinner meeting of the St. Maurice Valley Branch of the Institute was held on Saturday evening, March 22nd, in the Cascade Inn, Shawinigan Falls.

The retiring chairman, Mr. C. H. Champion, presided and the secretary-treasurer read the annual report and financial statement. This showed the Branch's financial position to be excellent.

C. H. Champion the retiring chairman and A. H. Heatley the incoming chairman of the St. Maurice Valley Branch.

The presiding chairman introduced the chairman-elect, Dr. A. H. Heatley, of Shawinigan Falls. Dr.Heatley thanked the retiring chairman for the good work accomplished during the past year, following which he introduced the members of his executive committee for the coming year.

The guest speaker of the evening was our general-secretary, Mr. L. Austin Wright, who outlined the setting up and duties of the Wartime Bureau of Technical Personnel under the directorship of Mr. E. M. Little, a prominent engineer and general manager of the Anglo-Canadian Pulp and Paper Mills, and the Gaspesia Sulphite Company. Mr. Wright stated that the Department of Labour by authority of the Minister, had handed over the operation of the Bureau to the engineers themselves with full authority to set up their own organization and choose their own directorate. Mr. Little had accepted the appointment on condition that all the engineering societies would support him, and Mr. Wright was selected to be assistant director of the Bureau.

He then gave a brief outline of the trouble to the Headquarters building, due to shifting soil conditions and the

Preceding the annual dinner of the St. Maurice Valley Branch. From left to right, A. H. Heatley, A. C. Abbott, C. H. Champion, J. P. Villemure, G. B. Baxter, J. M. Mitchell, V. Jepsen, H. K. Wyman.

necessary repairs that had to be made, which cost $10,000. He outlined several proposed schemes to pay for this. Stating that council believes that the Institute finances should be kept intact if possible since same are sure to be needed in the difficult period that will follow the end of this war. He pointed out that if each member, other than students, were to furnish $1.00 apiece, about $4,000 would be realized, which would be a big help.

Mr. Abbott thanked the speaker in a very capable manner, remarking that the members were always glad to hear news from the Institute Headquarters. He concluded by saying that he hoped that we would hear from him again in the very near future.

VANCOUVER BRANCH

T. V. Berry, M.E.I.C. - - *Secretary-Treasurer*
Archie Peebles, M.E.I.C. - *Branch News Editor*

Industrial Applications of the X-Ray was the subject of an illustrated address given by A. H. Eggleton, manager of the Industrial X-ray Company, Vancouver, before the Vancouver Branch of the Institute on Thursday evening, March 27th.

Mr. Eggleton first described some of the industrial uses to which the X-ray has been put in the past ten years. Even at the present time, the use of X-ray is generally associated with medicine and surgery, in spite of the fact that the first X-ray pictures made by their discoverer, Rôentgen, in 1895, were of pieces of metal. One possible reason for the slower development of their use for industrial purposes is the greater penetrating power required in most cases, requiring high voltage equipment with elaborate protective and cooling devices for safety in continuous operation.

In the packaged food industries, considerable use is now made of X-ray to detect foreign material which may have found its way into the product during processing. Typical of the products checked in this way are cereals, peanuts, confections, canned soups, etc. One firm marketing tobacco makes a similar check.

The X-ray technique in dealing with large numbers of articles is to pass them before a fluorescent screen so that the rays will penetrate the object and cast an image on the screen. Variations in the colour of this image indicate materials of different density, permitting the detection of foreign material or damaged product.

Where the use of a screen is not practicable, owing to the higher power required and the necessary protection of operators, the radiograph exposure method is adopted. A film is so placed in relation to the object that it will be exposed by the X-rays which have penetrated the material. The degree of penetration, which depends on the density of the substance and its thickness, will be indicated by light and dark areas on the developed negative.

Applications of the radiograph method include the testing of castings and welds, and the detection of highly stressed metal as might be caused by heat treatment. Power line poles have been X-rayed to ascertain the extent of decay before replacement. Automobile tires are examined for nails, stones, or damaged fabric, as well as being checked at the factory for inferior construction. About 75 miles of welded seams in the penstocks at Boulder dam were radiographed, using 36 in. of exposure at a time. In aircraft factories, many thousands of castings are examined daily for shrinkage, cracks or gas pockets. By means of such examinations, foundry procedure can be altered to eliminate these defects, such as by changing the radius of fillets or by pouring the mould at a different point. Steam tubing, valves, and all types of pressure tanks are now tested, and in some countries such testing is required by law. In some cases, rejects in casting have been reduced to 2 per cent from as high as 90 per cent.

Commercial X-ray machines are available up to 400,000 volts capacity, and these will penetrate up to 3½ in. of steel or 9 in. of aluminum. The largest unit is at the National Bureau of Standards in Washington, D.C., and develops 1,500,000 volts. A larger unit still is under construction for the Ford Motor Company. The usual commercial machines will photograph straight welds in 17 in. lengths, and circumferential welds in 10 in. lengths. A device known as a stepped penetrameter must be included in the radiograph to check the penetration. It is a stepped piece of metal varying in thickness by steps of known height, which forms a standard band of colour in the negative and permits checking the penetration of the X-rays to within 0.002 in. The heat generated in large units requires a circulating oil cooling system, and immersion of the tube and coils in oil. The operator must be shielded by a lead lined cab, as a protection against wandering X-rays. These large machines are now built completely portable, mounted on rubber-tired wheels. In some cases it is easier to move the subject material, while in others it is more convenient to move the machine.

The speaker predicted that very rapid growth in the use of X-ray would extend the control of products and manufacturing methods even more than it has done in the last few years, because of the large savings resulting from it, and the greater safety which is synonymous with products free from defects. A large number of radiographs and samples of welds and castings were shown to the audience by Mr. Eggleton, chief technician of the Industrial X-ray Company. The chair was occupied by Dean J. N. Finlayson, branch chairman, and the appreciation of the audience was expressed by Mr. W. N. Kelly. About 40 members and guests were present.

News of Other Societies

Items of interest regarding activities of other engineering societies or associations

JOINT MEETING OF COUNCILS OF THE ENGINEERING INSTITUTE OF CANADA AND THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF ONTARIO

A joint dinner of the members of Council of the Engineering Institute of Canada and of the members of Council of the Association of Professional Engineers of Ontario was held at the Royal York Hotel, Toronto, on Saturday, April 19th, 1941. That an event of this kind could be held was possible due only to the fact that a meeting of the Council of the Institute coincided with the quarterly meeting of the Council of the Ontario Association.

Dean C. J. Mackenzie, president of the Institute and S. R. Frost, president of Ontario Association of Professional Engineers.

Stanley R. Frost, President of the Association, acted as Chairman. Others at the head table included Dean C. J. Mackenzie, President of the Institute; McNeely DuBose, K. M. Cameron, W. C. Miller, Dr. T. H. Hogg, Alex Larivière (Vice-President of the Dominion Council of Professional Engineers), J. Clark Keith and Dr. J. B. Challies.

The Chairman in his opening remarks welcomed the Council of the Engineering Institute to Toronto and stated that it was a great pleasure for the Council of the Ontario Association to meet with them on this occasion recalling a similar meeting held in Toronto three years ago. He then called on Dean Mackenzie, Acting President of the National Research Council and President of the Institute, for a few words. Dean Mackenzie stated that the Councillors of the Institute welcomed the opportunity of meeting with the Council of the Association. He outlined the part that the engineer was playing in the war.

Alex Larivière, a councillor of the Institute and Vice-President of the Dominion Council of Professional Engineers brought greetings from that body. Other speakers included Dr. T. H. Hogg, immediate Past-President of the Institute; Lieut-.Comdr. C. P. Edwards, Deputy Minister

S. R. Frost addresses the joint dinner with Dr. T. H. Hogg, past-president of the Institute on his left.

McNeely DuBose, vice-president of the Institute was also a speaker at the joint dinner. On his left, W. C. Miller, Dean Mackenzie, S. R. Frost, Dr. Hogg, Alex Larivière and J. Clark Keith.

of Transport and Councillor of the Ontario Association; Dr. J. B. Challies, Past-President of the Institute and Dean C. H. Mitchell, Past-President both of the Institute and of the Association.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF ALBERTA

A joint dinner of the Association of Professional Engineers of Alberta and the Engineering Institute of Canada was held in the Marquis Hotel at Lethbridge on Saturday evening, March 22nd, 1941, following the annual meeting of the Association. H. J. McLean, president of the Association of Professional Engineers, presided.

About 60 members and guests sat down to dinner. Many came from as widely separated points as Edmonton, Calgary, the Crow's Nest Pass, Cardston, and Waterton, and a good representation from Lethbridge. Music was supplied during the evening by Mr. and Mrs. Geo. Brown and Mr. Henderson. After the toast to the King, community singing was led by Mr. R. S. Lawrence. Mr. Tom Smith and Mr. Geo. Brown, Jr., contributed to the enjoyment of the meeting by rendering several soli which were enthusiastically received. At the conclusion of the musical portion of the programme, Mr. H. J. McLean tendered the artists the thanks of the meeting for their splendid entertainment.

The chairman then introduced to the meeting Professor Cornish of Edmonton, president of the Association of Professional Engineers of Alberta, for the ensuing year. Professor Cornish made suitable acknowledgement in a brief speech of thanks.

The chairman next called upon Mr. J. T. Watson to introduce the speaker of the evening, Mayor D. H. Elton, which Mr. Watson proceeded to do with sundry reminiscences of previous similar gatherings which they had both attended.

Mayor D. H. Elton rose to address the meeting announcing as his subject **History Repeats Itself.** It is a matter for regret that we are not able to give a verbatim report of this address, which was acknowledged by those present to be of outstanding quality. In his presentation Mayor Elton quoted fluently from such a wide variety of sources as Mother Shipton's Prophecy, William Shakespeare, Oliver Cromwell, Thomas Grey, Wordsworth, Abe Lincoln, Tennyson, J. S. Blackie, Garibaldi, Winston Churchill, Chamberlain, Grenville, Franklin D. Roosevelt, Solomon, Kipling, the New York Times, and Norman Rogers. This with references to Hitler and Mussolini left no doubt in the minds of his listeners that history does repeat itself, The chairman in calling for a vote of thanks complimented Mayor Elton on an outstanding address, to which the meeting gave enthusiastic approval.

The meeting then closed with the singing of the national anthem.

The newly elected officers of the association are: President, W. C. Cornish; Vice-President, S. G. Coultis; Councillors, F. R. Burfield, J. A. Carruthers, H. B. Le Bourveau, C. W. Dingman, C. S. Clendening, R. R. Cauper, W. J. McFarland, C. S. Donaldson.

ASSOCIATION OF PROFESSIONAL ENGINEERS OF SASKATCHEWAN

The annual meeting of the Association of Professional Engineers of Saskatchewan wes held in the Saskatchewan Hotel, Regina, on Friday, February 21st, 1941, with the president, P. C. Perry, in the chair.

The newly elected officers are: president, R. A. McLellan, vice-president, A. P. Linton; councillors, R. W. Jickling, H. R. Mackenzie, B. Russell. Continuing councillors are G. L. MacKenzie, C. J. McGavin and A. A. Murphy.

Upon concluding the business session those in attendance gathered for an hour's informal get-together before proceeding to the annual banquet; following which, interspersed by appropriate musical numbers, greetings were conveyed on behalf of the Alberta Association by Squadron Leader Davidson, for Manitoba by George Cole, president, and from Ontario by Colonel Dillon. A telegram of greeting was read from J. J. White, registrar for the past several years and now on active service.

Presentation of a bowler hat was made to D. D. (Dave) Low for his excellent service during the past year in organizing the several meetings; presentation also of a gold Institute badge was made to I. M. Fraser, past president and past chairman, Saskatchewan Branch, Engineering Institute of Canada.

The main speaker of the evening was Hon. A. T. Proctor, Minister of Highways and Transportation, Saskatchewan, whose address may well have been entlied **The Professions Protect the Public.**

Terming a recent series of articles appearing in the public press as "part of a grand campaign to do away with what all democratic peoples are fighting for," Mr. Proctor said that "the effect on the public of the recent articles in the press can only be to make them think that professional bodies have a legalized method of robbing the public."

Mr. Proctor suggested that the presidents and executives of all professions should get together to offset the campaign through, possibly, a series of articles dealing with the achievements of the respective professions.

"We should give a true understanding," said Mr. Proctor, "of what the professions mean; not that the numbers of those engaged in the professions should be limited but to make sure that the people who enter should have the integrity and honour which the professions are trying to maintain."

He concluded with an appeal that the ideals of democracy for freedom and liberty, gained only through sacrifice in the past, could be maintained only at a heavy price in the future.

ENGINEERS' CLUB OF TORONTO

At a recently held meeting of The Engineers' Club of Toronto the following officers and directors were elected for the current year: *President,* W. S. Ewens, B.Sc. (McGill), vice-president, Sangamo Company, Ltd.; *1st Vice-President,* H. C. Crane, B.A.Sc. (Toronto), Chief Engineer, Turnbull Elevator Co., Ltd.; *2nd Vice-President,* J. F. Comer, B.Sc. (Queen's), J. F. Comer Company; *3rd Vice-President,* K. A. Christie, B.A. (Toronto), Chairman, Toronto Hydro-Electric Commission.

Other Directors: Messrs. G. Bishop, W. L. Dobbin, J. E. Greenland, J. M. Gordon, C. C. Huston, T. C. James, R. J. Jowsey, W. E. Ross, J. W. R. Taylor, G. E. Treloar and A. F. Wells.

Secretary-Manager, Wm. C. Foulds.

CORPORATION OF PROFESSIONAL ENGINEERS OF QUEBEC

The annual general meeting of the Corporation of Professional Engineers of Quebec was held at the headquarters of the Engineering Institute of Canada, Mansfield Street, Montreal, on Saturday, March 29th, with about seventy-five members of the Corporation present. The annual report of council, the treasurer's report and the financial statement showing a continued satisfactory condition were adopted unanimously.

The results of the elections to council for the current year were announced as follows: for the district of Montreal, Messrs. C. C. Lindsay, J. A. McCrory and Brian R. Perry; for the district of Quebec, Mr. A. O. Dufresne. The council for the ensuing year consists of Messrs. A. O. Dufresne, R. E. Jamieson, Alex. Larivière, Dr. O. Lefebvre, C. C. Lindsay, J. O. Martineau, J. A. McCrory and Brian R. Perry.

At a meeting held immediately after the annual meeting, Dr. Olivier Lefebvre was elected president, Mr. Brian R. Perry, vice-president, and Mr. C. C. Lindsay, secretary-

Professor R. E. Jamieson delivers his retiring address as president of the Corporation of Professional Engineers of Quebec. On his left are J. R. Smith, Brian R. Perry and J. A. McCrory.

treasurer. Mr. C. René Dufresne was appointed auditor for the current year.

In the evening, the Corporation held a dinner at the Windsor Hotel. The guests included Mr. McNeely DuBose, representing the Engineering Institute of Canada, Mr. J. R. Smith, representing the Province of Quebec Association of Architects, and Mr. Aimé Cousineau, representing the Alumni Association of the Ecole Polytechnique.

Part of the head table at the Corporation dinner. Left to right, Hector Cimon, J. O. Martineau, Aimé Cousineau, A. O. Dufresne, Alex Larivière.

McNeely DuBosc tells another one. At the right Dr. O. O. Lefebvre, newly elected president of the Corporation.

A.I.E.E. CONVENTION IN TORONTO

Canadian electrical engineers are to be hosts this year to members of the profession from the United States when the American Institute of Electrical Engineers holds its summer convention in Toronto, Canada, on June 16-20. Plans are now practically completed for the five-day gathering, to consist of technical sessions, inspection trips, entertainment and sports activities. A number of advance registrations have already been received by the Royal York Hotel, the Toronto Convention Headquarters, and this fact is taken as an indication that a record attendance may be expected.

The technical papers to be presented will cover every major branch of electrical engineering. Starting with a session on communications, there will be papers and meetings covering: instruments and measurements; basic sciences and electronics; land transportation; switching equipment; electrical machinery; relays, lighting and insulation; industrial power applications; power transmission; domestic and commercial applications; and power generation.

Generally speaking the afternoons and evenings will be free for sports and entertainment. The sports events include the annual A.I.E.E. Mershon Trophy competitions, (both golf and tennis), the Lee Trophy competition, and a variety of special golf tournaments. There will be sports events and special entertainment for the ladies at some of Toronto's beauty spots. For the evenings elaborate plans have been laid to present feature entertainments of a uniquely Canadian nature.

Of course, the war is bound to leave its imprint on the convention. Canada is an active participant in the present conflict, and accordingly wartime regulations will have some effect on the programme. On the whole, however, it is felt that the wartime spirit prevalent in Canada will add a zest to the convention which would not otherwise be present.

In spite of wartime regulations, the inspection trips committee has arranged visits to several utility properties and manufacturing plants. *Advance registration for these trips is absolutely essential due to national defence requirements.*

Expected to be one of the most popular trips is the one to be held on Monday afternoon to the Toronto-Leaside 220 kv. transformer station of the Hydro-Electric Power Commission of Ontario. Located on the outskirts of the city, some seven miles from convention headquarters, this station is one of two receiving terminal stations of the Hydro's 220 kv. system. The initial components of the station were placed in service in 1928, since then it has been expanded to its existing capacity of 420,000 kva. Three 220 kv. circuits enter and one leaves the station, on four-circuit bridge-type structure on a 200-ft. wide right-of-way. Six banks of 45,000 kva. and two banks of 75,000 kva. three-winding transformers are installed. Four 25,000 kva, vertical shaft, outdoor synchronous condensers are also installed.

Perhaps of still greater interest will be the Hydro-Electric Power Commission's new 220 kv. receiving terminal now nearing completion of the initial installation. It is located some 40 miles west of Toronto on the Queen Elizabeth Way. Known as the Burlington Transformer Station, this new receiving terminal has an initial installation of two incoming 200 kv. circuits and two banks of 75,000 kva. forced air-cooled transformers. The station is designed for an ultimate installation of 450,000 kva.

The 220 kv. transmission extension of the Commission, around the metropolitan area of Toronto and west to Burlington, consists of double circuit construction, utilizing type HH segmental-copper conductors. Arrangements will be made to inspect this new construction as part of the Burlington trip.

For cummunications men there will be a trip to the Bell Telephone Automatic Exchange on Monday, June 16, and on Tuesday, June 17, a specially arranged communication trip will take in radio station CBL, Hornby repeater station, and the Trans-Canada Airways beacon and airport facilities. A special trip for distribution men will cover the low voltage network of the Toronto Hydro-Electric System, also a tour of the recently completed primary network of York Township Hydro, as well as visits to the newly completed residential substation of the Toronto Hydro, and another to the Glengrove Avenue substation. A trip is also arranged to the Hillcrest Shops of the Toronto Transportation Commission.

Of special interest are organized strips to the Hydro-Electric Power Commission's laboratories, an inspection of the H.E.P.C's network calculator, and an evening trip (on Wednesday, June 18) to the Dunlap Observatory.

Efforts will be made to arrange trips to a number of manufacturing plants in Toronto, Hamilton and Oshawa. These trips, of course, must be governed entirely by National Defence Regulations which may be in force at the time of the Convention, but if advance registration indicates sufficient interest, the Trips Committee will do its best to arrange visits to such of the following plants as are of particular interest to visitors: Canada Wire & Cable Co. Ltd.; Canadian Westinghouse Co. Ltd.; Steel Company of Canada; Otis-Fensom Elevator Co.; Ferranti Electric Co.; Canadian General Electric Co. Ltd.—transformer plant, and others.

The personnel of the General Convention Committee is as follows: M. J. McHenry, general convention chairman; A. H. Frampton, vice-chairman; D. G. Geiger, secretary; C. E. McWilliam, treasurer; Sub-Committee Chairmen: M. J. McHenry, finance; T. W. Hill, publicity; W. J. Gilson, entertainment; T. W. Eadie, sports; J. F. Neild, transportation; V. G. Smith, trips; F. F. Ambuhl, hotel and registration; O. W. Titus, ladies' entertainment; J. W. Barker, technical programme; O. W. Titus, local representative technical programme; J. M. Thomson, local representative sections. Members at large: J. H. Steede, Vancouver; B. J.O. Strong, Regina; E. V. Caton, Winnipeg; R. B. Chandler, Port Arthur; A. W. Bradt, Hamilton; K. V. Farmer, Niagara Falls; G. R. Langley, Peterboro; W. G. C. Gliddon, Ottawa; H. W. Haberl, Montreal; C. H. Burchill, Halifax.

Library Notes

Book notes, Additions to the Library of the Engineering Institute, Reviews of New Books and Publications

NEW CANADIAN STANDARDS

The Canadian Engineering Standards Association announces the publication of the revised and new standards mentioned below.

C.E.S.A. No.

C22.2 No. 51—1941—Armoured Cables and Armoured Cords (2nd edition):

C22.2 No. 52—1941—Service-entrance Cables:

The Canadian Engineering Standards Association announces the publication of two Approvals Specifications, C22.2 No. 51-1941—Armoured Cables and Armoured Cords (2nd edition) and C22.2 No. 52-1941 —Service-entrance Cables—under Part II of the Canadian Electrical Code, the requirements of which must be met in order to obtain C.E.S.A. approval of the electrical device concerned. Both standards were prepared in collaboration with interested manufacturers and industrial associations, and are based on laboratory tests and record in service.

Specification No. 51 applies to the construction and test of armoured cables and armoured cords for use in power and lighting circuits in accordance with the Rules of Part I of the Canadian Electrical Code. These conductors are not ordinarily used on communication circuits. This Specification is effective as of April 30th, 1941, for new production.

Specification No. 52 applies to the construction and test of service-entrance cables for use on circuits involving potentials of 600 volts or less, and for use—in the case of cables embodying in their assembly an uninsulated conductor—on circuits involving potentials of 150 volts or less to ground, when installed in accordance with the Rules of Part I of the Canadian Electrical Code. This specification is effective as of April 15th, 1941, for new production.

Price 50 cents each.

B 62—1940—Welded Genuine Wrought-Iron Pipe:

This specification covers "standard weight," "extra strong" and "double extra strong" welded genuine wrought-iron pipe. Pipe ordered under this specification is intended for coiling, bending, flanging, and other special purposes. Butt-welded pipe is not intended for flanging and is not recommended for bending or coiling in sizes 1¼ in. or over.

Price 50 cents.

B 64—1940—Copper and Brass Pipes, Standard Sizes:

This specification covers seamless copper and brass pipes in standard sizes suitable for use in plumbing, boiler feed lines, etc.

Price 50 cents.

B 66—1940—Copper Water Tubes:

This specification covers seamless copper Tubes especially designed for plumbing purposes, underground water service etc., but also suitable for copper coil water heaters, fuel oil lines, gas lines, etc.

Price 50 cents.

S 69—1941—Welders' Helmets, Hand Shields and Goggles, and for General Purpose Anti-Glare Goggles:

The Canadian Engineering Standards Association announces the publication of a specification for the various protective devices against injurious radiations from welding operations. This specification covers the essential characteristics of helmets, hand shields and goggles, it is intended to provide against the hazards to the eyes and the skin of the head in operations involving exposure to intense ultra-violet, infra-red or visible radiation.

Price 50 cents.

Copies of these Standards may be obtained at prices quoted from the Canadian Engineering Standards Association, National Research Building, Ottawa Ontario.

ADDITIONS TO THE LIBRARY

TECHNICAL BOOKS

Cement Chemists' and Works Managers' Handbook

By W. Watson and Q. I. Craddock, London, Concrete Publications Ltd., 1940. 199 pp., 9½ x 6¼ in. $3.50.

National Building Code—Part 3, Engineering Requirements.

Published by National Research Council, Ottawa, 1941. 256 pp., 8¼ x 5½ in. $1.75.

Reinforced Concrete Chimneys

By C. Percy Taylor and Leslie Turner, London, Concrete Publications Ltd., 1940. 64 pp., 9½ x 6¼ in., $1.90.

Structural Drafting

By Carlton T. Bishop, New York, John Wiley & Sons, 1941. 287 pp., illus., charts, 9¼ x 6 in., $3.50.

Theory of Simple Structures

By Thomas Clark Shedd and Jamison Vawter, New York, John Wiley & Sons, 1941. 505 pp., illus., diagrs., 9¼ x 6 in., $3.75.

PROCEEDINGS, TRANSACTIONS, ETC.

American Institute of Electrical Engineers

Transactions, volume 59, 1940.

Canadian Good Roads Association

Proceedings of the 25th Annual Convention, 1940.

Electric Supply Authority Engineers Association, New Zealand

Transactions prepared for the 14th Annual Conference, 1939, Volume 12, 1940.

National Council of State Boards of Engineering Examiners

Proceedings 21st Annual Meeting, 1940-41.

REPORTS

Aluminum Research Laboratories—Technical Papers

Bending tests on panels of stiffened flat sheet, by E. C. Hartmann and R. L. Moore, Aluminum Company of America, 1941, technical paper No. 4; Static and repeated load tests of aluminum alloy and steel riveted hull plate splices by R. L. Templin and E. C. Hartmann, Aluminum Company of America, 1941, technical paper No. 5.

Aluminum Research Laboratories

Fatigue machines for testing structural units by R. L. Templin, 1939; Fatigue test results, their use in design calculations by E. C. Hartmann, 1941.

American Institute of Consulting Engineers

Constitution and by-laws and list of members, 1941.

Canada Department of Mines and Resources:

Report of the Department of Mines & Resources including report of Soldier Settlement of Canada, for the fiscal year ended March 31, 1940. Ottawa, 1941.

Canada Department of Mines & Resources—Mines & Geology Branch-Geological Survey papers.

Preliminary map Grave Flats, Alberta, paper 40-15; preliminary map Pembina Forks, Alberta, paper 40-16; preliminary map Bearberry, Alberta, paper 40-19; preliminary map Mishagomish Lake, Quebec paper 40-21.

Electrochemical Society—Preprints

Silver Plating baths containing amines; Studies of electro-chemical polarization; diagnosis of cancer by means of the dropping mercury electrode; Potentials of iron-chromium alloys containing hydrogen; Efficiency of a sodium chlorate cell with rod cathodes; Voltage (during discharge) of the sponge lead plate of the storage battery; Electric currents in the atmosphere and their effects. Preprints Nos. 79-13 to 79-19.

New Brunswick Electric Power Commission

Tweny-first annual report for the year ending October 31, 1940.

Nova Scotia Board of Commissioners of Public Utilities

Report of the Board of Commissioners of Public Utilities, for the year ended December 31st, 1940. Halifax, 1941.

Nova Scotia Power Commission:

Twenty-first annual report for the twelve months period ended Nov. 30th, 1940. Halifax, 1941.

Quebec Association of Architects:

Register for the year 1941.

United States Department of Commerce—Building Materials and Structures

Solar heating of various surfaces, BMS 64; Wall and floor constructions—supplement to report BMS 17.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet the books are not in the Institute Library, but inquiries will be welcomed at headquarters, or may be sent direct to the publishers.

ADVANCED ELECTRICAL MEASUREMENTS

By W. C. Michels, 2 ed. D. Van Nostrand Co., New York, 1941. 347 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, $3.50.

In addition to the standard methods and apparatus of the electrical laboratory, this book covers the application of instruments essentially electrical in character to the measurement of other physical quantities. Among alternative methods or instruments the author has chosen to describe those which he has found satisfactory from personal experience. The thorough revision for the new edition is particularly marked in the application of electronic methods.

AMERICAN PLANNING AND CIVIC ANNUAL, 1940

Edited by H. James. American Planning and Civic Association, Washington, D.C., 1940. 278 pp., illus., 9½ x 6 in., cloth, $3.00.

The papers collected in this volume constitute a record of recent civic advance in the fields of planning, parks, housing and neighborhood improvement. About half the material was prepared especially for the Annual; the remainder consists of the principal papers delivered at the 1940 National Conference on Planning and the nineteenth National Conference on State Parks, 1940.

ANALYTICAL DESIGN OF HIGH SPEED INTERNAL COMBUSTION ENGINES

By F. M. Cousins. Pitman Publishing Corp., New York and Chicago, 1941. 226 pp., diagrs., charts, tables, 9 x 6 in., cloth, $3.50.

Beginning with a brief review of thermodynamic cycles the author proceeds to a detailed study of the dynamics of high-speed engines. In-line, V-type, radial and off-set cylinder engines are all considered in the discussion of engine balance and the analysis and design of cams, crankshafts, etc. For practical purposes, the analysis has been restricted to the calculus and simple harmonic theory. A bibliography is provided.

APPLIED HEAT TRANSMISSION

By H. J. Stoever. McGraw-Hill Book Co., New York and London, 1941. 226 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $2.50.

The purpose of this book is to provide in readily usable form some of the more important data on heat transmission and to describe some of the common types of equipment for transferring heat and kinds of insulation used in industry. The presentation is a thoroughly practical one, intended for engineers. A large number of charts and tables for determining convection coefficients and values of the pressure drop is included.

CAR BUILDERS' CYCLOPEDIA OF AMERICAN PRACTICE, 15th ed., 1940

Compiled and edited for the Association of American Railroads—Mechanical Division. Edited by R. V. Wright and others. Simmons-Boardman Publishing Corp., New York., illus., diagrs., charts, tables, 12 x 8 in., cloth, $5.00.

This standard reference book presents definitions and typical illustrations of railroad and industrial cars, their parts and equipment. There are also descriptions and illustrations of shops and equipment employed in car construction and repair. Many new designs of cars and appliances have been added since the previous edition, and the table of contents and index to car parts have been amplified for better reference.

(The) CHEMICAL ACTION OF ULTRAVIOLET RAYS

By C. Ellis and A. A. Wells, rev. and enl. ed. by F. F. Heyroth. Reinhold Publishing Corp., 1941. 961 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $12.00.

In the sixteen years since this valuable monograph first appeared, there have been great advances in the field of photochemistry, and the new edition has called for much rewriting and considerable expansion. The book is characterized by comprehensiveness and profusion of bibliographical references. Part one describes the types of apparatus available for producing ultraviolet rays. Part two deals with photochemical reactions. In part three the uses of photochemistry in industry are described, and in part four the applications in biology.

COMMERCIAL REFRIGERATION AND COMFORT COOLING

By S. C. Moncher. Nickerson & Collins Co., Chicago, Ill., 1940. 109 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $1.50.

A brief, non-mathematical description of commercial refrigeration, with emphasis on engineering methods in common use. The book is intended for those with a general knowledge of the field, who wish definite information upon equipment and its installation. The book is confined to the type of apparatus used in retail shops and restaurants. Air conditioning is considered briefly.

CUTTING TOOLS FOR METAL MACHINING

By M. Kurrein and F. C. Lea. J. B. Lippincott Company, Philadelphia and New York, 1940. 219 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $6.00.

This new and informative book describes how the best results can be obtained from any machining operation. Workshop practice, or production as distinct from design, is the major consideration. Tool shapes and angles are treated fully, and much recent information on feeds and speeds has been summarized. Tool grinding and hardening are also briefly covered.

DESCRIPTIVE GEOMETRY

By A. S. Levens and H. C. T. Eggers. Harper & Brothers, New York and London, 1941. 240 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $2.50.

A full presentation of both graphic and algebraic methods of descriptive geometry provides a double check on solutions and achieves a correlation between descriptive and analytical geometry. In addition to the general coverage of fundamentals there is a long chapter on present-day practical applications in various technical fields.

DESIGN OF SHADING COILS FOR ALTERNATING-CURRENT ELECTROMAGNETS

By L. A. Doggett and F. S. Veith. Pennsylvania State College Engineering Experiment Station Bulletin No. 52, State College, Pa., 1940. 24 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, 50c.

This booklet contains complete instructions for the design of a shaded-coil alternating-current electromagnet, with special reference to minimizing vibration by proper selection of shading-coil resistance. There is a short bibliography.

DRAINAGE AND FLOOD-CONTROL ENGINEERING

By G. W. Pickels. 2 ed. McGraw-Hill Book Co., New York and London, 1941. 476 pp., illus., diagrs., charts, maps, tables, 9 x 6 in., cloth, $4.00.

The improvement of small areas of cultivable land by under-drainage and the reclamation of large areas of wet and overflow lands by surface drainage and by flood control are discussed in this treatise. The new edition has been thoroughly revised, and the information acquired during the last fifteen years incorporated.

ELECTRIC AND MAGNETIC FIELDS

By S. S. Attwood. 2 ed. John Wiley & Sons, New York, 1941. 430 pp., diagrs., charts, tables, 9½ x 6 in., cloth, $4.50.

The fundamentals of electricity and magnetism are presented in a manner intended to co-ordinate under-class work in mathematics, mechanics and physics with the professional work of the last two years. This edition has been revised with the object of providing an adequate background for courses in electronics, electrical design and machinery. The four parts of the book cover respectively the electric field, the magnetic field, the ferromagnetic field and combined fields.

ELEMENTARY STRUCTURAL ENGINEERING

By L. C. Urquhart and C. E. O'Rourke. McGraw-Hill Book Co., New York, 1941. 348 pp., diagrs., charts, tables, 9 x 6 in., cloth, $3.00.

Intended for use both as a text for non-civil engineering courses and as a manual for graduate engineers and architects, this book presents first the basic principles of structural mechanics and the more important properties of structural materials. Succeeding chapters cover the fundamental principles of structural theory and design in steel, timber and concrete. There are many worked-out examples.

GENERATING STATIONS, Economic Elements of Electrical Design

By A. H. Lovell. 3 ed. McGraw-Hill Book Co., New York, 1941. 471 pp., illus., diagrs., charts, tables, maps, 9 x 6 in., cloth, $4.50.

The application of economic principles to the problems of the design of generating stations and transmission systems is described. The selection and application of apparatus, the proportioning of details of the assembly, the balancing of initial and subsequent costs, and related topics are considered. The new edition has been revised in the light of recent developments. Illustrative problems accompany each chapter.

Great Britain. Dept. of Scientific and Industrial Research. Building Research. Wartime Building Bulletin No. 12. EMERGENCY PIPE REPAIRS

His Majesty's Stationery Office, London, 1941. 8 pp., charts, 11 x 8½ in., paper, (obtainable from British Library of Information, 50 Rockefeller Plaza, New York, 15c.).

This pamphlet tells what is known both of thoroughly tried methods alternative to lead jointing and of others of a less established nature which may be used to restore service quickly when pipe lines are injured by enemy action.

Great Britain. Home Office. Air Raid Precautions Dept.

Air Raid Precautions Memorandum No. 1 (2 ed.). ORGANIZATION OF AIR RAID CASUALTIES SERVICES. 32 pp., 15c.

Air Raid Precautions Memorandum No. 3 (2 ed.). ORGANIZATION OF DECONTAMINATION SERVICES. 12 pp., 5c.

Air Raid Precautions Memorandum No. 6 (2 ed.). LOCAL COMMUNICATIONS AND REPORTING OF AIR RAID DAMAGE. 49 pp., 15c.

Air Raid Precautions Memorandum No. 7 (1 ed.). PERSONAL REQUIREMENTS for AIR RAID GENERAL and FIRE PRECAUTIONS SERVICES, and the POLICE SERVICE. 11 pp., 5c.

His Majesty's Stationery Office, London, 1938-1939. Diagrs., charts, tables, 9½ x 6 in., paper, (obtainable from British Library of Information, 50 Rockefeller Plaza, New York).

These memoranda have been prepared for the guidance of local authorities in organizing services to deal with the problems that result from air raids.

Great Britain, Ministry of Health, Ministry of Home Security

RECOMMENDATIONS OF LORD HORDER'S COMMITTEE REGARDING THE CONDITIONS IN AIR-RAID SHELTERS WITH SPECIAL REFERENCE TO HEALTH; and a Brief Statement of Action Taken by the Government Thereon

His Majesty's Stationery Office, London, 1940. 7 pp., 9½ x 6 in., paper, (obtainable from British Library of Information, 50 Rockefeller Plaza, New York, 5c.).

These recommendations deal with various phases of the air-raid shelter problem, but are mainly concerned with sanitation, first aid, ventilation and other hygienic considerations. Annotations describe what is being done to comply with the recommended practices.

HEATING, VENTILATING, AIR CONDITIONING GUIDE, Vol. 19, 1941

American Society for Heating and Ventilating Engineers, New York. 1,120 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $5.00.

The annual revision of this comprehensive manual provides designers and installers of apparatus for heating, ventilating and air conditioning with up-to-date information on the subject. The theory and practical application presented cover both domestic and industrial practice. In addition to necessary revision the chapters have been rearranged and grouped into seven major sections. The Guide also contains a Catalogue Data section which lists apparatus and materials, a glossary of terms and the membership list of the Society.

HYDRAULIC MEASUREMENTS

By H. Addison. John Wiley & Sons, New York, 1941. 301 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, $5.00.

This is a manual of hydraulic measuring technique, intended to be of practical utility both in the laboratory and in making measurements under service conditions. The whole range of measurements is covered, and a great variety of methods and apparatus is considered critically. A glossary and a bibliography are appended.

INDUSTRIAL RELATIONS DIGESTS

I. The ORGANIZATION of a PERSONNEL DEPARTMENT. 7 pp.

II. The EMPLOMENT DIVISION. 7 pp.

III; RE-ORGANIZATION of HOUR SCHEDULES. 7 pp.

Princeton University, Industrial Relations Section, Princeton, N.J., 1941. Tables, 10 x 7 in., paper, 20c. each.

The three pamphlets listed above have been prepared for use in companies facing rapid expansion because of defense orders. They are based on information received currently from a large number of representative companies. In the case of No. III, a more complete study is in preparation.

MANUAL FOR THE DESIGN OF FERROUS AND NON-FERROUS PRESSURE VESSELS AND TANKS

By K. Siemon. Karl Siemon, Metuchen, New Jersey, 1940. 280 pp., diagrs., charts, tables, 8½ x 5½ in., cloth, $3.00.

The first part of this manual discusses the physical properties and fabricating characteristics of the principal metals used. The larger section, on design, gives, for each of the different elements entering into pressure vessel design, an analysis of the problems involved and a brief discussion of the methods suggested for the calculation of stresses. Tables of necessary data are appended and there are numerous references to books, papers and existing codes.

MANUAL OF A.S.T.M. STANDARDS ON REFRACTORY MATERIALS, prepared by A.S.T.M. Committee C-8 on Refractories

American Society for Testing Materials, Phila., Pa., January, 1941. 174 pp., illus., diagrs., charts, tables, 9 x 6 in., board, $1.50; cloth, $1.75.

All of the A.S.T.M. specifications, classifications, methods of testing and definitions pertaining to refractories are brought together in convenient form. Certain other pertinent information, of value in the testing and use of refractories, is also included, such as recommended procedures, standard sampling for chemical analysis, and industrial surveys of service conditions. The personnel and regulations governing the A.S.T.M. refractories committee are appended.

MATHEMATICS FOR ENGINEERS

By R. W. Dull. 2 ed. McGraw-Hill Book Co., New York and London, 1941. 780 pp., diagrs., charts, tables, 8½ x 5½ in., cloth, $5.00.

This work affords a convenient review of those phases of mathematics which are especially important in engineering work, and is intended for use as a practical reference work or as a text for private study. The chapter on the slide rule has been extended in this edition, and minor changes made throughout the text.

MECHANISM, Fundamental Theory of the Modification and Transmission of Motion

By S. E. Winston. American Technical Society, Chicago, Ill., 1941. 372 pp., illus., diagrs., charts, tables, 8½ x 5½ in., cloth, $3.50.

This book deals with mechanical movements and the combinations of links or machine elements by which these movements are modified and transmitted. The use of the graphical method for analyzing relative motions allows a simple mathematical treatment. Review questions and problems accompany each chapter.

MOLD-LOFT WORK, 2 Pts.

By A. C. Halliburton. International Textbook Co., Scranton, Pa., 1940. Pt. 1, 82 pp.; Pt. 2, 69 pp., diagrs., charts, tables, 8 x 5 in., cloth, $2.15.

The whole process of laying-out a ship is covered in this practical, concise textbook. The many illustrations assist in demonstrating actual procedures. Equipment, materials and personnel are also briefly discussed.

PRINCIPLES OF INLAND TRANSPORTATION

By S. Daggett. 3 ed. Harper & Brothers, New York, 1941. 906 pp., illus., diagrs., charts, maps, tables, 9½ x 6 in., cloth, $4.00.

Intended as a college text, this comprehensive work covers road, rail, water, air and pipe line transport, chiefly with respect to the United States. Early chapters present a brief historical survey and a consideration of transportation geography. Subsequent sections discuss rates, competition, labor and finance, relations of carriers with each other and relations between carriers and users. The problems and practice of regulation have been given full consideration. This new edition has been thoroughly revised for current use.

RUNNING AN ENGINE LATHE

By F. H. Colvin. McGraw-Hill Book Co., New York and London, 1941. 117 pp., illus., diagrs., tables, 8 x 5 in., cloth, $1.25.

This is a practical manual for apprentices and young machinists in which the foundation principles of engine-lathe work are presented simply and clearly.

THEORY OF SIMPLE STRUCTURES

By T. C. Shedd and J. Vawter. 2 ed. John Wiley & Sons, New York, 1941. 505 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $3.75.

This textbook for engineering students is intended to develop ability to solve problems in structural analysis by giving the student a thorough understanding of the underlying principles. A simple but complete discussion of the essential fundamental laws of statics and their application to simple structures is given, including many problems. The last two chapters present an introduction to statically indeterminate structures.

PRELIMINARY NOTICE

of Applications for Admission and for Transfer

April 28th, 1941

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, 1941.

L. Austin Wright, General Secretary.

*The professional requirements are as follows:—

A 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 attainment 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

ARPIN—JEAN VICTOR, of 571 Champagneur Ave., Outremont, Que. Born at Prince Albert, Sask., July 28th, 1913; Educ.: B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1938. Post graduate course in chemistry 1939-40; R.P.E. of Que.; 1934-37 (summers), asst. on Geol. surveys; 1938 (7 mos.), res. engr., 1939 (7 mos.), asst. engr., Dept. of Roads, Quebec; Aug. 1940 to date, production engr., Canadian Car Munitions, Ltd., Montreal, Que.

References: G. H. Kirby, R. Lanctot, H. A. Wilson, A. Circe, L. Trudel.

CARROLL—CYRIL JAMES GIBSON, of 171 Cochrane Rd., Rockcliffe, Ont. Born at Ottawa, Feb. 19th, 1904. Educ.: B. Arch. (Arch'l Engrg. course) S.P.S., Univ. of Toronto, 1927. Member R.A.I.C. 1939. 1925-26 (summers) office of J. A. Ewart, engrg. arch., Ottawa; 1927-28 dftsman. Chapman & Oxley, Toronto; 1928-31 arch'l engr., P. J. O'Gorman, architect, Sudbury, Ont. 1931 (May to Oct.) private practice as architect, Sudbury, Ont. 1931-2, research asst. Univ. of Toronto; 1932-33, student Ontario College of Education and Technical Training College; 1933-35, instr. of mech. and arch'l. drawing, Oshawa Vocational School; 1935-39, instr. of mech. and arch'l drawing, Ottawa Technical School; 1940, March to June, adviser and appraiser, National Housing Act; June 1940 to date, engr. officer (flying officer) R.C.A.F., i/c of drafting office handling planning and constrn. of all B.C. air training plan schools and R.C.A.F. stations.

References: J. A. Ewart, W. S. Kidd, J. M. Oxley, C. F. Johns, W. B. Pennock, T. R. Loudon.

DIXON—NOEL, of 39 Academy St., Valleyfield, Que. Born at Tickhill, Yorkshire, England, July 10th, 1898. Educ.: Mansfield Tech. College (England) 1934 R.P.E. of Ontario 1938; 1927-29 rodman, dftsman. instr'man; 1930-31, acting res. engr., Alberta and Sask., C.P.R.; 1935-36, instr'man and acting divnl. engr., Dept. of Northern Develop't of Ontario; 1937-38, instr'man and divnl. dftsman., Ontario Dept. of Highways; 1939, topographer and dftsman on land survey; 1940 (March to Aug.) transitman, Ont. H.E.P.C.; Aug. 1940 to Mar. 1941, asst. field engr. and at present office engr. H. F. McLean, Ltd., Valleyfield, Que.

References: T. F. Francis, G. H. Lowry, E. A. Kelly, K. Dixon, H. E. Barnett.

GRAY—NESBIT, of Three Rivers, Que. Born at Motherwell, Scotland, June 19th, 1907; Educ.: 1923-28 articled apprentice with Messrs. Stewarts & Lloyds, Ltd., Motherwell, Scotland, (3½ yrs. drawing office and 1½ yrs. shop experience), general plant engrg.; also attending Dalziel Techl. Sch., affiliated with Royal Tech. Coll., Glasgow. 1928-29, strct'l steel dftsman., Canadian Vickers Ltd., Montreal; 1929-31 dftsman. and designer on heating and ventilating layouts with E. A. Ryan, M.E.I.C. consltg. engr. of Mtl.; 1931 (6 mos.) designer on heating and ventilation layouts with L. A. St. Pierre, constlg. engr., Mtl.; 1932, dftsman and designer on ventilation layouts for C.N.R. Terminals, Montreal, with Wilson & Kearns, consltg. engrs.; 1933 to date constrn. engr. with Shawinigan Water & Power at Three Rivers, designing and supervising constrn. of sub-station structures, planning and supervising constrn. of commercial bldgs.

References: A. C. Abbott, J. H. Fregeau, H. J. Ward, J. F. Wickenden, K. S. Lebaron, C. H. Champion.

HOSEASON—HARRY J., of Toronto, Ont. Born at Liverpool, England, June 6th, 1912; Educ.: B.A.Sc., Univ. of Toronto, 1934; 1934, highway work, Rayner Constn. Co.; 1935, General Assurance Co.; 1935, Carter Halls Aldinger Co., Ltd.; 1936 jr. engr. Dept. of Ntl. Defence; at present sales engr. with H. H. Robertson Co. Ltd., mfrs. of steel roofing and siding materials, structural skylights and ventilation equipment.

References: J. Cooper, G. W. Raynor, T. R. Loudon.

JONES—DOUGLAS, of Montreal, Que. Born at Cardiff, Wales, July 7th, 1907. Educ.: 1925-28 McGill Univ. Completed first yr. Applied Science; 1935-37 with Forest Products Labs. of Canada as follows: plant supt., design and develop't of Johnston Pulp Classifier, design and develop't of miniature mechanical pulp grinder; 1937-41 paper mill control engr., Ontario Paper Co., Ltd., Thorold, Ont. At present, secretary-engr., technical section, Canadian Pulp & Paper Assoc.

References: J. Stadler, R. E. Jamieson, W. G. Mitchell, J. R. Donald, J. S. Bates.

LUCYK—JOHN WASYL, of 124 Spence St., Winnipeg, Man. Born at Krydor, Sask., Dec. 2, 1914. Educ.: B.Sc. (E.E.) Univ. of Man., 1936; 1937-39, post-graduate apprenticeship in engrg., 1939-40, electrical tester, with Gen. Elec. Co. Ltd., Wilton, Birmingham, England. At present demonstrator in Electrical Engrg. Dept., Univ. of Manitoba.

References: N. M. Hall, E. P. Fetherstonhaugh, G. H. Herriot, J. W. Dorsey, A. E. Macdonald.

MARSHALL—ROBERT FREDERICK MERRICK, of Beloeil, Que. Born at Pietermaritzburg, Natal, South Africa, July 27th, 1900; Assoc. Member, Am. Soc. Civil Engrs., 1937; 1917-23, dftsman., MacKinnon Steel Co., Sherbrooke, Que.; 1923-27, dftsman. and checker, Dominion Bridge Co. Ltd., Lachine; 1927-32, dftsman., full respons. for struct'l. design of bldgs., bridge dept., C.P.R., Montreal; 1932-35, partial time as dftsman., checker and designer, Canadian Vickers, Montreal; 1935 to date, designing engr., The Foundation Co. of Canada Ltd., Montreal, Que.

References: L. H. Burpee, R. E. Chadwick, R. J. Griesbach, W. Griesbach, P. B. Motley, E. P. Muntz, G. E. Shaw.

McLEISH—WILLIAM ANDREW EDWARD, of Shawinigan Falls, Que. Born at London, England, April 17th, 1887; Educ.: Night Schools, I.C.S. and Home Study; 1903-06, shops of Can. Gen. Elec. Co. Ltd., and Montreal Light Heat & Power Cons.; 1906-10, testing (lamps, transformers and gen.); and mech. dftsman.; 1910-18, mech. and elec. dftsman. (i/c of all elec. work from 1914), Dominion Bridge Co. Ltd.; 1918-20, power apparatus sales engr., Northern Electric Co. Ltd., Montreal; 1920-24, asst. to mgr. of power, i/c of engrg. design. etc., Laurentide Co. Ltd., Grand'Mere, Que.; 1924 to date, elc'l. supt., Belgo Divn., Consolidated Paper Corporation, Shawinigan Falls, Que.

References: E. B. Wardle, H. O. Keay, F. Newell, J. Morse, W. R. Way.

MITCHELL—WILLIAM GEDDES, of Walkerville, Ont. Born at Doneraile, Co. Cork, Ireland, Jan. 2nd, 1903; Educ.: B.A., B.A.I., Trinity College, Univ. of Dublin, 1925; R.P.E. of Ont.; 1926-29 dfting., etc., London office of Dorman Long Co.; 1936, designer, International Nickel Co.; with the Canadian Bridge Co. Ltd., as follows—1929-35, dfting., designing, 1935-41, charge hand in dfting room, and at present, chief dftsman.

References: F. H. Kester, P. E. Adams, A. E. West, D. T. Alexander, E. M. Krebser, T. H. Jenkins, C. M. Goodrich, C. O. Maddock.

MORISSETTE—JOSEPH SIMEON ANTONIO, of Sherbrooke, Que. Born at Ste. Marie, Beauce Cty., Quebec, April 15th, 1902. Educ.: B.A.Sc., C.E., Ecole Polytechnique 1926; R.P.E. of Quebec. 1923-26, asst. divnl. engr., Roads Dept., Quebec; 1926-27, National Research Council, Ottawa; 1927 to date, with Dept. of Roads, Prov. of Quebec as follows: 1927-33, divnl. engr., Beauceville; 1933-40, divnl. engr., Plessisville; 1940 to date, dist. engr. for the eastern townships.

References: A. Gratton, J. A. Lalonde, A. B. Normandin, O. Lefebvre, A. Frigon.

NIXON—WILLIAM HERBERT, of 262 Broadway Ave., Toronto. Born at Toronto, Oct. 31, 1894. Educ.: B.A.Sc. Univ. of Toronto, 1921; 1920 (summer) dfting. dept. James, Proctor & Redfern Ltd., Toronto; 1921-22 asst. highway engr., Toronto & York Roads Comm.; 1923-27 with James, Proctor & Redfern Ltd. as res. engr. on instlln. of various waterworks and sewerage systems; 1928-30 field engr. Peter Lyall & Sons Constn. Co. Ltd., on constrn. of lock section of Welland Ship Canal and the new Customs House, Toronto; 1930-31 field engr. Redfern Constrn. Co. Ltd.; 1931-32 res. engr. at Midland, Ont., for James, Proctor & Redfern Ltd.; 1933 field engr. for Quebec Paving Co. Ltd., Montreal; 1934-35 field engr. for Dufferin Constrn. Co. Ltd., Toronto; 1936-37 field engr. Foundation Co. of Canada, Montreal; 1938 field engr. for Scott & Jackson Constrn. Co., Toronto;

(*Continued on page 274*)

Employment Service Bureau

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party. Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted upon request after a lapse of one month. All correspondence should be addressed to THE EMPLOYMENT SERVICE BUREAU, THE ENGINEERING INSTITUTE OF CANADA, 2050 Mansfield Street, Montreal.

SITUATIONS VACANT

STEAM ENGINEER wanted by paper mill in Ontario. Applicants should be University graduates in mechanical engineering with experience in the generation and distribution of steam. Apply stating full particulars of education and experience, and giving references to Box No. 2283-V. Applications will not be considered from persons in the employment of any firm, corporation or other employer engaged in the production of munitions, war equipment, or supplies for the armed forces unless such employee is not actually employed in his usual trade or occupation.

GRADUATE MECHANICAL ENGINEER in good health, energetic, to work with large industrial concern in British Guiana. Applications should be sent to Box No. 2328-V.

MECHANICAL ENGINEER, preferably graduate, familiar with diesel engines, tractors and shovels for maintenance work with large industrial firm in British Guiana. Applications should be addressed to Box No. 2329-V.

CONSTRUCTION MAN with experience in heavy construction for either a long or short term contract in British Guiana. Applications should be addressed to Box No. 2330-V.

REQUIRED a number of experienced concrete detailers, designers and draughtsmen for work on industrial plants and power developments. Apply Box No. 2351-V.

GOOD practical steel designer, proficient in drawings and calculations of steel designs for industrial plants, and in addition able to approve details. Apply Box No. 2352-V.

SITUATIONS WANTED

CHIEF ENGINEER—twenty years industrial construction, production and operation. Structures, equipment, steam, hydro. Experienced conferences, preliminaries, organizing, preparing plans, estimates, specifications, negotiation of contracts. Apply to Box No. 36-W.

GRADUATE MECHANICAL ENGINEER, M.E.I.C., 14 years' experience as factory manager in machine tool factory and as consulting industrial engineer in widely diversified metal working trades improving factory and office methods specially cost accounting, desires permanent position $5,000 yearly. Apply to Box No. 1730-W.

FOR SALE

PLANIMETER, Dennerty & Pape, perfect condition, complete with case. Apply Box No. 42-S.

WANTED
MECHANICAL ENGINEER

Mechanical engineer required, young, with auto-aero engine testing experience, for immediate employment in Canadian factory in Montreal, engaged in construction of high-speed craft.

Applications from those engaged in War industries will not be considered.

Apply with full particulars to:
Box 2353-V
THE ENGINEERING JOURNAL
2050 Mansfield St.
MONTREAL

PRELIMINARY NOTICE (*Continued from page 273*)

1939 to date supt. of constrn. for Foundation Co. of Canada, Montreal, on the constrn. for the expansion of the Aluminum Co. of Canada, Ltd. plant at Arvida (at present night supt.).

References: W. B. Redfern, E. M. Proctor, C. R. Redfern, C. Johnston, H. M. Scott, R. E. Chadwick.

PINTO—ENRICO ARTHUR, of 1490 Fort St., Montreal, Que. Born at London, England, April 29th, 1884; Educ.: 1902-04, City & Guilds of London Institute. Diploma from the C. & G. Finsbury Technical College, 1904; Assoc. Member, Inst. of Elec. Engrs. (London); 1904-06, improver, National Telephone Service; 1906, improver, Witting, Eborall & Co. Ltd., Westminster; 1907, charge engr., Stalybridge Electricity Board, Lancashire, i/c H.T.-L.T. substations, etc., for lighting, power and traction; 1908-11, charge engr., Poplar Borough Council, i/c substations, generating station, boilers, recipg. and turbine engines, alternators, steam plant, etc.; 1911-32, own gen. engrg. and elect'l. contracting businesses, designing installns., etc., on all types of contracts, incl. private, industrial and governmental; 1932, district mgr., Superlamp Ltd., Gen. Engrs., London; 1933, sales mgr., Hendersons Wholesale Ltd., Brighton, England; 1937, manager, Unilectric Ltd., London, gen. elect'l. contracting; 1938-40, mgr. of elect'l. dept., G. Hopkins & Sons Ltd., London; at present, engr., United Kingdom Technical Mission in Canada, Montreal, Que.

References: M. Wolff, G. H. Kirby, E. A. Ryan, D. Anderson, H. B. Dickens C. H. S. Leheup.

RYLEY—ALFRED ST. CLAIR, of Montreal, Que. Born at Ottawa, Ont., Oct. 24th, 1888; Educ.: B.Sc. (Civil), McGill Univ., 1910; R.P.E. of Que.; Summers, 1907-08, G.T.P.Ry., 1909, Ferro Concrete Constrn. Co., Montreal; with the Truscon Steel Co. as follows—1910-12, designing engr., Windsor and Winnipeg; 1912-15, district mgr. and engr., Winnipeg; 1919-21, sales mgr., Windsor; 1921-26, district mgr., Montreal; 1926 to date, vice-president and district mgr., Montreal.

References: G. G. Ommanney, C. S. Kane, E. R. Smallhorn, J. B. Stirling, E. V. Gage.

SCHENCK—WILLIAM EDWIN, of Stratford, Ont. Born at Stratford, Ont., Feb. 12th, 1911. Educ.: 1924-29, Stratford Collegiate. 1929-39 City Engrg. dept., Stratford; 1939-40 mgr., contracting dept., and 1940 to date partner-owner of The Pfeffer Co., Stratford, Ont. (lumber, builders' supplies, gen. contractors, mill work). (Asks for admission as Junior or Affiliate).

References: W. H. Riehl, A. B. Manson, J. A. Vance, W. G. Ure, S. Shupe.

SWIFT—LIONEL D., of St. Roch P.O., Quebec, Que. Born at Shawinigan Falls, Que., Aug. 8, 1910; Educ.: B.Eng. (Elec.), McGill Univ, 1934. With the Shawinigan Water & Power Co. as follows: Summers, 1930 mtce. work; 1931 and 1932 constrn. work; 1933 transformer work; 1934-36 apprenticeship course; 1936-39 engrg. work, relay man and tester, Thetford Mines District; 1939 (May to Oct.) system operator's office, Shawinigan Falls; Oct. 1939 to date, test work and misc. engrg., relay man and mtce. foreman, Quebec district.

References: J. St. Jacques, G. H. Cartwright, R. Dupuis, H. J. Ward.

FOR TRANSFER FROM STUDENT

ARNASON—EINAR, Capt., R.C.E. Born at Winnipeg, June 7th, 1910; Educ.: B.Sc. (E.E.), Univ. of Man., 1937; 1937-39, sales engrg., English Electric Co. of Canada; 1939 to date, 2nd in Command, 1st Cdn. Corps Field Park Coy., R.C.E., c/o Base Post Office, Canada. (St. 1937).

References: E. P. Fetherstonhaugh, J. H. Edgar, A. E. Macdonald, W. A. Capelle, W. F. Riddell, G. H. Herriot, N. M. Hall.

BERENSTEIN—LESLIE, of 3180 Van Horne Ave., Montreal, Que. Born at Montreal, Oct. 3rd, 1908; Educ.: B.Sc. (Civil), McGill Univ., 1930; R.P.E. of Que.; Summers—1928, dftsman., Distillers Corp'n Ltd., 1929-30, dftsman., detailing dept., Dominion Bridge Co.; 1930-32, struct'l designing dept., Dominion Bridge Co. Ltd.; 1932-33, designing engr. and partner in firm of Allied Engineers; 1933 to date, struct'l engr. in charge of all steelwork, and at present vice-president, Louis Pickard & Co. Inc., Montreal, Que. (St. 1929).

References: N. Cageorge, C. S. Kane, D. J. Lewis, E. Kugel, W. G. Hunt.

CORBETT—BRUCE SHERWOOD, of Montreal, Que. Born at Montreal, April 12th, 1914. Educ.: B.Sc. (Civil) Univ. of Alta. 1936, M.Sc., Univ. of Toronto, 1937. 1934-37 (summers) dftsmn. with Edmonton City Waterworks, chainman, Alberta Highways Dept., Engrg. dept. Northwestern Utilities, Ltd.; 1938-41, International Nickel Co. as follows: 1938 asst. to ventilation engr. at Frood Mine, 1939-41 engrg. dept., underground surveyor and stope engr., Frood Mine, Copper Cliff, Ont. At present attending Aeronautical Engrg. School, R.C.A.F., Montreal. (St. 1936).

References: J. D. Baker, J. Garrett, R. J. Gibb, R. S. L. Wilson, H. R. Webb.

DIGGLE—WILLIAM MARVIN, of 677 Kildare Rd., Windsor, Ont. Born at Saskatoon, Sask., Oct. 14th, 1917. Educ.: B.Sc. (Civil) Univ. of Sask., 1940. 1938-39-40 (summers) rodman, Dept. of Highways, instr'man and asst. i/c layouts, etc., P.F.R.A., and instructor i/c levels and topography, summer survey camp, Univ. of Sask. At present dftsman. Can. Bridge Co., Walkerville, Ont. (St. 1940).

References: C. M. Goodrich, P. E. Adams, A. H. MacQuarrie, R. C. Leslie, R. A. Spencer, E. K. Phillips.

DOW—GORDON YOUNG, Capt., R.C.E., of 162 Orange St., Saint John, N.B. Born at Woodstock, N.B., Sept. 17, 1908. Educ.: B.Sc., Univ. of New Brunswick, 1932. 1930-31, elect'l constrn. with C.P.R. at West Saint John; 1937-39, service engr., Refrigeration Service Co., Saint John. At present officer commanding 1st Brighton Fortress (E. & M.) Coy., R.C.E., Saint John, N.B. (St. 1934).

References: A. A. Turnbull, W. H. Blake, J. Stephens, A. F. Baird, G. A. Vandervoort.

DUNLOP—DUTHIE McINTOSH, of Reston, Man. Born at Lauder, Man., Apr. 3, 1909, Educ.: B.Sc. (Civil 1934) (Elec. 1933), Univ. of Manitoba. 1930 (summer), rodman, Good Roads Manitoba; 1936-40, transitman, 1940 to date roadmaster, C.P.R. (St. 1934).

References: K. A. Dunphy, W. H. McLeod, G. H. Herriot, E. S. Braddell, A. Sandilands, J. C. Holden.

EVANS—EDWARD NORTON, of Westmount, Que. Born at Montreal, Oct. 11th, 1907. Educ.: B.Sc., McGill Univ. 1931. 1931 (6 mos.) inspr. of concrete, Beauharnois Constrn. Co., Beauharnois and Valleyfield, Que.; 1936 to date, sales rep. Champion Spark Plug Co. of Can., Windsor, Ont. (St. 1930).

References: C. E. Frost, A. P. Sherwood, H. E. Cunningham, R. N. Warnock.

GOODSPEED—HERBERT NEWCOMBE, of Sudbury, Ont. Born at Penniac, N.B., April 27th, 1911. Educ.: B.Sc. (Elec.) Univ. of N.B., 1934. 1936-37, asst. engr. Eclipse Gold Mining Co.; 1937 (4 mos.) resident engr. with Kanasuta Gold Mines Ltd.; 1937-39, elec. constrn., Thompson-Cadillac Mining Corp., and assay office, Lapa Cadillac Gold Mines; 1940 to date International Nickel Co., electl. dept., Garson Mine. (St. 1934).

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HARE—CHARLES MacKAY, of Noranda, Que. Born at Woodstock, N.B., Jan. 30th, 1906. Educ.: B.Sc. (Civil) McGill Univ., 1929. 1926-28 (summers) asst. on various surveys; 1929-30, detailer strc'l steel, Dominion Bridge Co., Lachine; 1930-32, asst. engr. Atlas Constrn. Co. and Standard Dredging Co., west Saint John Harbor improvements; 1936 surface transitman, Arntfield Gold Mines Ltd., 1936-37, engr. foreman i/c constrn. camps and roads, Arncoeur Gold Mines Ltd. 1937-39, underground surveyor, later chief underground surveyor Arntfield Gold Mines Ltd. At present surveyor and dftsman., constrn. and mech. dept., Noranda Mines Ltd., Noranda, Que. (St. 1928).

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PIETTE—GUILLAUME, of Quebec, Que. Born at Berthierville, Que., Dec. 4th 1913. Educ.: B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1939. Summers (1937) inst'man, Local Constrn. Co.; 1938, inspr., Industrial and Commercial Labs.; 1939, res. engr., 1940 soil engr., Highways Dept., Quebec. At present taking post graduate course at Univ. of Michigan in soil mechanics (St. 1938).

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CHARACTERISTICS AND PECULIARITIES OF SOME RECENT LARGE POWER BOILERS IN ENGLAND

GERALD N. MARTIN, Jr.E.I.C.
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Paper presented before the Montreal Branch of The Engineering Institute of Canada, on February 13th, 1941

In July, 1938, the author went to England for the purpose of obtaining a broader experience in boiler engineering, and to this end joined the staff of International Combustion of London and Derby, while remaining under the guidance of Mr. Johnstone Wright, chief engineer of the Central Electricity Board.

This was prior to the Munich episode, when peace-loving Britain was thought to be still very much asleep. But, while the then foreign, and now enemy propaganda machines were deriding Britain for her impotence and weakness, an industrial revolution was being started; Britain was rearming; not guns or other weapons of war as yet—but she was renovating her industrial machinery.

Electricity is, of course, the very heart of the modern industrial machine, and in England, 98 per cent of the electrical energy is derived from coal. Previous to three years ago, however, many of the central power plants operated at low efficiency, and a few years previous to that the distributing systems were decidedly haphazard. The systems overlapped; the current frequency often differed on the two sides of the same street; alternating and direct current systems operated side by side.

In 1936-37, however, it became apparent that great changes were under way. Larger, more efficient, and better located plants had to be installed to relieve London's overstressed system and to help industrialize the so-called "distressed" areas: Wales, Lancashire, Scotland. Extensions of existing plants were studied and new installations were planned with an eye to a higher national efficiency and availability.

To undertake such a task, British engineers were in an advantageous position. Authority to promote such schemes had been vested in a non-political, government-free institution: The Central Electricity Board. This Board could base its decisions on information derived from the latest practical researches conducted in the United States and on the Continent, and on local and national conditions. Reports of boiler plant operations from these countries led to the consideration of the use of larger output, higher pressure and temperature units, also to the introduction of the forced circulation principle. Thus, plants of 300,000 lb. per hr. steaming at 1,500 lb. per sq. in. with final steam temperature of over 900 deg. F., were conceived. Now, LaMont and Loeffler units are in use alongside natural circulation boilers.

It is not the author's intention to describe these stations in detail nor to inflict upon the reader quantities of figures and data. Numerous articles written by recognized authorities have already been published on this subject. It is, however, the purpose of this paper to illustrate, through examples with which the author was actively and closely connected, the present trends of power plant practice in Britain.

The majority of the central power plants installed in Britain are of the natural circulation type, divided equally as to the type of firing; that is, stoker and pulverized fuel. For stoker firing, the chain grate type is the most commonly used with the American favourite, the multiple retort, running second. It appears that most English coals are suitable for this type of firing, and are equally satisfactory for firing in the pulverized form. For the latter type of firing, the unit system is mainly used, the mill being the only intermediary between the raw coal bunker outlet and the burner.

It is of interest to note the types of turbines and generators most widely used in British power stations. Two types of plants are used: condensing units and non-condensing units. The latter classification includes the superposed turbines or topping units which have been so front-paged in the United States. They find their economy in plants where the space restrictions or the available capital, or both, do not warrant the extra expenditure required by a complete new high pressure system, involving a new condensing plant.

For these turbines, a throttle pressure of 1,250 lb. per sq. in. is the average, with steam temperature of 925 deg. F. Since a 50-cycle frequency has been adopted for the British Grid System, the generator revolves at 1,500 or 3,000 r.p.m. depending on the kva. capacity. The back pressure against which the turbine exhausts, naturally depends on the existing plant characteristics.

Condensing turbine units operate with 1 or 1½ in. Hg. vacuum and a proposed standard of practice is described in Table I.

The average over-all efficiency of British stations lies between 20-25 per cent from the coal barge or freight car to the station's bus bars.

However, most of the preferred stations, such as Barking, Battersea, etc., which carry the bulk of the electrical output, average 25-30 per cent efficiency. Brimsdown station in London has a design efficiency of 32 per cent, the highest in Europe.

Naturally, these efficiencies are greatly in excess of those met in industrial steam power plants. They are made pos-

TABLE I

Rating, kw.	10,000	12,500	15,000	20,000	25,000	30,000	50,000	75,000
Speed, r.p.m.	3,000	3,000	3,000	3,000	3,000	3,000	3,000	1,500
Steam throttle, lb. per sq. in.	650	650	650	850	850	850 or 1,250	850 or 1,250	850 or 1,250
Steam temp., deg. F.	825	825	825	900	900	900	900	900
No. of bleed points	3	3	3	3	3	4	4	4
Temper. at bleed points at rated output, deg. F.	170 225 290	170 225 290	170 225 290	170 225 290	170 225 290	120 225 290 350	120 225 290 350	120 225 290 350
Turbine capacity, per cent of kw. rating	125	125	125	125	125	125	125	125

sible through the use of feedwater heaters and turbine bleeding; by the maintenance of a nearly complete vacuum and by an efficiency of steam generation in the neighbourhood of 85-90 per cent.

This last efficiency requires the use of economisers and air heaters to cool the gases to the vicinity of 300 deg. F. and calls for a combustion 98 to 99 per cent efficient.

Since the aim of the central station designer is to generate a certain quota of electricity in the most efficient fashion, he must be guided by the foregoing limits of efficiency.

A typical arrangement of a stoker-fired boiler is shown in Fig. 1. The unit is a normal tridrum, steaming at 300 lb. per sq. in. with final steam temperature of 785 deg. F. at the normal rate of 120,000 lb. per hr. and capable of 150,000 lb. per hr. (maximum continuous rating) with peaks of 165,000. The boiler heating surface is 14,800 sq. ft. The furnace walls are partly protected by finned tubes externally fed by down-coming pipes, connected to the boiler mud drum. The steam and water mixture rising in the furnace wall tubes is collected in two side wall headers, and, from there, taken to the front drum. The front wall tubes are also connected to this drum. Circulation tubes return the water and the steam to the rear steam and water drum; the water to be started again on its cycle, and the steam to be extracted and led to the superheater.

Attention is drawn to the smallness of the ignition arch, high volatile coal being fired on a "type L" self-cleaning louvre type stoker, 26 ft. wide by 22 ft. 6 in. long, providing a grate area of 585 sq. ft. This permits a burning rate of approximately 35 lb. per sq. ft. per hour when an efficiency of approximately 85 per cent is obtained.

The gases, following the conventional path after their passage through the screen tubes at the furnace outlet, travel at an average velocity of 35 ft. per sec. through the Melesco superheater, and then transfer their heat energy to the water in the boiler tubes. Similarly, the remainder of the recuperable energy is absorbed by the finned tube economiser of 7,452 sq. ft. of heating surface and by a plate air heater of 17,000 sq. ft.

It can be seen from the layout of the ducting that preheated air is admitted underneath the coal bed while secondary air jets force the flame away from the front wall, helping to obtain complete combustion by creating turbulance in the gases released from the fuel bed.

The removal of the ash is typical; two front hoppers collect riddlings and a hopper is provided at the rear end of the stoker for the ash removal.

Dust particles carried in the gas stream are extracted by a cyclone local to the induced draft fan. National smoke abatement laws make compulsory the use of dust catchers. This is done with a cyclone (as in this unit), or with precipitators in conjunction with pulverized fuel units. Some large plants even resort to gas washing.

Part of the preheated air is re-circulated into the eye of the forced draft fan, increasing the temperature of the air to approximately 130 deg. F. at the air heater inlet. This process, better illustrated in connection with another installation, has been found the cure for the operating trouble well known to operators as "low dew point."

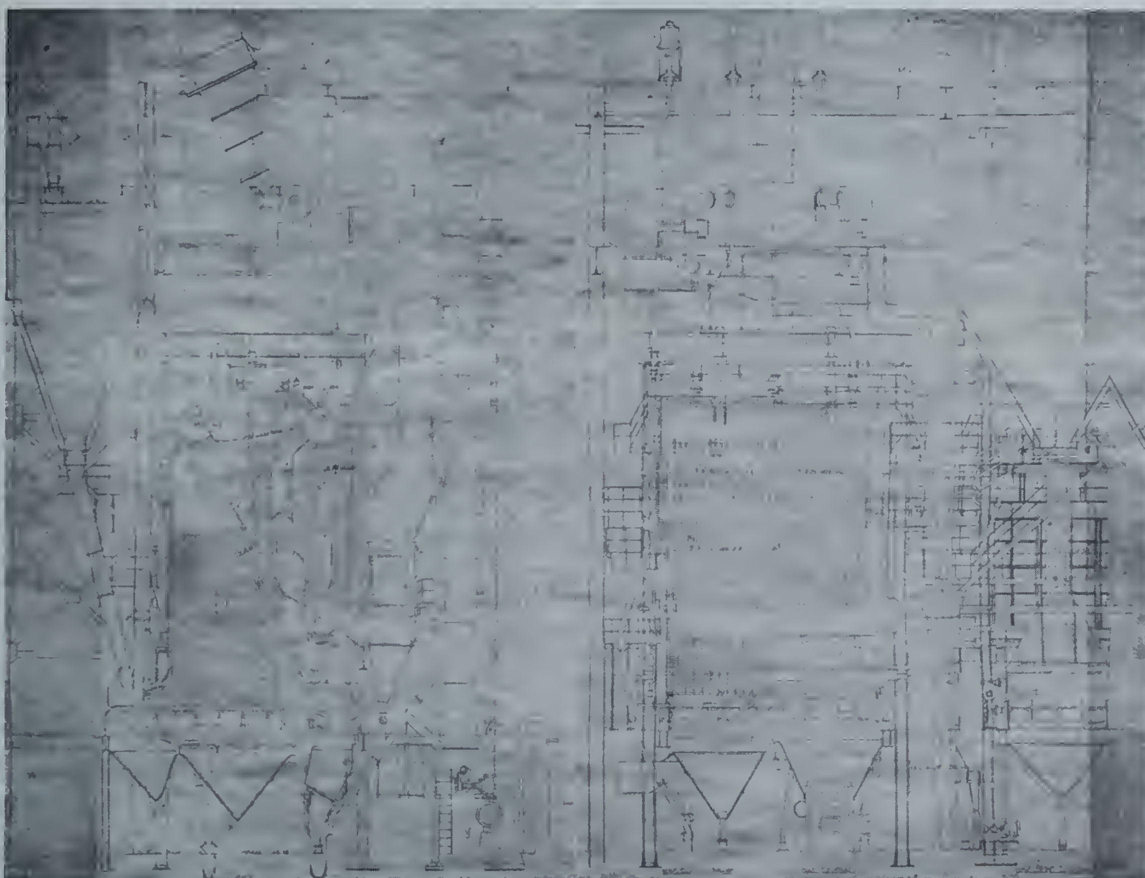

Fig. 1—Layout of stoker-fired boilers at Kilmarnock, Scotland. Capacity, 150,000 lb. per hr. (m.c.r.).

A further illustration of this type of boiler plant is given in Fig. 2, which shows the general arrangement of one of the three boilers installed in the Borough of Stepney, in the heart of London's well known Whitechapel district. These units were erected in an existing building in replacement of obsolete equipment.

The furnace consists of finned tubes with exterior downcomers and risers; the boiler itself is a standard Stirling design, popular with many British engineers. Its normal evaporation at 370 lb. per sq. in. with final steam temperature of 860 deg. F. is 125,000 lb. per hr. and it is capable of an overload capacity of 150,000 lb. per hr. A total heating surface of 12,919 sq. ft. is installed, divided as follows:

Boilers....	11,619	Superheater M=L=S. design	7,200
Side walls.	360	Econo. finned tube.........	8,235

Front wall.	750	USCO plate heater......... 17,437
Rear wall..	190	Final air temp... 296 deg. F.
	12,919	Final gas temp.. 277 deg. F.

A twin-grate stoker, 21 ft. wide by 20 ft. long giving an area of 420 sq. ft. permits the burning of 34.5 lb. of coal per sq. ft. per hr.

The coal cycle starts from a belt conveyor feeding the gunite-lined coal bunkers. Three travelling chutes distribute

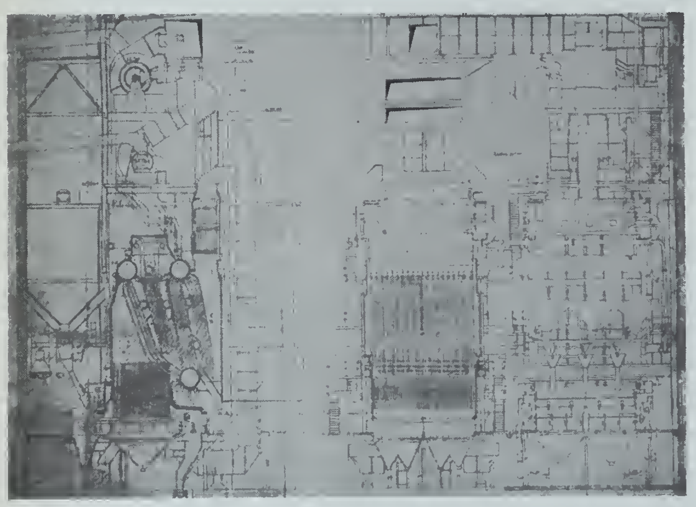

Fig. 2—Layout of stoker-fired boilers at Stepney, London. Capacity 125,000 lb. per hr. (m.c.r.).

the coal evenly in the stoker hoppers. This even distribution is obtained through a screw arrangement linked by a chain to the stoker drive. The feeding, therefore, is effected in direct ratio to the grate speed.

An adjustable guillotine door at the hopper outlet maintains the fuel bed thickness found most suitable under the individual prevailing operating conditions. This thickness is mainly governed by the type, size, moisture-content and quality of the fuel burned.

Variations in steam output are met with an adjustment of an eight-speed gear-box on the stoker drive or, in the case of a direct current motor drive, by a voltage variation.

The construction of this stoker is of further interest, in that no air zoning is provided; a plenary air chamber together with adjustable air valves provided along the grate permit proper distribution of the air quantities necessary for complete and efficient combustion. Floating air seals eliminate leakages and the air passage, provided by a special construction of the louvres, is kept clear by the self-cleaning arrangement which is the most important characteristic of this equipment. Thus the grate is kept cooled, and maintenance costs are therefore at a minimum.

The use of preheated air at 300 deg. F., necessitated by the desire to obtain a high efficiency, and by the presence of high initial feedwater temperatures, was for a long time the bug-bear of stoker manufacturers, and their latest designs are a direct answer to this problem.

The ashes and clinkers are dumped in the rear hopper and continuously removed under water by a drag scraper. This principle of ash removal eliminates the infiltration of air during ashing operations, which sometimes last as long as 30 minutes in each 8-hr. shift.

The gases, cooled below the ash softening point by the absorption of their radiant energy by the furnace wall tubes and water-cooled arches, travel in a normal way through the boiler's four passes; and finally lose their remaining recuperable energy to the feedwater in the economiser and to the air in the air preheater.

The air cycle starts with extraction of air at the top of the boiler house, helping to keep a moderate ambient temperature and to reduce radiation losses. After its passage through the preheater, the air is ducted down to the stoker plenary chamber.

A proportion of air had already been extracted at the heater outlet for recirculation, and in the basement another quantity is abstracted by two secondary air fans for injection at 6 to 12 in. presure above the ignition arch.

This plant includes also two types of de-superheating equipment: one of the non-contact type, to be described further on, and one of the jet-type, where part of the treated feedwater is injected in a controlled way into a vessel set in parallel with the main steam range. Part of the superheated steam is thus cooled, the feed-water is evaporated, and the increased steam quantity is re-introduced along with the original steam, thus decreasing the final steam temperature to the desired level.

Figure 3 gives the arrangement of a high-pressure high-capacity, pulverized fuel unit. It is one of the four boilers recently commissioned for the Little Barford plant of the Edmunson's Electricity Corporation. In this new central station in Bedfordshire the unit system has been used throughout. The installation is complete, from the coal bunker to the electric generator, in a single common room. Two steam generators were supplied by the Babcock-Wilcox Company and two by International Combustion Limited.

The author had the privilege of working on this contract during its development, in the design and drawing stages, and in the contracts department. Throughout the design, it was necessary to keep in mind the availability of the plant, as an uninterrupted service of twelve months was specified. Moreover, the appearance of the unit was of more than usual importance as the boilers were in the same room as the turbo-generators. For this reason, the layout had to be cleancut and simple.

The normal evaporation of each boiler is 270,000 lb. per hr. with overload capacity of 300,000. The pressure at the superheater outlet is 675 lb. per sq. in. while the drums are designed for a working pressure of 775 lb. per sq. in.

The coal is fed from a triple outlet bunker to three automatic weighing machines. A by-pass is provided so that the continuity of the service may not be impaired by the failure of any one of these three machines. The coal chutes, approximately 50 ft. in length, distribute the coal to table type feeders which feed Loesch design mills similar to the

Fig. 3—Layout of pulverized fuel units at Little Barford, Bedfordshire. Capacity 300,000 lb. per hr. (m.c.r.)

American bowl mill. The coal is then ground and a rotating classifier maintains the desired fineness. Three exhaust fans of 24 in. static pressure deliver the coal-air mixture to burners arranged in the four corners of the combustion chamber for tangential firing. Two of the three mills serve two diagonally opposed burners while the third mill, used as a stand-by, can fire the four corners simultaneously.

As can be seen in the figure, the unit installed is of the high-head type, the water level being approximately 50 ft.

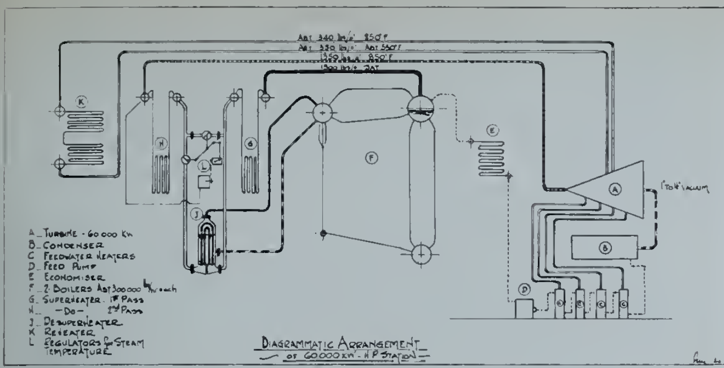

Fig. 4—Diagrammatic arrangement of Littlebrook power station. 60,000 kw.

above the bottom mud-drum. Substantially, it consists of a completely water-cooled finned tube furnace integrally-fed, surmounted by a three drum boiler arranged to provide an extended furnace volume.

The furnace tubes are bent around the burner and tertiary air castings and are fed from the mud-drum through screen tubes and horizontal side-wall feeders. A tile baffle protects from the heat the downcomer tubes which are kept inside the boiler casing. Side and front wall release tubes carry the steam-water mixture to the top drums directly, or through the intermediary of top side wall headers.

An elaborate system of interior baffling was devised to eliminate foaming and priming and to ensure the generation of clean, dry steam.

A multiloop two-pass superheater of the Melesco type is arranged in a vertical position for easy cleaning and replacement of elements. The saturated steam is abstracted from two nozzles on the rear top drum and fed to both ends of the primary superheater headers. After its passage through the primary elements, the steam enters the secondary superheater through inter-connecting pipes at the top front of the unit. On the outlet header, a Y-piece is provided connecting the two superheater outlets to the 12 in. steam main.

The final steam temperature of 910 deg. F. is maintained by the automatic operation of dampers permitting the bypassing of a proportion of the flue gas.

It will be seen from the figure that the structural steel design must present certain difficulties. Vibrating loads of 100 tons had to be accommodated on an independent suspension 70 ft. high. Care had to be paid to thermal expansion, casings were designed for pressures due to sudden ignition of the pulverized coal; galleries had to be provided for, etc.

A 13,600 sq. ft. steaming economizer is provided in the back of the boiler and arranged for downward flow of the gases. A gas by-pass can be used when starting up the unit. The outlet tubes are directly expanded in the drum and the general construction is of the steel-tube type with cast-iron extended surface shrunk on. An asbestos curtain damper can be dropped at the outlet of the economizer to help retain the heat in the component parts of the unit during short shut-down periods equivalent to banking conditions in a stoker fired unit.

The gases are ducted from the economizer to two Ljungström air-heaters of 23,200 sq. ft. each arranged for horizontal shaft and bearing. The air which is sucked from the top of the boiler house by the forced draft fans located in the basement is heated to 434 deg. F. at the outlet of the heaters, while the gases are cooled to 286 deg. F.

The air ducting can be followed from the outlet of the heaters down underneath the operating floor where a manifold section serves the longitudinal ducts from which three connections to the mills are tapped and which continue to the front of the boiler. From here, four branches are taken vertically upwards to the coal burners and to the tertiary air ports.

In order to avoid possible operating trouble with the air heaters due to low dew point condition of the gases, the principle of re-circulation was made use of. That principle, already referred to in connection with the previously shown installations, is best illustrated in this instance. A certain proportion of the air from the heater outlet is tapped in a controlled way through a damper and directed into the suction of the forced draft fan, so that the entering temperature of the air will be above 100 deg. F. Thus, the cooled elements of the regenerative heater are maintained at a temperature high enough to prevent sudden chilling of the gases with resulting deposits of moisture, possible adherence of fly-ash carried in suspension in the flue gas, and with accompanying formation of H_2SO_3 and resulting corrosion. This expedient results in a higher power consumption by the fan motors but it has proved to be a definite remedy for an operating trouble which, for certain coals, reduces so much the availability of the plant.

In order to comply with the very strict smoke abatement laws, a precipitator is installed with all powdered fuel stations in Great Britain. The most frequent type met with is the electrostatic precipitator, consisting of a large concrete building, housing electrically-charged tubes of large diameter hanging in the gas path. The dust particles carried in suspension are electrically attracted to these tubes and deposit on their surface in a very thin layer. A rapping gear is set in motion, causing the fall of these particles

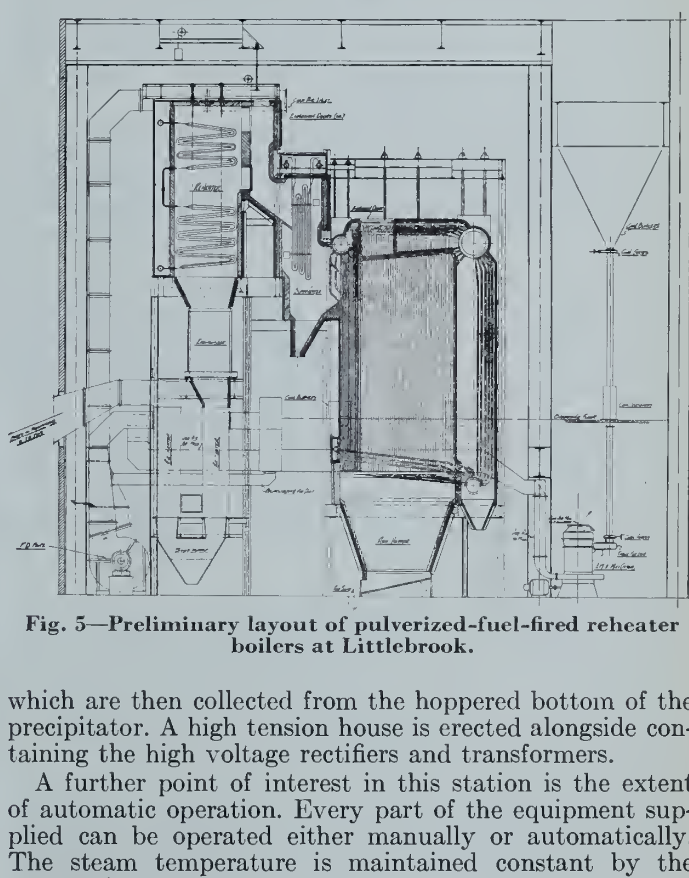

Fig. 5—Preliminary layout of pulverized-fuel-fired reheater boilers at Littlebrook.

which are then collected from the hoppered bottom of the precipitator. A high tension house is erected alongside containing the high voltage rectifiers and transformers.

A further point of interest in this station is the extent of automatic operation. Every part of the equipment supplied can be operated either manually or automatically. The steam temperature is maintained constant by the automatic operation of a gas by-pass; the boiler output changes are met by an automatic change of the fuel feed with corresponding variation of the required air quantities; the ashing operation is started at the touch of a push button; valves are motor-operated, even the sootblowers are automatic, their sequence of operation being followed on a light chart. All damper control gears are centered at the front of the boiler. Bi-colour water gauges with reflectors of the floor pedestal type are also in front. The mills, located in a separate dust-tight room in the basement, can be operated manually from the main panel where pilot lights indicate the state of operation. Practically all that the operating engineers have to do besides taking half-hourly readings is to stand ready to push the right button

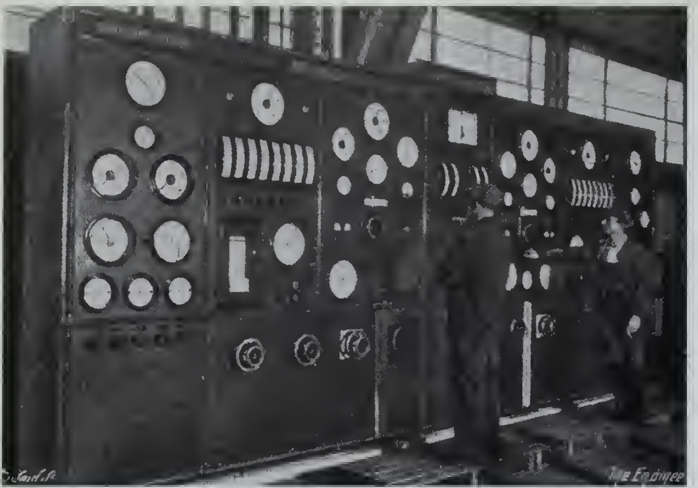

Fig. 6—Control panel for Loëffler boilers.

at the right moment and to see that their automatic servo-motors are in order.

Figure 4 is a diagrammatic arrangement of the extension for the Littlebrook power station owned by the Kent Electric Company. The layout of this extension was guided by a previous installation and was started before the latter was put in operation. It consists of units capable of developing 60,000 kw. at maximum continuous rating, the turbine being of the two-stage type and the boilers of the reheat principle. Incidentally, it was the last contract the author worked on in England.

The cycle begins at the feedwater heaters, receiving the water from the condensers through lift pumps. The water is heated by steam bled from the turbines at various temperatures and pressures and receives a further increase in temperature in the economizer, from which it is fed to the boiler.

The bulk of the steam generated in the boiler enters the superheater's primary elements. From there they pass to the secondary elements either directly or after the passage of a portion of the steam through the desuperheater. The function of the latter will be explained later. The superheated steam is then directed to the turbine where it expands to a point determined by the economies of the installation, whence it is returned to the reheater to be superheated once again, but this time at a lower pressure.

From the reheater outlet this low pressure but high temperature steam is returned to the turbine for further extraction of energy.

The non-contact condenser fitted at the outlet of the turbine condenses the steam by extracting its latent heat of evaporation through the intermediary of circulating water. The steam thus returns to its original state and starts another cycle as feedwater. Like most central stations, the water cycle is a closed one with as little as ½ per cent make-up water.

Figure 5 shows a preliminary arrangement of the boiler room for the same station. Slight alterations were made in the course of the contract's development, but the general idea was maintained.

It will be seen that the boiler is of the radiant type, consisting of a huge furnace lined with finned tubes; the only convection surface provided is in the form of screen tubes. A generous number of downcomer tubes feed the bottom drum which, in turn, supplies the rear wall tubes, the front wall tubes through the bottom granulating screen tubes, and the side walls through the intermediary of the side headers.

Water and steam circulators are provided between the two top drums. Thus to generate 300,000 lb. of steam at 1,500 lb. pressure, or, to develop 10,000 boiler hp. to suit the still-popular conception of boiler rating, only 4,500 sq. ft. of heating surface are provided. Using these same popular standards, we can translate this evaporation as a rating of over 2,000 per cent of normal rating, which is between five or ten times the rating of normal boilers. The average furnace temperature at maximum continuous rating is 1,980 deg. F. The gases are cooled to 1,900 deg. F. through the screen tubes. They then enter the second phase of the unit, which consists of a large two-pass Melesco superheater of the pendant type.

In order to maintain a constant final steam temperature over a wide range of ratings and therefore obtain a high thermal efficiency without incurring the risk of damaging the plant equipment, a desuperheater is put in parallel to the steam circuit between the first and the second pass.

Thermostat-regulated valves control the quantity of steam taken from the superheater's first stage to the desuperheater. There, some of its enthalpy (heat content) is dissipated in evaporating boiler water which returns to the boiler as saturated steam. That is, the final steam temperature is controlled by reducing its heat content by a required amount at the middle of its path through the superheater.

The final temperature of the steam is thus maintained at 850 deg. F. while the pressure at the outlet of the superheater drops to 1,300 lb. per sq. in. Steam is taken to the high-pressure end of the turbine through an 8-in. pipe; is expanded down to 350 lb. and returned through two 12-in. pipes to the third section of the unit, the re-heater. This section is virtually a low-pressure superheater, raising the steam temperature from about 530 deg. F. to 850 deg. F. This low-pressure steam is piped to the low-pressure end of the turbine and is finally condensed and ready to start the cycle over again. The gases are cooled from 1,320 to 1,000 deg. F. while passing through the 22,500 sq. ft. reheater. A gas by-pass is provided in order to maintain a constant final steam temperature. This operation is done automatically.

From then on, the rest of the plant is very similar to the previous installations shown. The heat recovery sections consist of an economizer weighing 120 tons of the finned-tube type, cooling the gas from 1,000 to 665 deg. F. This is followed by two air-preheaters of the plate type providing 81,000 sq. ft. of heating surface and weighing 100

Fig. 7—Stokers for two Loëffler boilers.

tons each, which keep the final gas temperature below 300 deg. F. All these temperature figures mentioned are for maximum continuous output. Here again the air re-circulation principle is made use of, as evidenced by the ducting layout.

The two units are corner-fired two pulverizers being supplied for each unit, each capable of milling 12 long tons per hour. The water circulation problems involved can be appreciated when comparing the densities of the water and of the steam at 1,500 lb. pressure. The margin producing the thermosyphonic circulation is very small, thereby necessitating a large vertical distance between the top and bottom drums. To illustrate this problem, it may be mentioned that the ratio of the steam density at 150 lb. per sq. in. to that of water is 152, whereas, at 1,500 lb. per sq. in. it is only 11.5, a reduction of over 92 per cent. In this case, vertical distance of 43 ft. 6 in. was necessary between drums to get adequate circulation. The bottom drum was set 20 ft. above the basement level in order to provide head room for an ash hopper of 50 ton capacity.

These requirements affected the physical aspect of the plant and necessitated a final height of 92 ft. to the top of the 100-ton re-heater. The supporting of this re-heater, together with a 60-ton superheater, and a 250-ton boiler at heights varying between 70 and 90 ft. presented no easy problem.

The design of the drums presented another group of interconnected problems. The large steam and water drum required an internal diameter of 54 in. This diameter was determined by the steam liberating surface required and also by the physical dimensions of a steam washer.

The function of the steam washer mentioned above is to remove the salts entrained in the steam and thus lengthen the life of the turbine blades at the low pressure end, and, also, the life of the superheater elements. The removal of these solids is accomplished by washing the steam in the clean entering feedwater.

Thus, it was necessary to design a large diameter vessel for a pressure of 1,500 lb. per sq. in. while sustaining static loads of over 100 tons. Using material of an ultimate tensile strength of 80,000 to 86,000 lb. per sq. in. we arrive at the amazing required thickness of 6 in. for the wall of the vessel. To reduce bending stresses, the drum is supported at intermediary points and its wall thickness had to be increased by ⅜ of an inch at the support points in order to provide enough material to sustain the stresses. Bending moments due to the weight of the drum itself—approximately 50 tons—and due to the suspended loads were investigated and contributed in increasing the drum thickness to its final dimension. Special equipment had to be designed for forging these drums and the tube drawing machines had to be altered to accommodate 3 in. o.d. tubes ⅜ of an inch thick and 45 ft. long.

The units are totally steel encased and walkways are provided at six levels for easy access to operation points. Combustion control is centralized in a single panel located mid-way in front of the two boilers.

So far, we have looked only at arrangements of natural circulation boilers of the latest and most familiar types. It may be of interest, then, to examine briefly some other types of boilers in use in Britain.

Restricted by a shortage of materials and a reluctance to import special alloys necessary in the building of high pressure units of the natural circulation type, Germany, Czecho-Slovakia and a few central European countries started some time ago exploring the possibilities of economical steam generation using the forced circulation system in the design of the boilers. These conditions did not obtain in Great Britain nor in the United States. Therefore, it is logical that the engineers of these two countries started investigating this related problem only after the Central European engineers had discovered unforseen advantages in the use of this type of plant. The most popular system of forced circulation boiler in Europe is that first put forward by a United States' naval officer—the LaMont system. International Combustion secured patents for England and built the first unit of this type for the Imperial Chemical Industries plant at Wallerscote. Then another boiler company—the John Thompson Co. also secured patents for the same boiler and in the last five years they have built a few large units. One was for the London Power Company and was then the largest LaMont boiler in the world. The steam output is 350,000 lb. per hr. and the final steam conditions are 350 lb. per sq. in. and 850 deg. F.

The outstanding feature of the LaMont system is the use of forced circulation through the boiler tubes. A circulating pump running at constant speed forces the water into distributing headers replacing the multiplicity of expensive drums used in a normal boiler. From that point, the water is divided to each boiler tube system through an orifice so that each element may receive the quantity of water required by its evaporative potentiality. Thus, the pump overcomes the frictional losses of the system, while absorbing but ½ per cent of the energy output of the boiler.

Small tube diameters and greater tube lengths can be used in the LaMont system with better heat transfer and decreased boiler weight. Since the percentage of power required by the circulating pump remains a small part of the energy output of the boiler, even at very high pressure, this type of boiler is usable over the whole pressure range up to the critical pressure (3,200 lb. per sq. in.).

The latest and largest unit of this type of boiler is at present under construction in the U.S.A. It is designed for 650,000 lb. per hr. at 1,850 lb. per sq. in. at the superheater outlet, and it is to be equipped with all the modern heat recovery sections, so that an efficiency of 89 per cent will be attainable at maximum continuous rating.

Another system of forced-circulation is that used by the boiler designed originally by the Austrian, Dr. Stefan Löeffler. The first installation of this type in England was built

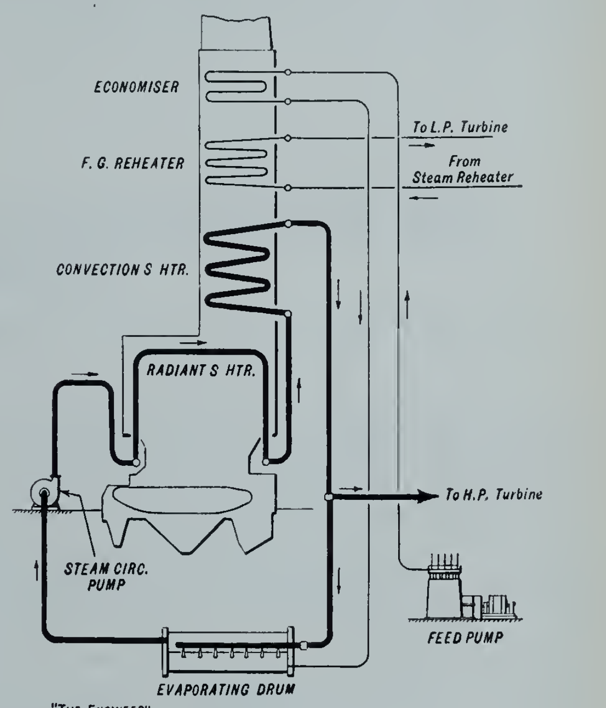

Fig. 8—Diagram showing the principle of operation of the Loëffler boiler.

for the central station of the North Metropolitan Power Supply Company, at Brimsdown, a Borough of London. The layout of the new high pressure plant is perhaps not as good as it might have been had it not been necessary to utilize the existing buildings.

Figures 6 and 7 show the control panel and the stokers for two Loëffler boilers, each rated at 210,000 lb. per hr. (maximum continuous rating). High-pressure steam is delivered to the high-pressure set, which develops 19,000 kw. After the steam has been reheated, it passes to the low-pressure 34,000 kw. set. Although it was originally intended to reheat the steam in two stages: first in a steam-to-steam reheater using the high-pressure high-temperature steam, and then in reheaters incorporated in the boilers, it has been found to be possible to reheat to the specified temperature without the steam-to-steam reheater.

The principle of the Loëffler boiler is diagrammatically explained in Fig. 8. Contrary to the usual practice, in the Löeffler boiler the steam is not generated in water tubes heated directly by the fire, but in evaporating drums which can be located in any convenient position outside of the boiler. Heat for evaporating the water in the drums is supplied by injecting superheated steam into it. This superheated steam is produced by pumping, by means of a steam circulating pump, saturated steam at a pressure of 2,000 lb. per sq. in. out of the drums and passing it through the boiler, which is actually a superheater. The first portion of the boiler, lining the combustion chamber, becomes a radiant superheater absorbing approximately 50 per cent of the energy of the fuel and raising the steam temperature up to 750 deg. F. which comes out at 940 deg. F. at the final outlet. At this point it divides, approximately ⅓ going to the turbine plant and ⅔ returning to the evaporating drums into which it is discharged by special nozzles. Once the boiler is working, it is this steam that evaporates the feed water; but, for starting up, an external supply of low pressure steam is required.

Thus a limitation to the use of this type of boiler is imposed by its inherent design but it also offers many redeeming qualities.

Internal cleaning of the boiler, together with the dangers of scale deposits and bursting tube failures are eliminated. The power consumption of the pump necessitates the use of high pressure steam. That could be verified by a quick glance through the steam tables under the heading: specific volume.

Valves, piping, etc., are of special design. High molybdenum and chromium steels are necessary. Special high creep tests have to be conducted. Trained, skilled workers have to be employed for the field welding of the tubes and a hand picked plant personnel is required to take charge of operations.

It may be mentioned here that no operation difficulties were encountered in this plant, except a few related to the combustion. The author spent six months here supervising the operation of a twin grate stoker supplied by International Combustion, and finally became familiar with seeing the needle point at 2,000 on the pressure gauge without thinking of running for cover.

Apparently the owners were satisfied with the operation of the plant as they gave a repeat order for two larger boilers of the same design. Their erection was started early last spring.

Since the underlying principle of the conception of the Grid System was to increase Britain's industrial efficiency, the efficiency of its component parts had also to be increased. In the main stations with which the author had contact, this increase was obtained by carefully-judged increased pressures and temperatures and increased capacity of units; by the extensive use of automatic devices and by thoughtful planning of safety features.

The general effect of this development was to provide Britain at the outbreak of war with a beautifully balanced power house from which to expand her additional war industries.

THE JUSTIFICATION AND CONTROL OF THE LIMIT DESIGN METHOD

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SUMMARY—Many engineers who have watched the fabrication and erection of steel and the uses and abuses to which it is often subjected, must have been impressed by the fact that if steel must break when strained to the equivalent ultimate stress as given by a constant ratio of stress to strain, very few of our structures would survive their fabrication, let alone their erection and the abuses to which they so often are subjected. To state this matter more plainly, steelwork is nearly always strained during its fabrication and subsequent life, far above its ultimate stress equivalent as measured by the strain and does not fail, but continues to function as if undamaged.

The question which must occur to many designers is, why is the fact ignored that steel can yield sufficiently to bring understressed paths into proportionately greater resistance than the conventional theories allow.

Limit design is based on the utilization of these understressed paths.

In this discussion of limit design, complicated formulae are avoided, as they tend to befog the main object of visualizing the practical effect of yield and its control.

Introduction

The present accepted practice of designing steel structures involves the rigid application of the elastic theory. Limit design proposes to modify this method by also considering yield, and has been discussed by many engineers on both sides of the Atlantic.

A recent paper on this subject by Professor Van den Broek* entitled "Theory of Limit Design" has claimed that the capacity load and not the stress in one member should be used in determining the safe limit of loading. In a general way, the same theory is followed in this discussion but it deals more directly with the amount of strain or yield which should be counted on in estimating the capacity load. This was briefly but ably referred to by Professor L. H. Donnell in discussing Professor Van den Broek's paper.

The object of the present paper is to suggest again that ductile yield does influence the strength of steel structures and, therefore, should be counted on in its design. It is hoped to lead some of our scientific investigators away from the fascinating hobby of solving exactly the theoretical elastic strains in complicated structures and induce them to pursue the equally important question as to whether it is reasonable and safe to count on some of the ductile yield of steel to bring the excess strength of understressed paths automatically into increased resistance.

Structural steel is more reliable in its physical properties than any other material extensively used in construction. Its elasticity is constant up to about half its ultimate strength. It is highly ductile and there is no loss of strength as it deforms until it has yielded to a very considerable extent.

The design of steel structures is entirely based on the strain varying exactly with the stress, and prohibits reliance on, or even risking, any permanent distortion in any part of a structure. This has led to the modern demand for exact stress computations and the definite limitation of specified unit stresses. At the same time many secondary resistances are disregarded, and also the fact that the external forces are generally only assumptions, the present theory ignores the faults of assembling, the strains from fabrication, and many other conditions which affect structures to such a degree that some parts must often have been strained far beyond their elastic limit.

To produce failure in a steel structure the strain in some part of it must exceed some limit to which it can be de-

*Prof. Van den Broek, *Trans.* American Society of Civil Engineers, V. 105 and C. M. Goodrich, *The Engineering Journal*, January, 1940.

formed without loss of strength, and it must be stressed above its strength. For instance in Fig. 1a, the rod is proportioned to support a load which will stress it to the allowed unit stress, 20,000 lb. per sq. in. and it will fail if the load is increased by its factor of safety (20,000 x 3) as there is nothing to restrict it being stretched to its ultimate strain. If the same load is applied to a similar rod but under the conditions shown in Fig. 1b, it will not fail because it will not be strained more than 0.067 in. Even if the clearance is increased to 0.2 in. (Fig. 1c) which is the strain equivalent to its ultimate strength, it will not fail and possibly will not be weakened for continuing to exert its full strength.

Since ductile yield is such a remarkable and unique property of steel, it seems extraordinary that in the designing of steel structures there should be a stricter guard against partial overstraining than there is with most other materials.

Much thought and time is being consumed in solving the exact distribution of stress in so-called indeterminate structures, these solutions being based on the elastic theory and absolute correctness of all factors. In these structures, the variation of strain sought for might amount to 0.03 per cent deformation, while the safe deformation of ductile steel is likely to be ten times this amount, provided the straining is not intermittent. Therefore, why be so particular ?

It is only in recent years that the reasonable use of the ductile yield of steel in designing has been suggested by what has been named or rather misnamed "limit design."

Limit design differs from the present methods in that it recognizes that steel will deform far more quickly than in direct ratio to the stress after it reaches a certain stress and it is proposed to utilize this feature to a limited extent in estimating the safety of structures.

It is well known that steel frequently stressed or substantially strained above its elastic limit will fatigue, and that, some limit of strain must be placed on its most rigid path, in order that it will not be too greatly deformed before the strength of other paths comes into sufficient operation to provide the required resistance. Therefore, it is tentatively proposed that design should be based on three assumptions: (1) To estimate on the sum of all resisting paths at the normal unit stresses when treated independently. (2) That no path be strained above the elastic limit when the whole structure is treated elastically. This insures that deformation of the material is only counted on in the factor of safety and not for normal conditions. (3) That the stress in a member is constant after the strain in it has passed the proportional (or elastic) limit. This is not actually correct, but it errs on the safe side, as it will show slightly greater maximum unit strain.

These suggestions differ from those of Professor Van den Broek, who would estimate the capacity load on the elastic limit of the most limber primary path, instead of placing a limit of strain on the most rigid path.

Typical Illustrations

It is not intended in this paper to go deeply into the science of devising the correct formula for applying the limit design theory or to decide upon the exact amount of strain or deformation that can be safely permitted, but rather to visualize the probable distribution of stress at failure in complicated structures, and from that to judge whether it is reasonable and safe to count on the ductile yield of steel to modify the strength given by the elastic theory. In order to indicate the effect of yield on the strength of steel frames, the computed stresses as given by the elastic and yield (limit design) methods are compared in the following typical examples:—

(1) A hanger composed of bars of different lengths.

(2) The bending resistance of beams of various cross sections.

(3) Continuous girders.

It is interesting to compare the figured safe tension values of a hanger composed of rods of the same length with one having rods of different lengths.

First consider one with three rods of the same length, as shown in Fig. 2. The computed allowed load by either method would be 60 kips.

Second, consider one with rods of different lengths as shown in Fig. 3. The allowed load according to the elastic theory works out as follows:—

It has been recognized for many years that a round section, the only solid section that is frequently used in structural steel design, is stronger in bending than the elastic theory allows for. Specifications have arbitrarily permitted a substantial increase in the allowed unit for bending stress in pins, thereby partially recognizing the principle of limit design. In fact, the raising of that unit stress from 20,000 to 27,000 lb. per sq. in. as is done in the C.E.S.A. specification, is more than that which is here proposed.

In our medium steel specification the material has to meet a bend test without fracture which strains the extreme

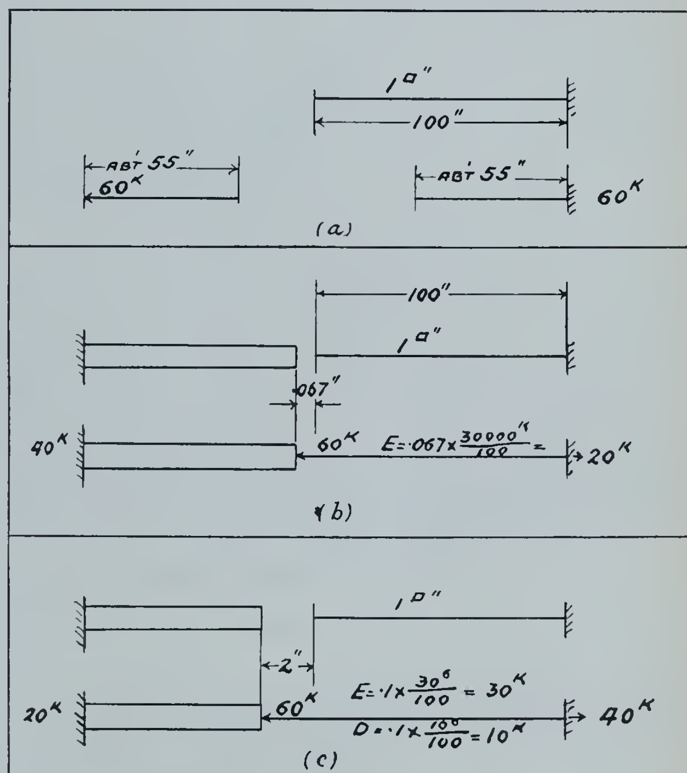

Fig. 1

Scale: Length 1″=40″, Clearance 1″=0.4″
Elastic Limit: 30,000 lb. stress, 0.1″ strain
E=30,000,000-1; D=10,000,000-1.

fibre to 43 per cent of its length. If the stress-strain ratio was constant this would induce a fibre stress of 12,900,000 lb. per sq. in.

The greater use of or reliance on the inner fibres of beams in bending seems at least to warrant serious thought and investigation, as its adoption in some degree might bring about considerable economy and possibly a safer or more efficient type of beam sections.

In such structures as continuous beams, it should be our object to find out the safe limit of loading and not merely the loading which will produce an allowed unit stress in the most highly stressed fibre. Therefore, the problem to solve is whether very minute deformation of the most rigid paths of resistance in structures can occur (without damaging their strength value) and bring the latent resistances of other paths more fully into action. If this occurs, the advisable factor of safety should be applied to this con-

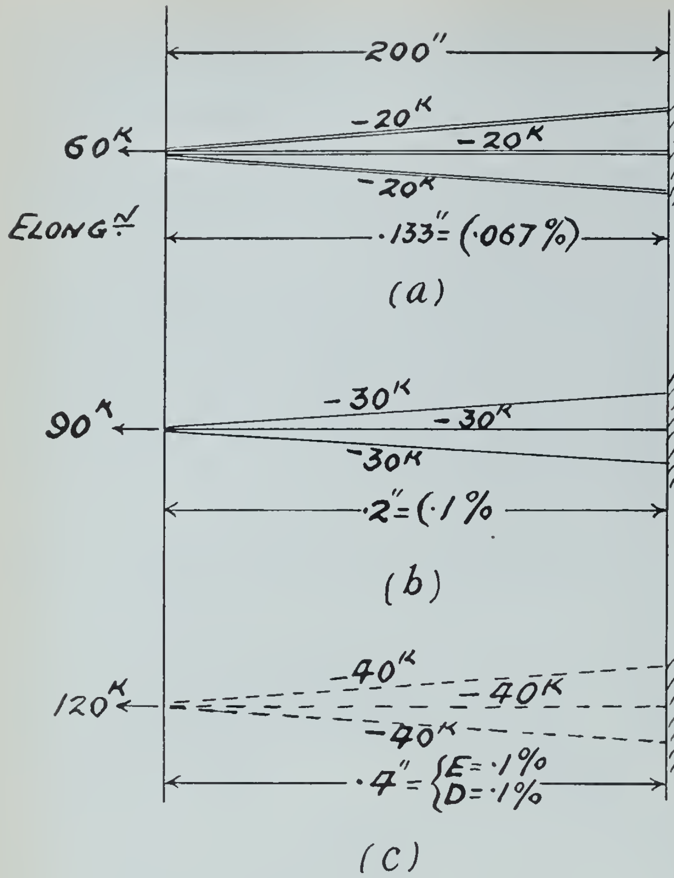

Fig. 2

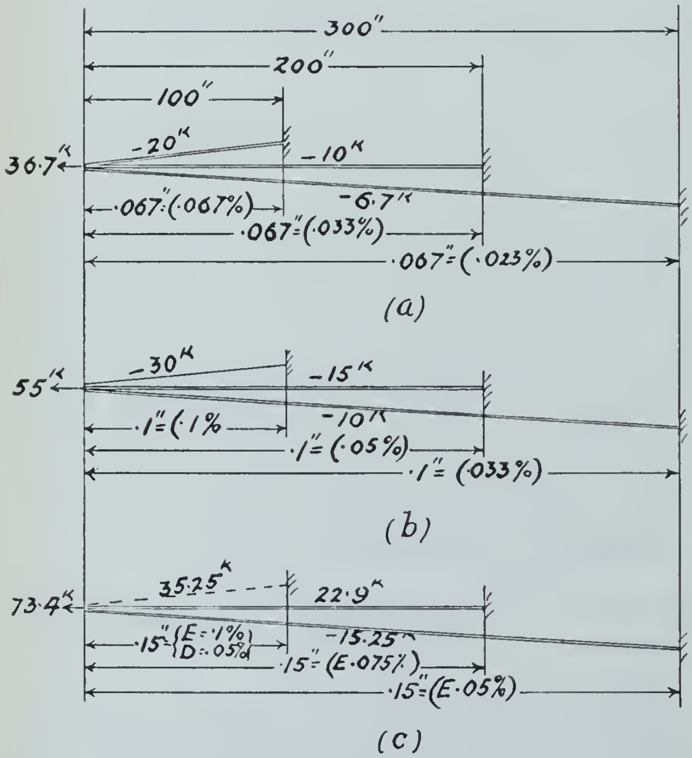

Fig. 3

LEGEND

3 rods, 1 sq. in. each. Allowed unit stress: 20,000 p.s.i.
E=30,000,000⁻¹; D=10,000,000⁻¹

═══ Rods stressed below 30,000 p.s.i. (elastic limit).
——— Rods stressed at 30,000 p.s.i. (elastic limit).
- - - - Rods stressed above 30,000 p.s.i. (elastic limit).

dition, instead of restricting the loading to the allowed unit stress of its most rigid path.

To obtain some insight into this matter, it should be helpful to visualize what happens to a beam with rigidly fixed ends as it is progressively loaded. A fixed ended beam subjected to a uniform load has its flanges stressed and strained in varying amounts throughout its length, but as its ends are rigidly fixed the sum of these deflections (strains) in each flange must be zero, and, therefore, the point of contraflexure (c.f.) must be at a point which will produce this result. So long as the strains vary in direct ratio to the stress the c.f. in a beam of uniform cross section will be at 0.211 of its length, but if the strain at the point of maximum stress exceeds the proportional limit and the fibres along the overstressed part of the flanges have their ratio of unit strain to unit stress increased, the c.f. must be moved towards the overstressed part in order to preserve the balance of plus and minus deflections, and so keep the ends unmoved. This will increase the positive and decrease the negative moments.

If the loading is further increased, this shifting of the c.f. will continue so long as the fibres on the one side of the c.f. are increasingly over-strained as compared with the other side. When the loading is increased so that the addition of over-strain becomes as great on the positive portion of the beam, the stresses will become balanced, and so an automatic action exists to utilize both resisting moments to their full extent. Thus, failure will only occur when one path is either overstrained or the combined strength is over stressed. The problem is to find out the unit strain that can be safely permitted under the various conditions of loading.

In Fig. 7 is shown a beam of uniform section with a span of 200 in. stressed by a uniform load. The parabolic curves

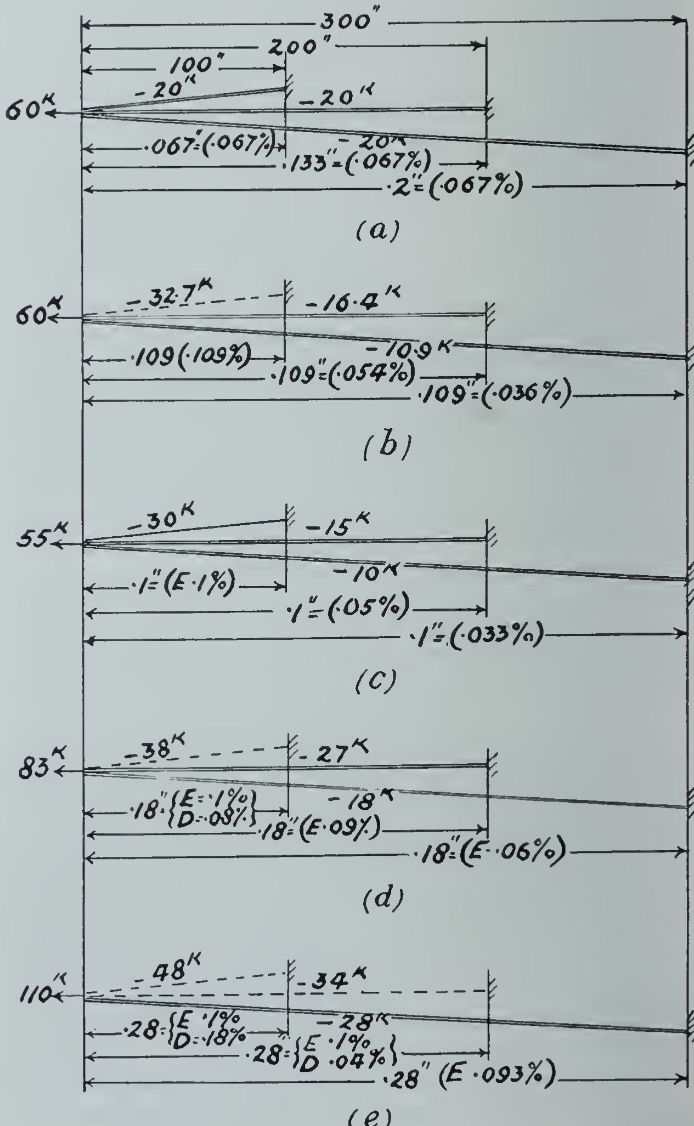

Fig. 4

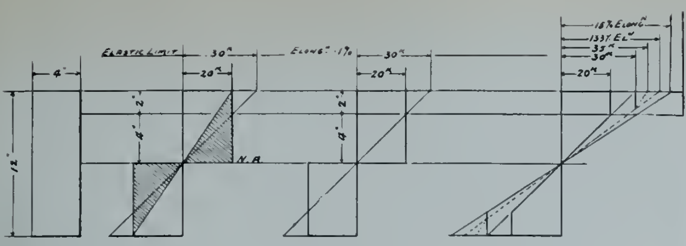

Fig. 5

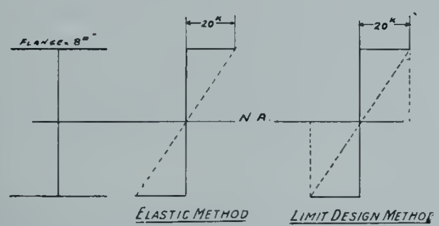

Fig. 6

represent the sum of the moments allowed under various uniform loadings.

Curve A is the allowed resisting moment for a simply supported beam stressed to 20,000 lb. per sq. in. In this there is only one possible path of resistance, and consequently nothing to resist the maximum moment except the beam strength's at the centre.

Curve B is the resisting moment for a fixed-end beam allowed by the elastic theory for a unit stress of 20,000 lb. per sq. in. In this there are three paths of resistance interdependent on one another. Elastic conditions place the c.f. on the line "yy," which gives equal plus and minus strain length in each flange, but the positive moment is only half the negative and there is strength available to prevent any overstrain from the negative moment.

Curve C is the allowed resisting moment if calculated by the limit design method, that is, to arbitrarily assume the c.f. where it will give the greatest combined resistance, viz.: at "xx" where the positive and negative moments become equal, and the beam is fully stressed. This, however, cannot occur so long as the strains vary directly with the stresses and the ends remain fixed, because the tension and compression deformations will not equal one another. The real unit stress at the supports (while still acting elastically) will be 26,700 lb. instead of 20,000 lb. and at the centre 13,300 lb. instead of 20,000 lb. If the loading is increased so as to stress the fibres over the supports to over 30,000 lb. (assumed elastic limit) the strain at this point will begin to increase at a higher rate than the stress, and to maintain equal plus and minus flange deflections the c.f. must move towards the support, and so reduce the negative moment and increase the positive. This will continue as the load is increased until the stresses at the centre from the positive moment also exceed the elastic limit and the deformations increase as rapidly as those in the negative region.

Curve D is the maximum moment which will not strain any part of the beam above the elastic limit. It indicates that there is no deformation at normal loading if a beam is proportioned by the limit design method, that is by assuming equal positive and negative resisting moments.

Curve F is the moment when the combined maximum fibre stresses are 50 per cent greater than given by curve "C" (viz. 60,000 lb.). Acting elastically, the negative stress is 40,000 lb. and the positive 20,000 lb. which brings about nine inches of the flange to be overstressed and causes extra deformation in it which will move the c.f. down the curve towards the support, possibly to point "T" and so transfer about 2500 lb. fibre stress from the negative to the positive stresses.

Curve G is for combined maximum fibre stresses amounting to 70,000 lb. When treated elastically, it is divided into 46,700 lb. negative and 23,300 lb. positive, which overstrains about 13 inches of the flanges adjacent to the supports and probably shifts the c.f. to the point "r" bringing the positive maximum fibre stress to just over the elastic limit (30,000 lb). To bring about this condition, the deformation required in the over-strained portion must make up the difference between the tension and compression elastic strains of the whole flange. From curve "G," it is apparent that the extra deformation required in the negative side to equalize the plus and minus deflections must be produced

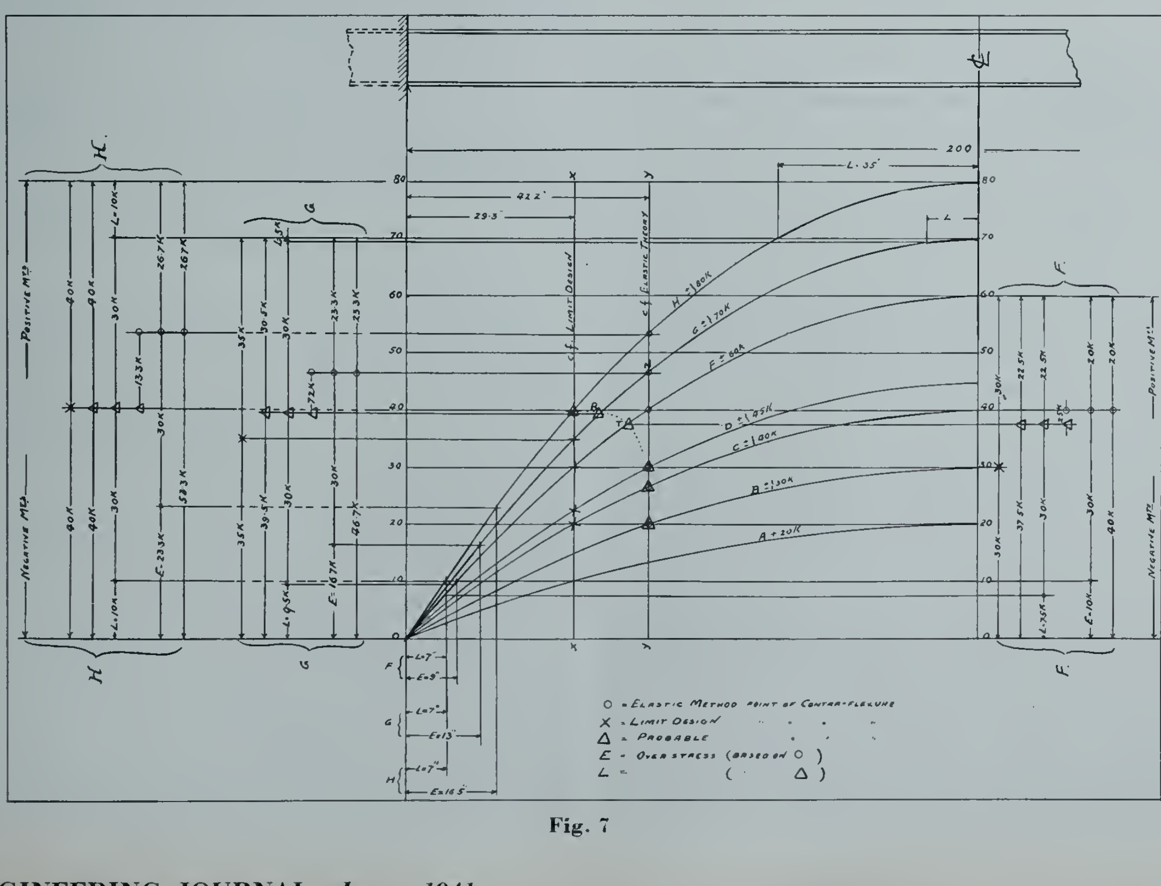

Fig. 7

by a stress equal to the vertical distance between n and r (7200 lb-stress) acting over the half length of the span.

$$\text{i.e. yield} = \frac{7200 \times 100}{30,000,000} = 0.024'' = (\text{less than } \tfrac{1}{32}'').$$

This has to be provided for by deformation in the overstrained 13 inches (shown by heavy lines) adjacent to the support. Assuming that the yield varies from zero at 30,000 lb. stress to a maximum at the highest stress, the maximum percentage of elongation in these flanges will be

$$\frac{0.024 \times 2}{13} \times 100 = 0.37 \text{ per cent.}$$

$$1\text{—}100 \text{ in. rod} = 1 \times 20000 \times \frac{100}{100} = 20000$$

$$1\text{—}200 \text{ in. rod} = 1 \times 20000 \times \frac{100}{200} = 10000$$

$$1\text{—}300 \text{ in. rod} = 1 \times 20000 \times \frac{100}{300} = 6700$$

Total 36700

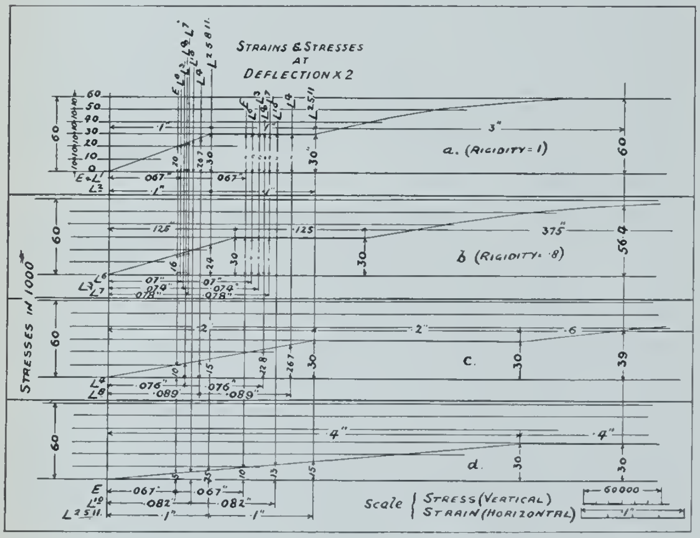

Fig. 8

By the limit design method, the allowed load, treating the rods as independent, would be as shown by Fig. 4, viz:— 3 x 1 x 20000 = 60000 lb. (or 60 per cent more than by the elastic theory).

But if the hanger as a whole is assumed to act elastically the distribution of stress for this load would be as shown on Fig. 4b, the stress in the short bar would be above the elastic limit (30000 lb.). Therefore, the maximum load which will not deform any of the bars will be as shown by Fig. 4c (which is in accordance with the suggested limitation) and the allowed load will be 55,000 lb., or 50 per cent more than if computed by the elastic theory as in Fig. 3. It is also about 8 per cent less than if the rods were all the same length.

As it is the safety of the hanger as a whole that is our aim, the hanger should be proportioned to give a certain factor of the capacity load and not merely a factor of the strain in any one part of it, and so it is interesting to examine what happens when these loads are increased by 50 and 100 per cent.

By increasing these computed loads by 50 per cent and assuming that the deformation beyond the elastic limit is three times as great as below it, the resulting stresses and strains will be about as shown by 2b, 3b and 4d. In 2b all the rods are just at the point of deformation and there is no elastic reserve. In 3b the shorter bar is at the limit of elasticity, while the other rods have 50 and 67 per cent of their elastic stress resistance unused. In 4d the shorter bar has deformed 0.08 per cent of its length, but the 200 in. rod has 10 per cent and the 300 in. rod 40 per cent of their elastic resistance in reserve.

If the computed allowed loads are doubled, the strains and stresses are about as shown in 2c, 3c and 4e. In 2c all the rods are deformed by about 0.1 per cent and there is no reserve elastic resistance. In 3c the short rod is deformed 0.05 per cent, while there is still 25 and 50 per cent elastic stress resistance unused in the other two. In 4e the shortest rod is deformed 0.18 per cent which is only about 3/16 in. for the 100 in. rod and the intermediate rod is deformed 0.05 per cent, but there is still 7 per cent reserve elastic stress resistance in the long rod to prevent progressive creep.

Reviewing these results and assuming that the proportioning by the elastic theory as given in Fig. 2 is correct, it would seem that the safe loading given in Fig. 3 hanger (viz. by the elastic method) is extravagant and that that given by the limit design method in Fig. 4c is quite as safe as in Fig. 2.

The question to be investigated is whether under certain loading conditions some of the members of a steel structure which only provide a part of the total resistance can be restrictedly deformed to some limit (say 0.1 per cent or even 0.2 per cent) without harm. From practical experiences, it does appear to be permissible for a great proportion of structures and well worthy of consideration.

It should also be kept in mind that medium steel specification calls for an elongation of 22 per cent or equivalent to a stress of 6,600,000 lb. per sq. in.

The reasons for considering the limit design method as a justifiable way of estimating the safe bending resistance of beams can be best visualized by comparing the allowed resistances based on the elastic and limit design theories for a solid beam with that of a beam having all its bending resistance concentrated in its extreme fibres.

Consider a 12 in. x 4 in. beam as shown by Fig. 5a. The stress-strain diagram is as indicated by Fig. 5b for the elastic theory, and by Fig. 5c for the limit design (i.e. that all fibres act independently). In Fig. 5b only the extreme fibres are resisting at their full value, whereas in Fig. 5c all the fibres are assumed to be equally stressed. The latter cannot occur while the extreme fibres are still strained within the elastic limit but the inner fibres will begin to assume this condition as soon as the outer fibres pass their elastic limit (when the stress does not increase proportionately with the strain).

If it were possible to strain infinitely the inner fibres of the beam, and the fibres could deform without increased resistance after passing the elastic limit. the stress diagram would be two rectangles as shown by Fig. 5c and the calculated section modulus would be:

$\frac{bd^2}{4} = 144$, or 50% greater than $\frac{bd^2}{6} = 96$, as given by the elastic theory (Fig. 5b.).

In Fig. 5b (elastic theory) only the extreme fibres are fully used and all the interior fibres have reserve elastic strength, which is not used in the estimate of the beam's strength. Thus no credit is taken for this reserve resistance which is indicated by the hatched area in Fig. 5b in spite of the fact that the outer fibres can probably deform enough before injuring the beam to bring much of this excess elastic resistance into effect.

In a beam with all its area concentrated in the outer fibres, (Fig. 6a) the computed bending resistance is the same by either method, since there is no unused resistance to be included in the limit design result.

It is quite evident from the stress diagrams, Fig. 5c, that the limit design cannot function fully, because the fibres inside the point where they are not stressed above the elastic limit must act elastically. If it is assumed that the outer fibres can be strained to 0.15 per cent of their length without harm, assuming the stress in the overstrained fibres remain constant after passing the elastic limit, the stress-strain diagram will be as shown by Fig. 5d (full lines)

TABLE No. I

1	2	3	4	5		6	7	8	9
No.	Path	S	Method	Allowed Stress		Excess L/E	5% deflection or ult. strength	Factor 7 to 5	Factor as Compd. with Ex. No. 1
				Unit	Total				
1	a	1	E & L	1@20000	20000.	0	60000	3	. . . .
2	a (1) b (.8) c (.5) d (.25)	1 1 1 1	E	1@20000 1@16000 1@10000 1@ 5000	51000.		185400	3.63	1.21
			L	4@20000	80000.				
				1@30000 1@24000 1@15000 1@ 7500	76500.*	50%		2.42	.81
3	a b	1 1	E	1@20000 1@16000	36000.	11%	116400	3.23	1.08
			L	2@20000	40000.			2.91	.97
5	a d	1 1	E	1@20000 1@ 5000	25000.	50%	90000	3.6	1.2
			L	1@30000 1@ 7500	37500.*			2.4	.8
6	a b	3 1	E	3@20000 1@16000	76000.	5%	236400	3.1	1.03
			L	4@20000	80000.			2.95	.99
7	a b	1 3	E	1@20000 3@16000	68000.	18%	229200	3.37	1.12
			L	4@20000	80000.			2.87	.95
10	a d	3 1	E	3@20000 1@ 5000	65000.		210000	3.23	1.08
			L	4@20000	80000.	23%		2.62	.87
11	a d	1 3	E	1@20000 3@ 5000	35000.		150000	4.28	1.43
			L	1@30000 3@ 7500	52500.*	50%		2.85	.95

S —relative independent strength of path.
* —maximum elastic resistance which will not strain any path above its elastic limit.

and the calculated resistance of the beam will be $(2 \times 4 \times 5 \times 2) + \frac{(4 \times 8^2)}{6} = 122.6$ or 28 per cent above what is given by the elastic theory. This divided by the factor of safety should give a safe working value.

As the stress does increase (but at a much slower rate) after the strain passes the elastic limit, the full lines in Fig. 5d are not actually correct, and it is likely that the actual stress diagram will be somewhat as shown by the light dotted lines, and the strain diagram by the heavy dotted lines. This will give somewhat greater strength and less deflection than given by the full lines. To calculate the precise bending resistance of beams as their outer fibres are strained beyond their elastic limit is a complicated problem. It has been discussed in many books on the "Strength of Materials" (by Swain and Morley) and "Theories of Elastic Stability" (by Timoshenko, and others). What is here discussed is limited to the main question as to whether it is justifiable to consider yield in the extreme fibres, and does not touch on the more involved problem of finding the exact amount.

This strain is only about 1/50 of the elongation specified for the material and while it is realized that most of the specified elongation cannot be safely used, it seems likely that this relatively small proportion can be relied on to redistribute much of the overstress into the path which is still acting elastically before failure occurs.

Curve H is for unit stresses which are still within the strength of the beam when considered as acting elastically. It is interesting as showing the lengths which become overstrained (deformed) as the loads are increased. When acting elastically about 16½ in. of the negative side are overstrained, but if adjusted to give equal moments, there are only about seven inches on the negative side which are overstrained, while on the positive side 35 in. become overstrained, indicating a far more rapid lengthening of the positive overstraining as the load is increased. Of course, both of these conditions cannot occur together, but they point to the probability of ensuring the location of the point of contraflexure so as to utilize nearly the full strength of both paths before failure occurs through overstraining.

In the case of a fixed ended beam with a concentrated load, the limit design method gives results similar to the elastic theory, because the paths of resistance are of equal rigidity and both are stressed to the maximum and any yielding in one will merely throw excess on to the other which is already fully stressed.

In the moment diagrams, which are given in Fig. 7, the movement of the c.f. from its elastic position is, of course, largely approximate guessing, and therefore the distribution of stress between the positive and negative portions of the beam is not definitely known. But is this so very important if the yield of the overstressed part can be relied on to be sufficient to bring other paths which still have excess elastic strength into sufficient resistance to prevent the overstressed path exceeding its safe limit of strain?

It is probably at present impossible to calculate the exact location of the c.f. and consequent distribution of the resistance between the positive and negative moments in continuous beams before failure (or fatigue) occurs, but it is evident that these moments are inter-dependent and that extra deformation in the overstrained path must automatically reduce the proportion of stress in the heavier strained path by transferring it to the understrained one.

The three examples which have been discussed represent only a few cases of the types of structures in which yield should be considered, but apply equally to all so-called indeterminate structures such as arches, buildings supported on numerous columns, etc.

In order to illustrate graphically the distribution of stresses and strains among the several paths of complicated structures, diagrams giving the strains and stresses of four paths having different rigidities are shown in Fig. 8.

The stress-strain diagrams are intended to represent those of medium structural steel. It is, therefore, assumed that the strain varies directly with the stress up to 30,000 lb. per sq. in. and amounts to 0.1 per cent of the length, then there is a strain of 0.1 per cent without increase of stress after which the strain develops at an increasing rate until a strain of 0.5 per cent with a stress of 60,000 lb. per sq. in.

Diagram "a" is for a path with the equivalent strain of 0.1 per cent.

Diagram "b" is for a path equivalent to 0.125 per cent or 80 per cent rigidity as compared with "a."

Diagram "c" is for 0.2 per cent and 50 per cent rigidity.

Diagram "d" is for 0.4 per cent and 25 per cent rigidity.

The actual strains and stresses computed by the elastic theory and the limit design method, for various combinations of these paths can be obtained by scale from Fig. 7.

It will be seen from Table I that the working or allowed capacities (Column 5) given by the limit design, are much higher than those allowed by the elastic theory, the difference varying from zero for a one path structure to 50 per cent extra when the major resistance is from the limber paths.

The increased resistances developed by doubling the deflection can be scaled from Fig. 8. They indicate a reasonable agreement between the limit design method and a structure with only one path, while the elastic theory gives a considerable excess for nearly all combinations.

In Column 7 are given the resistances when the most rigid path is stressed to the assumed ultimate (60,000 lb. per sq. in.). Column 8 gives the ratio of this to the working stress as given in Column 5. If these factors of safety (Column 9) are compared with that given for a one pathed structure, it is found that the elastie theory gives a considerably greater factor of safety and the limit design a decidedly lower factor. It must, however, be remembered that a 0.5 per cent strain will not fracture medium steel and that any further increase of strain will develop increasing proportional resistance from the other paths while the stress in the rigid path will scarcely alter.

This simple illustration is extremely superficial and is merely shown to help visualize in the simplest way what must tend to happen in a complicated structure,—it shows that the present elastic method fails to give a true safety factor and emphasizes the need of considering deformation as well as elastic strain when designing structures with more than one path of resistance.

In order to count with safety on the effect of yield in designing steel structures, it becomes important to determine whether and how much yield can be endured without damage. There is not at present any accepted practice as to the amount of yield that may be counted on, nor the precise ratio of yield to stress. It is, however, accepted, first that on reaching the elastic limit a relatively large amount of strain takes place with little or no increase of stress, and, second, that further increase of stress produces a greater and accelerated ratio of strain.

Fatigue

Many tests have shown that repetition of stress, even well below the elastic limit, will produce failure and, therefore, it may be claimed that it is dangerous to count on the stress in any part of a frame ever passing the working limit. Nearly all fatigue tests have been made by applying frequently certain loads to bars which have had nothing to restrict progressive elongation. It seems likely that if the strain had been restricted, the probable reason of fatigue, viz., progressive creep, would have been stopped and fatigue would have been avoided.

The application of limit design principles to the design of structures which will probably seldom or never be loaded to their designed capacity, and to those carrying an immovable load, seems quite permissible, while for structures intermittently supporting their full load or those subjected to severe vibration, its application is less safely justifiable.

The aim of structural engineering is to practise safe and efficient methods of designing structures and any permanent and reliable resistance which must function before failure or damage occurs and which is not included in estimating the safe loading, is waste and is not, therefore, good engineering.

As is the case in all our discussions, the object of drawing attention to these questions is to place the subject before those who are fortunate enough to be in a position to investigate it further. The subject of limit design, which is bound up with the determination of the amount of strain or yield which can be relied on before damaging the material, is recommended to those who have the opportunity to examine the matter minutely from a scientific research point of view.

The establishment and general recognition of the amount of restricted yield that can be used with safety would give confidence in a wider use of rigid construction, it should often influence the investigations regarding the safety of old bridges and other steel structures, and would simplify the designing of indeterminate structures. It might even cultivate a keener appreciation of deformation effects, and prevent too much dependence on the strict literal application of standard specification rules applied in accordance with conventional practice.

The safe unit of strain as well as of strength for different conditions of loading is essential, but it has never been, even approximately, determined.

Acknowledgment

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RESUME OF PRESENT DAY POWER TRENDS

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Today's trends in power development are influenced by recent economic and political events. The depression which started in 1929 led to large reductions in the power loads of utilities and industries. As a result ample reserve capacity was available for several years and few new generating units were installed. But the domestic load continued to increase throughout this period. The Government undertook large-scale hydro-electric developments in various parts of the country with the stated intention of lowering rates for electrical service. The Government also started a campaign for rural electrification. While many engineers disagree with the methods by which the selling prices of the various services have been fixed by the Government's agencies, these developments have been contributing factors in the present trends.

In 1937 a noticeable improvement in business made it apparent that an early pick-up in industry would require additional generating capacity. This has proved a fortunate circumstance for the equipment ordered at that time is now available. The start of the war in 1939 and the rapid rise in industry since then have greatly increased the demands for power. One large utility recently stated that its output in kilowatt hours doubled in the last six years. Fortunately, new hydro-electric capacity now available, together with the reserves of the public utilities, have been sufficient to meet all demands to date with a reasonable stand-by. In the meantime, additional equipment aggregating a large kilowatt capacity has been ordered or is being installed, and this will add to available power as demands increase. Baring untimely strikes, sabotage or dislocation of labour in plants building power plant equipment, the electric utilities appear able to meet all demands due to the defence emergency.

Hydro-Electric Power Development

The attention of the public has, for some time past, been centered on hydro-electric developments. Some notable plants have been completed by the Government in the last decade such as Boulder Dam, the TVA plants, and Bonneville, while work is actively progressing at Shasta and Grand Coulee. The Canadian plants at Niagara Falls have been permitted to use additional water during the present emergency and in anticipation of the diversion of water into Lake Superior from the Hudson's Bay watershed. Additional capacity has been added at Beauharnois on the St. Lawrence river and at La Tuque on the St. Maurice river.

Hydro-electric plants serve two classes of customers, the large power user located close at hand as at Niagara, Shawinigan, Alcoa, Arvida, etc., or public utility loads at varying distances from the plant. Boulder Dam is among the latter, with transmission lines 267 miles along to Los Angeles. Others have loads closer at hand. The American consumer demands continuity of service and consequently steam stand-by plants are already provided or will soon be needed by the vast hydro-electric systems of the United States. For instance, new steam stations are now under design for the TVA system and at Los Angeles for Boulder Dam. Other large hydro-electric systems may add steam stand-by plants, in some cases to care for low water flows, in others to avoid interruptions to service.

From a military point of view, hydro-electric plants are vulnerable while long distance transmission lines are subject to interruptions. These considerations further emphasize the necessity of steam stand-by service in the communities served. Also transmission lines should be located so that these can be easily patrolled in case of war.

The latest available figures for this country indicate that 26 per cent of the kilowatt-hours output of the public utilities came from hydro plants though the installed capacity was 28 per cent of the total of hydro and steam capacity in all.

What about further hydro-electric development? Canada possesses many large undeveloped sites ranging from Labrador to the Pacific Coast which can be developed as needs arise in the future. By means of remedial works in the rapids above Niagara Falls, additional water can be diverted for power development on both sides at a central point where it can be of maximum value. Additional sites are available on the Colorado river above Boulder Dam. Other developments are possible in many other parts of the country.

The development of the International Section of the St. Lawrence river has been retarded by political considerations concerned with the proposed deep waterways through the Great Lakes. There is much confusion regarding the cost of this large project. In 1925 the Hydro-Electric Power Commission of Ontario published a report of their studies of this development. One proposal was for a single dam to give 75 ft. head which would permit the development of 1,113,000 kw. at a total cost of $141,700,000, or $127 per kilowatt. Provision for deep waterway navigation would cost $68,150,000 additional. With 75 per cent load factor the Commission estimated that this power could be delivered at the end of a transmission line 300 miles long and stepped down to 12,000 volts at a cost between one-half and two-thirds cents. This project awaits international agreement before development is undertaken.

One can safely predict that additional hydro-electric capacity will be developed as rapidly as political and economic considerations warrant.

Steam Generated Power

Great central stations have been built and others will be planned. But one must consider factors which may influence their size. Difficulties arise where too many large feeders must radiate from a single plant. A large station makes an excellent target for aircraft attack. A number of smaller stations feeding into various portions of the distribution system would make the system less liable to complete outage. The large station emits enormous volumes of flue gases into the surrounding atmosphere, the dispersion of which raises problems. A number of smaller stations emitting the same total gas volume at widely scattered points would lead to more satisfactory dissipation. Finally, the practice of unit construction of one boiler-one turbine permits the design of smaller plants with efficiencies practically equal to the super-power plant. A trend towards more scattered stations of moderate size may be considered a future possibility.

There is a distinct tendency towards the employment of high pressures and high temperatures in new plants. Many will operate at 850 p.s.i. and 900 deg. F. at the throttle, while an increasing proportion of new units will employ 1,250 p.s.i. and temperatures up to 950 deg. F. Superposed units in general are built for the higher pressures and temperatures. Temperatures in these ranges are closely controlled by desuperheaters, by-pass dampers, etc. Advances to still higher pressures appear to depend on the production by our metallurgists of metals capable of standing even higher temperatures. There is considerable basis for the expectation that such metals suitable for 1,200 deg. F. may soon be at hand in which case initial pressures of 2,000 to

2,500 p.s.i. may be employed on the regenerative cycle without excessive moisture at the exhaust.

This advance in pressure will not be made without some extensive changes in plant equipment. The increased density of the saturated steam may necessitate the more rapid development of forced circulation boilers. Already one such boiler for 2,000 p.s.i., 960 deg. F. with reheater is under construction. The problems arising from circulation in boilers are receiving much attention and boilers are being modified to secure more positive flows in steam generating tubes.

A marked trend in recent years is towards the employment of bent-tube steam generators with definite circulation paths from and to the drums. These appear to have overcome the recirculation difficulties experienced in certain earlier straight tube types.

The tremendous influence on boiler design of radiant heat as a means of effective heat transfer is now recognized in the design of practically all boilers. This means of heat transfer has not been fully exploited, even though one manufacturer is now offering a "radiant type." Some future design may provide still higher furnaces than at present or use two stage furnaces, both of which will be designed almost wholly for radiant heat transfer to the steam generating tubes forming the solid furnace walls.

While stokers continue to be added in the older stations and where special fuels are used, practically all new coal-fired plants burn pulverized coal. Furnaces with powdered coal may have wet or dry bottoms, depending upon the fusibility of the ash and the nature of the load. Low fusing ashes such as are found in midwestern coals, and high continuous loads favour the wet bottom. Eastern high fusing ash and loads requiring frequent shutdowns as on stand-by or peak load service, lead to the use of dry bottom furnaces. Due to low grindability of western and northern lignites, the spreader type stoker may be employed for their combustion.

The nature of the ash in available fuels has a great influence on steam generator design. The fusible ash particles formed during combustion must be cooled and solidified before coming in contact with boiler or superheater surfaces or the deposit on such tubes will plug up gas passages and require hand labour for lancing while in service. To avoid such deposits, furnaces may be made larger with lower average rates of heat release to insure proper gas temperature at exit and tubes of both boiler and superheater may be spaced wider apart, even at the expense of greater total superheater tube surface.

It will be evident from the preceding paragraphs that steam generator designs are still being modified. No standardization is in sight and further changes are forthcoming.

A most important consideration in operation is the assurance of clean steam. Methods of centrifuging and washing the outgoing steam have been tried and notable advances have been made. Studies of boiler water conditioning to avoid scale and corrosion have led to marked improvements in operation. Much still remains to be learned about the action of water in high pressure boilers. Silica in feed water has been difficult to remove. Our chemists will eventually develop satisfactory boiler water.

Steam generators have been built for outputs up to 1,000,000 lb. per hour. There appears to be no obstacle to the construction of larger boilers with welded parts. Troubles with rolled joints at high pressures may lead to the welding of all boiler tubes. Long water wall tubes and most of the piping connected to the steam generator are now welded. Steam lines to turbines are now generally welded throughout.

The trend in steam turbine development is towards the use of units operating at 3,600 r.p.m. They are of less weight and, with smaller physical dimensions, are less affected by temperature changes than 1,800 r.p.m. units. These condensing units are more economical than 1,800 r.p.m. turbines in sizes below 50,000 kw. There is little thermal advantage in the 3,600 r.p.m. units in condensing turbines above 50,000 kw. capacity but larger units have been purchased for other reasons. Earlier difficulties with high pressure blading appear to be overcome.

Generators above 25,000 kw. are now generally cooled with hydrogen. Large two pole generators at 3,600 r.p.m. are subject to 120 cycle vibration. This has been overcome by mounting the stator core on supporting devices, which prevent the vibration being carried to the foundation.

Rearrangements of the tube layout have improved condenser performance and still further changes can be made. Tubes rolled at both ends with some flexible member to care for differential expansion are now generally employed. More attention will be given to tube materials and to tube supports which prevent vibration, in order to secure longer life and lower maintenance charges.

It is becoming general practice in coal-burning plants to install some form of dust catcher in the flue gas ducts. Cottrell precipitators, cyclones and washers are in use for this purpose. Clean flue gases will be required from most new plants in the future.

Improved operating efficiency and increased heat drop have decreased the B.t.u. per k.w.h. which results in decreased coal consumption. However, increased coal prices may offset this reduction in cost. As a result, production costs may change only slightly.

The mercury-steam stations now in service continue to operate satisfactorily and improvements have been made in the design of the mercury boilers. The additional cost of this equipment and the narrowing margin of gain in thermal performance over high pressure steam plants tend to restrict the increasing use of this efficient system.

Internal Combustion Engines

Many Diesel engines have been built during the past few years. The vast majority of these have been used in automotive equipment such as tractors, railroad locomotives, trucks and contractors' equipment and in marine installations. A considerable number have been installed in industrial plants. While many have been built for public utility service in municipal and other plants, the aggregate output in kilowatts is only a small fraction of the nation's generating capacity.

The Diesel engines will continue to be used in small plants and for automotive service. They will probably never be a large factor in public utility service because they have not been built in large sizes and, if built, their economy would not differ greatly from that of large steam stations.

The gas turbine is attracting attention and several have been installed in oil refineries operating on the Houdry process. Its efficiency is dependent upon initial gas temperatures which are now limited to about 1,000 deg. F. Under such conditions, it is not a competitor from a thermal standpoint with Diesel engines or condensing turbines. However, when metals are available for higher temperatures and gas turbines are built in such sizes as to warrant the use of several heat recovery auxiliaries, it may find a place in sections where cheap oil and gas are available and particularly where water is scarce, as no condensing water is needed. It may also be used on locomotives.

The Future

Predictions of future developments are dangerous as they are usually wrong. However, the continued increase of output of our utilities indicates that loads have not ceased growing and that greater total plant capacities must be provided in future years. Larger and more economical steam generators and turbines will be utilized and improved forms of equipment provided. Power plant development in the future will require the best skill and equipment this country can offer, for progress must not cease.

SCIENCE AND ART IN ENGINEERING

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Address delivered at the American Institute of Consulting Engineers, New York, March 5th, 1941, and printed in the publications of the Engineers Council for Professional Development.

(ABRIDGED)

There are countless cross-currents in the stream of life and often there seems to be no pattern, or distinguishable direction, in the trends of civilization. This difficulty is frankly announced by modern youth who remark we don't know where we're going but we're on our way.

Yet this viewpoint will not deter the engineer from attempting to appraise the present and forecast the future. His method is that of extrapolation, which is based on the observation that the pathways of the present lead out of the past, and the best guide to the future can be secured by extending their alignment. There has been a great change in our profession—a change which has had a momentous effect both on engineering, and through engineering, on modern life, namely, the advent of the modern scientific technique in engineering which has transformed an ancient art into a modern science. These remarks will be confined to one branch of engineering, civil engineering, but apply also, with more or less force, to other engineering fields.

It may be said that for forty-nine of the fifty centuries of recorded history, engineering was practised as an art. Then, beginning in the early years of the eighteenth century, but reaching its first marked development less than a century ago, much of the detail of this ancient art was found to be based on mathematical and mechanical principles, and much of its technique was rapidly "reduced to a science." It is desirable, if only by way of contrast, to recall certain fundamental professional practises in the days before this advent of an unwelcomed new baby.

The practice of an art, we are told, depends upon an intuitive genius for that art, a feeling and a judgment, in the case of civil engineering, primarily for structure, ripened through apprenticeship to a master and matured through experience. The young man of today sees little of this element in engineering, but all of us can recall this quality in many of our earlier masters and in many of our associates whose engineering judgment we now value. The uncanny skill in design which the outstanding engineers of the past possessed, although clearly qualitative in character, was almost quantitative in its results. Recall, for example, Perronet's Pont de la Concorde at Paris, which could be little improved in its effective and economical use of material through the application of even the most advanced modern analysis. Or the Gothic cathedral, masterpiece of construction, which will probably remain man's greatest achievement in stone, for the age of stone masonry is past. These, and countless other examples from the Roman aqueduct to the truss bridge, attest the accomplishment of engineering as an art.

How then has this intruding science found a welcome in the engineering nest? The basic force has been purely economic. Listen to the words of Wellington writing about 1880:

"It is beyond doubt that the true reason for the striking progress in bridge-building in recent years has been, not that men have been driven to excellence by the 'responsibility for human life' resting on them . . . The impelling force has been the keen competitive struggle to bring the first cost of every bridge as low as possible, and yet do nothing which shall injure its permanent efficiency and compel it to be speedily rebuilt."

This is exactly what science in engineering permits the bridge designer to do.

Clearly, when we are able, through the use of applied mechanics and a knowledge of the strength of materials, to proportion each part of a structure or machine to the load which it actually carries, we can secure material savings over a design which is purely the product of judgment and experience. Also, depending upon this technique, we may plan and erect structures of a magnitude which an earlier generation would have classed as visionary.

One of the first consequences of this revolutionary change in technique was the establishment of engineering schools. When engineering was an art, education for its practice was through apprenticeship. With much of the basic technology of engineering rationalized and scientific, much of this training could be transferred to the formal teaching of the classroom, for such transfer resulted in economy of time and in increased efficiency of instruction. In our own country there were but two schools of engineering before 1850, whereas, following the introduction of such books as Rankine's Applied Mechanics and his Steam Engine, there was a tremendous jump, and, by 1870, a total of seventy such schools were active. The engineering school was thus born of this revolution in engineering.

Just recall, for a moment, the reception of the young graduate of such a school when he attempted to secure a position after graduation. He was received by the so-called practical engineer with about the same smile that spreads over the face of a cannibal chief as he observes the landing of a missionary on his desert isle. Yet, today, these same practising engineers practically insist that graduation from an engineering school is a first essential to admission to a professional engineering society and to professional registration. The young engineering graduate had something that was worth dollars and cents.

But the urge of economy only furnishes the impetus to activity in reducing engineering to a science; the fuller meaning of this movement lies deeper. Standardization has also been a factor in modern development, the standardization not only of structural and machine elements, structural shapes, screws and threads, reinforcing bars and pipes, and to a very considerable extent of structures and machines, together with the even more important standardization of method, in which science has been an essential.

A century ago the practise of engineering was limited to those who possessed a native gift and genius for the art and had achieved a skill and reputation through practice. Such men were few in number. It is inconceivable, with engineering merely an art, that a handful of gifted men could meet the engineering needs of a modern world. The reduction of the technique of engineering to a science has made possible a widespread extension of engineering all over the globe by putting much of the labour of engineering planning and design in the hands of men of more ordinary intelligence. Once the type of a modern structure, its general features and principles of design have been established, patience and skill, but no especially gifted genius, are required to elaborate its details.

In his biography of Richelieu, Hilaire Belloc observes that, while "the conquests of physical science have been due to the minute and extensive observation conducted by vast numbers of men, and therefore, for the most part, by the unintelligent, . . . this, for the most part unintelligent, mass of observation called 'Modern Science' has led to astounding results."

Mr. Belloc does not deny that there have been great men in science—men who had the breadth of vision to draw from this mass of observation the great generalizations of science. Neither does he attempt to belittle science; it "has led to astounding results." Why? Because it is possible through the methods of science to utilize the labours of the relatively unintelligent in advancing scientific knowledge.

It is interesting, at this point, to consider for a moment influences which have made European rather than American engineers the leaders in the development of the scientific approach in engineering design. The answer, it would seem, is to be found in the fact that, abroad, skilled labour is generally plentiful and cheap. The emphasis is on economy of material rather than, as it has been here, on economy of production. Clearly a more exact technique of design leads to economy of material. On the other hand the situation in America has been changing. Whereas in the past simplicity and ease of construction was a criterion, continuous bridges, the statically indeterminate structure, rare twenty years ago, have become commonplace. Why? Because the former saving, which rested on the use of unskilled labour, is no longer such a determining element in many lines of construction. The ultimate economy of a saving in material—the result of more exact design—begins to make itself felt. There is thus every reason to expect that the movement for more science in engineering will continue to grow and expand.

And how does this affect the practise and prospects of our profession, especially the position of the consulting engineer?

To put it bluntly, the great bulk of engineering practise today is carried on by organized groups of employees—federal, state and municipal departments on the one hand, or the highly organized functional divisions of the industrial engineering offices on the other. The consulting engineer is now called upon only for the great and the difficult—the unusual job that is uneconomical for the routine office staff to handle.

The consulting engineer is thus the modern representative of the *art* of engineering. He is pre-eminently the master of those problems in practice which are not solved in books. He is a court of last resort for the solution of problems which have not, as yet, been fully rationalized. He is the custodian of the one unchanging thing in our profession—those basic principles which make it a profession rather than a simple technology. Technique may change but these principles remain. If, which God forbid, engineering is ever reduced completely to a science, it will no longer be a profession but a dull form of scientific accounting—and there will be no consulting engineers.

But the consulting engineer is also a leader in the movement for rationalization which is perpetually working him out of a job.

There is one activity in modern life that furnishes a parallel to this situation. Fortunately this is an activity of which I actually know something. Not being a consulting engineer, it would otherwise be presumptuous on my part to offer advice to the American Institute of Consulting Engineers.

In short, I am a professor and am responsible in part for the administration and policies of a type of engineering school, which seems to face problems closely parallel to those of the consulting engineer, namely, the privately endowed engineering school.

The independent, privately endowed engineering school of the present day is outnumbered, say, ten to one, by state-supported institutions; furthermore, if the struggle is for numbers, or for great and costly equipment, the public tax list is far more potent than the private pocketbook. If it is a matter of dollars and cents, free tuition at public expense is far more attractive than the prospect of $400 per year in a private school. While not wishing to cast any aspersions on the tax-supported schools, among which are some of the foremost schools of our country, it is evident that the privately endowed engineering school can stay in business only when it does a better job than the tax-supported institution, and this is exactly the reason why the consulting engineer is still in business.

Now there are certain basic reasons why, not always but in general, the private school can do a better job.

It can hire and, within reasonable limits, it can fire its staff. Political preference need never determine the quality of its faculty.

It can select its students and it can reject the laggards without fear or favour—*provided* it has sufficient endowment so that fees do not constitute its full measure of income. No uncle on the legislature can keep the lazy and incompetent in its classes.

The independent consulting engineer has similar freedom in the choice of personnel.

The privately endowed school can never cease to struggle for leadership. It must keep ahead of the procession. It must be progressive in its educational ideas. It must look ahead, endeavour to anticipate future demands—and so must be consulting engineer. It has not been by accident that many of the newer ideas of modern technique—soil mechanics, for example—originated in private engineering schools.

One of the most vital elements in stimulating engineering education is research—the determined and orderly search for new knowledge and new methods. It is surprising how many important contributions to modern practice have been the results of college research. Truly productive research adds greatly to the respect in which our profession holds any engineering school. A recognition on the part of a school of the kind and type of research it can profitably undertake is fundamental—it must base its programme on its interests, on its facilities of staff and equipment and on its contacts.

It is also true that some schools undertake such research as a thing separate from their main business which is education. A consulting office would not advise or follow this plan even if it could afford to do so. Your research is directly related to the improvement of your business—of your technical methods and practise. Similarly, the chief object of college research must be the improvement of its business, the enrichment and stimulation of education. Accordingly, we have, in the school I serve, no horizontal division between research and teaching. The man who guides research also inspires the undergraduate to take part in the great adventure—to do some independent, productive thinking.

From all of which, I take it, you will agree with me that the basic element in our progress—in our ability to maintain our positions—the privately endowed educational institution and the independent consulting office—lies primarily in the maintenance of a free and dynamic leadership. We must be willing to venture into new fields and seek new forms in which to pioneer in the progress of our profession.

Engineering is not merely an instrumentality of western civilization whereby man endeavours to meet his material needs and wants and to make himself increasingly master of his environment; it is a habit of mind, a conviction, and a viewpoint, holding much greater potentialities. A habit of mind which recognizes that there is a rational way of doing things as opposed to the emotional, unreasoning, biased, partisan approach; that seeks to discover and perfect this honest path of science and reason, and a conviction that mankind can apply this method with profit, not only in one field but in the solution of a much wider variety of life's problems.

What opportunities there are in this picture for the continued advance of our profession—for pioneering and leadership by those who guide its destinies—the consulting engineers and our engineering schools.

THE YOUNG ENGINEER IN TO-MORROW'S DEMOCRACY

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Address delivered by the Chairman of the Committee on the Training and Welfare of the Young Engineer, at the Annual Meeting of The Engineering Institute of Canada, at Hamilton, Ont., on February 6th, 1941.

Canada is facing a great national emergency. The capacity of our engineering skill will be taxed to its limits. Our national effort can go that far and no farther. The engineers of Canada must carry the load on their shoulders if the materials of war are to be produced, and if those materials are to be better than the products of our enemies.

The president of the Junior Institution of Engineers of Great Britain had this to say in his recent presidential address—

"The watchwords for engineers to-day are these—elasticity of thought, adaptability of mind, readiness to alter preconceived ideas when necessary, and willingness to improvise with new methods, new tools and strange materials. There will not always be a war. When victory is achieved we shall not be able to sit back and pause. A heavy weight of responsibility will sit on the shoulders of the engineer, for though the planning of reconstruction may be in other hands, the methods and actual work of restoring a stricken world will fall largely to the scientist and the engineer.

"To-day we must leave the engineer carrying on the vital task of designing, building and operating the immensely complicated machine which we call mechanized war. On the success of that machine depends our very existence, and the happiness of the world in the coming years. When victory is accomplished we shall still look to the engineer to take his part in establishing and reconstructing the future of the world."

Wishful thinking will not win battles. There is no group, no social organization, no profession, if you will, that looks facts squarely in the face as do engineers. It is from these facts that we make our deductions, we draw our conclusions, and we plan for the future. A great task faces us. The question is, could we have been better prepared ?

We cannot turn back the pages of life, but we can face the facts of the past and plan the future of our profession so that it will more adequately meet the demands which must lie ahead.

It is mainly for these reasons that your Committee on the Training and Welfare of the Young Engineer has continued its studies. It is in a time of great stress that we can best determine our failures.

Some may ask—what is a profession, and why an engineering profession ? Dr. Wickenden, the distinguished educationist who is with us at this meeting, has given us his views on this subject. He separates professional characteristics into those of individuals and of groups.

The individual attributes must be:—

"1. A type of activity on a high intellectual plane.

"2. A motive of service.

"3. A motive of self-expression.

"4. A conscious recognition of social duty by sharing advances in knowledge, by guarding standards and ideals, by rendering gratuitous public service."

In the attributes of group professional life, he includes:—

"1. A body of knowledge (science) and art (skill).

"2. An educational process.

"3. A standard of qualifications for admission.

"4. A standard of conduct.

"5. A recognition of status, and

"6. An organization of the professional group."

These ideals are the standards to which we, individually and collectively, must aspire. It is to such ideals that your Committee must turn as we study the training and welfare of the young engineer.

I shall first treat the subject as a normal evolution without considering the emergent war condition. There are two groups of Canadian citizens who are responsible for the training of future engineers—the educationists and the engineering profession itself. Both are represented on your Committee, and in our future proposals it will be advisable to consult both groups.

Our activities have in view the development of a professional consciousness and a true professional spirit. Where should this development begin, how can it be fostered, and what should be the results ?

The engineers of the future come from our public and secondary schools. It cannot be expected that every young man, on entering high school, will know his vocation. During that period of indecision, he should have some source from which to obtain definite and authoritative information.

It should be the objective of The Engineering Institute to provide such a source. In collaboration with provincial and local educational authorities, a system can be worked out to furnish reliable advice to those who are contemplating an engineering career.

The actual methods of approach can be left to the individuals or Institute Branches, but everywhere there must be uniformity of information, careful preparation of detail, and sincerity of purpose. Advice must deal with opportunities of employment, trends in engineering occupation, the extent and value of available courses, and the need for adequate preparation to meet the responsibilities of citizenship.

We believe that essential aid to the standing of our profession can be given by such wise counselling of prospective engineering students.

Then we follow the student into his university course. What should he find of value there; how should he be directed; can his cultural and technical training be well balanced when he completes his course; will he be worthy of assistance in his further training, and has he the outlook on things cultural and things material, which will make him a credit to his profession and a worth while citizen.

Members of this Institute have pointed out that the training of an engineer should be of a general character, and that attention to cultural and economic subjects is necessary to equip him for the present day requirements of his profession.

Although the engineers of this continent have endorsed these basic principles, the advances of science crowd new technical courses into the limited time available, and it would seem that the training in the humanities must wait.

It is stated that few graduate engineers fail through lack of technical training. Failures are due to lack of personality, of ambition, of willingness to co-operate, of initiative, and so on. It is evident, therefore, that our engineering educators are keeping abreast of scientific advances and industrial and construction demands, but more care must be exercised in the selection of students who have the qualities grouped under the term "personality."

The recent report of the Committee of the Society for the Promotion of Engineering Education on the "Aims and Scope of Engineering Curricula" says:—

"Broadening of the base of engineering education, now in process, should be continued. Its roots should extend more deeply into the social sciences and humanities as well as into the physical sciences in order to sustain a rounded educational growth which will continue into professional life."

Copies of this report have been studied by the members of your Committee, in order that we may be acquainted with the trend of thought in the United States on this most important subject.

The report tabulates the results to be expected from broadening engineering curricula, with emphasis on:—

(a) Mastery of fundamental scientific principles.

(b) Understanding of the engineering method.

(c) Ability to select the significant results of an engineer-study and to present them clearly and concisely by verbal and graphic means.

(d) The stimulation of a continuing interest in further professional development.

In fact, in the studies which are new in the engineering curricula, he will be led to an "understanding of the evolution of the social organization and of the influence of science and engineering on its development."

All this means a revision of present day curricula; higher efficiency in the use of the limited time available; abandonment of some specialization courses; greater concentration upon the mastery of fundamentals, and the cultivation of intellectual powers required in the more advanced use of the engineering method. The student would then be prepared for subsequent professional development.

Keep in mind, however, that while all these new concepts are vital and their importance must be adequately recognized, engineering science and method are still of dominant interest in the curriculum.

Among the conclusions reached in the report are:—

"The present flexible arrangement of four-year undergraduate curricula, followed by postgraduate work, will better meet the needs served by engineering education than will longer undergraduate curricula of uniformly prescribed duration.

"Advanced training for the higher technical levels of engineering should be included in the general programme of engineering education, but should not become its domnant aim.

"Undergraduate curricula should be made broader and more fundamental through increased emphasis on basic sciences and humanistic and social studies. This will require greater efficiency in the use of the student's time to be gained by pruning to the essentials of a sound educational programme.

"There are advantages in the parallel development of the scientific-technological and the humanistic-social sequences of engineering curricula. The present integrated type of programme extending throughout the entire undergraduate period should therefore be preserved.

"No measures taken with respect to engineering education should limit the freedom that now exists for experimentation and change."

This report is recommended for careful study by all interested in engineering education.

The question now arises whether these young men coming from our colleges, filled with technical knowledge, inspired by the guidance they have already had, are to be left to their own devices as they tread the devious paths which we all know so well.

Here we reach a field in which we, as members of the Engineering Institute, have missed many opportunities. We have allowed these young men, some 600 or 700 each year, to step out into the world of action with too little recognition. These men need the loyal co-operation of their seniors.

Many industries have developed means of selecting and training students for post-graduation employment in the sales, administrative or technical branches of those industries. But, unfortunately, this only provides for a small percentage of the young graduates. The others, in many cases, find themselves without guidance as to the best means of continuing their studies, and if initiative is lacking, little or no further progress is made.

The industries to which I have referred, teach these young people how to develop their characteristic talents and how to go about their job. In this connection, your Committee has made several suggestions and we shall probably continue to do so as certain practices come to our attention. We have already recommended that:—

1. Each Branch should organize junior sections or committees;
2. Contacts should be made and should be continued with university students and faculties;
3. Study groups for the purpose of self-development should be organized and encouraged;
4. Junior and Student members should be given a larger part in Branch activities and the encouragement of the senior members.

The war emergency has brought home to us, to the people of Canada, and to the responsible authorities, the need for more technically trained men. To-day our Army requires that our junior engineer officers must have the educational standards necessary for admission to the Engineering Institute. Further, young officers are given special intensive training to fit them for the many technical branches of the armed forces.

It is not expected, therefore, that our engineering schools can provide a training sufficiently diversified to cover all these fields. Why, then, should it be expected that the engineering schools of this country can provide the diversity of training necessary for the many branches of governmental technical services in peace time?

With this in mind, we shall advocate the recruiting of all such governmental technical services from selected university engineering graduates. They should be embodied in a training group under combined departmental and civil service supervision, with a training period so planned as to develop individual characteristics and permit of the separation of the group into the departments and services for which their talents are best fitted.

It may be argued that this will take time and expense which cannot be considered as economically sound. If industries can do this, why cannot the greater industries of government do the same? If the Army, Navy and Air Force can do it, with definite results, without which they could not function, why should not our peace-time services do likewise, with a consequent increase in efficiency? The better training given to the technical branches of these services, the more economically they will be operated and the more valuable they will be to the social structure.

There are other matters which can be discussed under the "welfare of the young engineer," but we cannot attack all the problems at once. We should like to promote the extension of educational facilities to those whose finances are not sufficient for the cost involved. We intend, however, to postpone more concrete proposals until a fair start has been made along the avenues already opened.

No programme of development for young engineers can be successful without their own co-operation. These young men must not think that their student days are over when they leave college. They must be urged to become associated with an active engineering organization and to be inspired with the professional spirit.

The four years at college are only the beginning for an engineering career; as one leading member of our profession has said—"there will be plenty of time for further study between the hours of 5 and 12 and between the ages of 21 and 70."

We have been pleased to learn that the work of this Committee has engendered discussion in many places. This alone will be of some value. Let us continually keep in mind the future of our profession. It has been worth while to us, let us make it more worth while for our successors.

DISCUSSION ON CONSTRUCTION OF THE HYDRO-ELECTRIC DEVELOPMENT AT LA TUQUE

Paper by J. A. McCrory, M.E.I.C.,[1] published in *The Engineering Journal*, February, 1941.

Irving B. Crosby, affil.e.i.c.[2]

Mr. McCrory has given an excellent description of the engineering problems of an interesting development. This writer will outline the geological situation which made possible the dam and which caused some of the problems.

The streams of this region are deeply incised in the Laurentian Plateau, the St. Maurice Valley at this point being some 800 ft. deep. The region was heavily glaciated, the north-south valleys were widened and straightened by the removal of spurs, and when the ice melted, the valleys were partially filled with debris, sand and clay, washed from the ice. This filling was so deep that pre-glacial divides were sometimes buried. The reborn streams took their courses over the surface of the glacial deposits without regard to the topography of the buried bed rock. They often passed from one pre-glacial drainage system to another and as they entrenched their channels in the sand and clay they frequently cut down upon buried rock ridges and spurs. Such was the case at La Tuque.

At the close of the glacial period the St. Maurice Valley was filled with glacial deposits up to the level of the plain upon which the town of La Tuque stands. (Fig. 15.) The two granite knobs projected from this plain. The river happened to flow to the west of these knobs and it eroded the sand rapidly and soon became entrenched on rock between the northern knob and the mountains to the west. Erosion upstream from this point was checked by the sill of bed rock but downstream it cut 100 ft. deeper in the sand and produced the La Tuque falls. The depth to bed rock in the centre of the main valley has been determined by electrical prospecting as approximately 500 ft., indicating that the St. Maurice Valley is filled with some 500 ft. of glacial deposits. The pre-glacial depth of the valley was therefore twice the present depth. If the reborn post-glacial river had flowed east of the knobs instead of west of them, it would have cut down rapidly through the sand, produced a graded channel without falls, and there would have been no easy opportunity for power development.

Fig. 15—Aerial view of La Tuque dam showing the two granite knobs and the sand-floored valley to the east (right) under which the pre-glacial valley is buried.

The dam blocks the river gorge in the saddle between the granite knobs and the mountains to the west, and the main valley is blocked by the sand plain upon which the Brown Corporation mill and the town of La Tuque stand. This plain forms a natural dam of sand with a minimum width of over 2,000 ft. A study was made of seepage through this natural sand dam, both under present conditions and when the river is raised, and it was concluded that seepage is and will remain harmless. Two observation wells have been provided in order that any rise of ground water level may be detected.

The bed rock at the dam site is largely gneiss with intrusions of granite, but the knob at the east end of the dam is principally granite. Under the west bulkhead and sluice sections of the dam the foliation of the gneiss strikes north 29 deg. west and makes an angle of 40 deg. with the axis of the dam. The rock is in beds from one to several feet thick which diagonally dip upstream at an angle of approximately 30 deg. from the horizontal, thus producing a corrugated surface on the rock. In preparing the foundations, weathered beds were stripped off leaving a corrugated surface of fresh rock which provided an excellent footing for the dam. In order to slide, it would be necessary to push the dam up these inclined surfaces or else shear the granite gneiss across the grain, both of which would be impossible.

In the west end of the intake section of the dam are three parallel faults, mentioned by Mr. McCrory. One of these showed on the surface as a small gorge 10 ft. deep, but 20 ft. deeper it and the other faults were merely cracks, half an inch wide, tightly filled with rubbery clay gouge. These faults did not cause any problems or difficulties. They are all very old and there is no evidence of geologically recent movement.

The fault zone at the east end of the dam has been described by Mr. McCrory. When the writer made a preliminary investigation of the dam site for the Brown Corporation in 1928 he recognized on physiographic evidence the probability of a fault along the western base of the two granite knobs. (Lefthand base in Fig. 15). There was no subsurface information available at the time, but he reported that a fault with a great thickness of broken rock must be expected at the eastern end of the dam site. Subsequent excavation has proved that there is a fault zone about 200 ft. wide along the east side of the gorge. This fault zone extends up and down the river, probably for miles, and there is no place at La Tuque falls where a dam could be built without crossing this fault. The problem was, therefore, to meet the unfavourable geological situation by engineering measures, which has been done successfully.

The fault zone is formed by two nearly parallel fault planes which form the foot wall and the hanging wall. Between these are secondary faults and numerous fractures which cut the rock into irregular blocks. The fractures have permitted the circulation of ground water which has attacked the different beds of the gneiss to varying degrees. Some beds were badly disintegrated while others were sound, though fractured. Excavation was carried down along the foot wall to a bed of gneiss which was sound and undecomposed, though fractured. This rock was consolidated by shallow grouting. To insure against seepage through the underlying fractured rock, a cut-off wall was carried down along the foot wall 50 ft. deeper to a level about 70 ft. lower than the river bed. To control possible seepage under this end of the dam, closely spaced deep holes were grouted under high pressure. Provision has been made for additional grouting, if needed, from the inspection tunnel, as has been described by Mr. McCrory.

The possibility of unequal settlement of the east bulkhead section and the provisions to allow this to take place harmlessly were described by Mr. McCrory. The seals used in the vertical construction joints were adapted from those

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[2]Consulting Geologist, Boston, Mass., U.S.A.

used at Conchas Dam, New Mexico, where the danger of settlement was much greater.[3]

This development is a good example of the proper relations of geologists and engineers. The geologist interpreted the subsurface conditions and pointed out their practical importance, and the engineers designed the dam to meet these conditions. The geologist visited the site at frequent intervals during the construction period and discussed details, as they were disclosed, with the engineers. It was known in advance that certain unfavourable conditions existed at the La Tuque dam site, but by means of adequate investigation and competent engineering these conditions have been overcome and a safe and satisfactory dam has been constructed.

H. R. Sills, m.e.i.c.[4]

To one whose contact with large power developments was made in the late twenties, the speed with which the physical structures at La Tuque materialized was truly amazing. The writer had the privilege of spending a little time there last June, again in September during the hectic days of starting up, and yet again this January in the final mopping up. Mr. McCrory has mentioned that the assembly of the generators began in February after the power house was closed, except for the penstocks, and at the breech of one of these the rotor of the first generator was being assembled. To quote Robert Service, "Talk of your cold, through the parka's fold it stabbed like a driven nail." This assembly is rather finicky work, and the excellent job the field men did under this condition is much to their credit.

The generators have already been described in the technical press (*Electrical News*, June 15, 1940), but it may be of interest to outline some observations made during their tests and early operation. In general the performance was close to that predicted; the excitation characteristics came within three per cent, the reactance within five per cent; and the efficiencies were about 0.3 per cent higher than the guarantees. Even though the generators were equipped with a pole face winding the distribution of the stator winding and skewing of the slots was effective in producing a voltage wave with the remarkably low telephone influence factor of 1.5.

Mechanically, the units were sweet running machines; when enclosed for air recirculation they were very quiet, even at maximum over speed. The balance of the rotors as assembled was perfect; no field balancing was necessary. In view of the extent of housing enclosing these machines we were fortunate in avoiding vibration or drumming in them. Instantaneous short circuits at normal voltage and above, both three-phase and single-phase, were applied to secure the transient reactance characteristics and the inspection afterwards showed everything in perfect condition.

It is pleasant to catalogue these virtues but hardly interesting or informative. They do, however, form a necessary background for the following comments on ventilation which, at first, was by no means perfect, although the machines were able to carry load from the beginning. The Shawinigan Engineering Company had consented to the otherwise duplicate machines being built with slightly different types of ventilating arrangements in each so that it would be possible to compare the effectiveness of several innovations which were being tried, and so get a direct comparison. The main difference was in the type of wedge used to hold the stator coils in their slots. The shape of these wedges can materially affect the flow of air out through the ducts in the stator core forming, as they do, the entrance to these ducts. It has been standard practice to make the wedges flush with the surface of the teeth and notch them back at the ducts so as to enlarge their orifice. Previously a wedge had been used that was serrated in the direction of rotation at the ducts. This gave very good characteristics on machines having relatively high angular velocities but with machines of large diameters and relatively low angular velocities the air did not distribute evenly. It was discovered that this flow could be equalized by projecting the wedge out beyond the teeth or by recessing it below the face of the teeth, but there were no performance data in large machines. So one machine was furnished with recessed wedges and the others with projecting wedges of two different types. It was found that the projecting type wedge exhausted considerably more air than the recessed wedge but both exhibited a duct pressure distribution entirely different from any previously had. The pressure in the ducts nearest to the intake side of the rotor had the highest pressures and this tapered off toward the opposite end. Past experience had suggested the opposite, that is, low pressure at the intake side and high pressure at the other end. The rotor had been baffled to prevent recirculation of air blowing off the fans as previous experience showed that fans at the end of the poles would generate a pressure higher than that of the intake air and this air would tend to recirculate. However, with the new type wedges there was a suction at the end of the poles that would take all the air the fans could supply. At the opposite end, air was being sucked in from outside of the stator to supply the ducts at this end. Hence the air at this end was recirculating from the hot outside air and this had to be stopped. Eventually this was done by removing all the recirculation baffles for the rotor and opening up the rotor spider arms to feed the other end of the core through the rotor spider arms. These experiences were most valuable. The new type wedging is most effective; the tangential velocity of these rotors is 9,000 ft. per minute; manometer readings 1 in. back from air gap show pressures of 3.6 and 3.2 in. of water on opposite sides of the stator coil. This represents a 75 per cent conversion from tangential to radial velocities which is remarkably high, as much air is exhausted through these machines as in other machines of the same size and capacity running at 25 per cent higher speeds. This improvement in ventilation shows direct benefits in lower temperatures—the resistance temperature detector reading of this machine was 48 deg. rise compared to the guaranteed and designed value of 60 deg. rise. Low temperatures mean additional life to the winding and reserve capacity.

Thanks are due to the Shawinigan Engineering Company for their co-operation in assisting in this investigation. In large generator design, model tests are not often possible and developmental work must be done on the machines themselves. Such work may involve some adjustments after the machines are running and, at this stage, the co-operation of the purchaser in arranging clearances is invaluable. This assistance is often entirely altruistic, bringing no direct benefits, but the knowledge gained is of ultimate benefit to the industry as a whole, as it results in improved design and better and safer machines. The writer's company has found that when the object of a proposed development or investigation has been outlined to the utility engineers they have been most helpful. As an ardent believer in experimental research as a method of finding facts, the writer takes this opportunity to thank the utilities as a whole and the Shawinigan Engineering Company in particular for their willing co-operation. It is a policy which can be extended to the mutual benefit of the utilities and the manufacturer.

Prof. Robert W. Angus, hon. m.e.i.c.[5]

The writer has found the first part of Mr. McCrory's paper of considerable interest, dealing as it does with the method of finding the style and size of turbine that was used. Models which were made and tested, have enabled the author to find the best turbine to be used on the job, and he is to be commended for bringing to the attention of members of the Institute the amount of preliminary

[3]I. B. Crosby. Engineering Geology Problems at Conchas Dam, New Mexico. *Transactions*, American Society Civil Engineers, vol. 105, pp. 581-599, 1940.

[4]Assistant A.C. Engineer, Canadian General Electric Company, Peterborough, Ont.

[5]Professor of Mechanical Engineering, University of Toronto, Toronto, Ont.

work that should be done in advance of the actual selection of the turbine.

Unfortunately, the paper is not complete enough to enable a reader to get from the model tests the data from which the final decisions were made, nor can one get much technical information from the testing that was done. In Fig. 1 the curves all correspond to the same σ, but presumably the models were all tested at the same head, and if so they all had different specific speeds. Since the best value of σ is known to be connected with the specific speed, information on that point should be given in this connection.

A similar argument applies to the speed coefficient ϕ, and further information should be given in Section 3 at the top of Page 56.

The writer would ask about the method of obtaining the different values of σ in Fig. 2. Since the head used on the model has not been stated, it is difficult to discuss this point, but if one assumes the headwater level to remain constant, then variation in tailwater level may make quite large changes in the head, and therefore in the specific speeds on which σ depends. Would the author give further information on this point?

The statement is also made on Page 56 that the curves of Figs. 3 and 4 were calculated from the model tests by "the Moody step up formula and on information available on the performance of large units as compared with that on the small models on which they were based." The latter part of this statement nullifies the first part, for the figures are either based on Moody's formula or they are not. The writer asks data on the model and on the prototype so that the Moody formula may be checked for such turbines as were finally built from the model tests.

As the statements in the paper stand, they are not complete enough in the writer's opinion.

M. V. Sauer, m.e.i.c.[6]

The evidence of the co-operation between the author's company and the turbine manufacturers to determine the characteristics and performance of various types of runners is most praiseworthy. That they succeeded in producing a turbine of an improved type by such study and testing is sufficient warrant for the time and expense spent on such studies. It is to be hoped that actual performance tests on the installed units will be the subject of a further paper by the author.

There are many features of interest in the La Tuque development that have been brought out by the author but the writer will confine himself to only one or two.

In regard to pressure grouting of the rock foundations, there has always seemed to him an element of risk in the use of high pressures resulting in a possible shifting or raising of some of the rock layers and consequent further disturbance of the foundation. To determine if there was any such shifting on a recent job in the United States, measuring rods were grouted into the bottom of a series of holes and as grout was pumped into adjacent holes any shift of the surface rock could be detected by noting the lift of the surface rock as compared to the tops of the rods, thus eliminating any risk of further disturbance. It has been the writer's experience that a pressure only slightly in excess of the actual head above the bottom of the hole accomplished as much sealing of the rock seams as the higher dangerous pressures.

In regard to the construction of the upstream coffer dam, it would be of interest to know how much stress was imposed on the cables in pulling the cribs into place, also the depth and velocity of the water. It was found in a recent job with which the writer was connected, in which cribs of 20 ft. depth were placed in water flowing at a velocity of 14 ft. per sec., that the stress on the cables amounted to 50,000 lb.

In a later job in which the cribs were 35 ft. in depth and in which the velocity of the water was 12 to 14 ft. per sec., it was realized that the placing of timber cribs would be a very expensive operation, if indeed possible. In consequence, instead of using timber cribs, steel frames or open boxes were substituted and only sufficient rock placed in them to make them stable. In this manner all the frames were placed and being much more open than timber they allowed the water to pass through without building up a large head and producing scour on the bottom as the last cribs were placed. After the frames were thus placed it was a simple matter to dump rock in horizontal layers from trucks running back and forth until the dam was filled up.

[6]Hydraulic Engineer and General Supt., Generating Stations, Montreal Light, Heat & Power Cons., Montreal, Que.

The Author

The author appreciates the interest shown in his subject as evidenced by the discussions submitted. Mr. Crosby has described, in considerably more detail than was contained in the paper, the very interesting geology of the site and has mentioned some of the foundation problems which developed and which he assisted in solving.

Mr. Sills has in his discussion well illustrated the fact that a project of this kind is pre-eminently a co-operative effort to which a large number of engineers contribute and that advances in the art are brought about by this co-operation and by experimentation.

The following explanation will I think answer the questions raised in the discussion submitted by Prof. Angus:

1. The curves in Fig. 1 were drawn to show a direct comparison on a unit power base of four of the models tested. Different σ values might have been used for the different curves but it would not have materially altered either their shape or their values as is illustrated in Fig. 2. The specific speed of Model D-22 is 60 and that of D-30A is 66. The other two models have specific speeds slightly smaller than D-30A.

The values for the speed coefficient ϕ used in Fig. 1 are those determined by the series of tests run as giving the best efficiency for the various models.

2. The elevation of the Testing Plant forebay above centre line of turbine casing remains constant at 60 ft. The different values of σ are obtained by varying the level of the tailrace and the corresponding variation in the total head is taken into consideration in working up the test results. In the tests referred to in the paper the heads for different σ values, for average conditions, were approximately as follows:

σ..............	0.33	0.30	0.27	0.24	0.21	0.18
Head in ft.......	70.0	71.0	73.0	74.5	76.3	78.0

3. The statement on Page 56 with regard to the basis on which the curves in Figs. 3 and 4 are drawn is evidently not quite clear and probably should read that these curves were based on the Moody set-up formula modified by experience.

In the testing of large turbines it has been noted that while the point of maximum efficiency usually agrees fairly closely with that expected from the model tests stepped up in accordance with the Moody formula, some divergence exists for powers both below and above the peak, this part of the performance curve usually lying above the expectancy curve. The divergence in the case of the Rapide Blanc turbines, which are based on Model D-22, amounts to between four and five per cent above the stepped-up curve at the lower power outputs.

It is reasonable to assume that a similar runner installed at La Tuque would show a similar divergence from the stepped-up curve and so the curves shown in Fig. 3, while based on the Moody step-up formula, have been modified to conform with the performance of a prototype of the model.

The curves shown in Fig. 4 on the other hand being an estimate of the possible performance of a runner based on a newly developed model, D-30A, follow more closely the values derived by the Moody step-up formula. Our aim was to give to Model D-22, our starting point, the highest performance possible on any known and reasonably accredited basis.

The curves submitted in the paper are only typical of the tests made on a large number of models and there was no intention of dealing in detail with the relation between the performance of large units and of models.

Mr. Sauer's point with regard to the danger of disturbing the rock foundations by excessive grouting pressures is well taken. It was with this in view that, in grouting along the upstream face of the dam, the pressure in the upper parts of the holes was limited to 50 lb. per sq. in. By means of a gadget made up on the job, grouting could be done below any desired level in the hole and at any pressure up to 90 lb. per sq. in., which was the maximum air pressure available. Pressures up to 200 lb. per sq. in. were obtained by means of a grout pump and were used only in the foundation of the east bulkhead after the concrete structure was completed.

Two 1 in. dia. steel cables were used for holding the coffer-dam cribs in place after they were launched and while they were being loaded with rock. The tension in these cables was not measured and the author would hesitate guessing as to its amount. The cribs were built in sections 16 ft. long and were placed in water having an average depth of 15 ft. and flowing at a velocity estimated to have been 10 to 12 ft. per sec. The maximum depth of water was 20 ft.

Abstracts of Current Literature

Abstracts of articles appearing in the current technical periodicals

SAFETY IN THE CAMPUS

In practically every walk of life people nowadays are subject to hazards with which previous generations did not have to contend. Most of these dangers are due to the increased complexity of present-day existence, and the more rapid tempo of our pursuit of happiness. But along with increased risks, effective counter measures have been developed, so that accidents can be rendered less harmful and in many cases prevented. The effectiveness of these precautions, however, depends on timely preparation, proper instruction and the willing co-operation of the persons concerned.

Thus it is not surprising to find that in the United States a pamphlet* has been issued by the National Safety Council which is devoted to the dangers to life and limb existing on the college campus, and even in university buildings, where one would suppose that academic calm would give security. Apparently this is not so. Indeed modern education has its own perils, affecting not only the care-free student, but also the instructing staff, college employees, and the visitors who flock to see the sights of great American universities. The pamphlet is intended as a guide to college administrators in promoting accident prevention programmes. The survey on which it is based has been a thorough one.

It is true that records available are not very complete, but they indicate that some 25 per cent of student deaths (as reported by nine universities) were due to accidents; more than half these were automobile accidents. College athletics account for more than 10,000 injuries per year. There are 1,628 colleges and universities of all types in the United States, employing a staff of 110,000 in administration, teaching and research, and registering about 1,300,000 regular students annually. Higher education is in fact a major American industry.

From the figures for accidents to students in the college buildings it would appear that mechanical engineering laboratory and shop work courses head the list, followed by chemical and physical laboratory work.

Automobile traffic on the campus needs and receives attention, particularly in the larger universities. In many places it has been necessary to place special restrictions on the driving privileges of students; parking for staff and student cars has to be planned and regulated.

The booklet can be recommended as giving a general survey of desirable safety practices. If students and instructors become familiar with them, the safety consciousness thus produced may well have a lasting influence on their habits and attitude towards safety problems.

R.J.D.

* Student and Employee Safety in Colleges and Universities, National Safety Council, Inc., 20, North Wacker Drive, Chicago. One dollar per copy.

IRON MAN

From Robert Williamson, London, Eng.

It is now possible to cut coal, without any men at hand, on a steep coal face with a gradient of 60 degrees.

This remarkable advance in the technique of coal mining has been brought about by a famous engineering firm in Scotland.

The clue to the new use of these "iron men," as miners in early days called the coal-cutting machines, lies in the ingenious design of the hydraulic winch which, from its position on top of the coal face, directs the mechanical coal-cutter with extreme ease and certainty. For example, the strong wire rope connecting the winch to the coal-cutter draws the machine up the steep face at any one of seven speeds.

Safety devices operate at all points. The pull on the rope cannot exceed the fixed maximum, which is more than enough to haul the machine up the face during the hardest cutting, and, should the picks or teeth of the cutter be blunted or the machine be jammed by timber, work comes to a standstill.

After a little experience, the haulage operator in charge of the winch on top of the coal face can tell how the machine is cutting, the hardness of the material and the sharpness of the mechanical picks, as accurately as if he were actually close at hand to the coal-cutter itself.

THE SPITFIRE MK 111

From *Aeronautics* (London), April, 1941

Permission was given in February for the release of details of the latest Vickers-Armstrong Spitfire which is now in service. This machine, the Mark 111 type, is armed with cannon, and it has already proved to be even more deadly against the enemy than its predecessor. Modifications to the engine and the airframe have brought a marked improvement in the general performance so that the top speed is nearly 400 miles and hour and the powers of manoeuvre are phenomenal. Outwardly, there are few striking changes; the wing tips had been clipped so that the span was 33 ft. 8 in., as against the span of the earlier type which is 37 ft. 4 in., but later the wing tips were replaced. The engine has been boosted still further so that the power the Merlin now yields is sensational. The removal of the wing tips spoilt the appearance of this famous fighter. The performance has been very greatly improved. Moreover, pilots report that the machine handles superbly and is as free from any vicious tendencies as the Spitfire 1.

SPECTROSCOPIC ANALYSIS

From *Trade & Engineering*, (London), April, 1941

The examination of steels and non-ferrous metals for important constituents present only in very small quantities is being carried out on an ever-widening scale by means of physical tests made with the spectroscope rather than by chemical analysis. The rapid routine control of steels is an outstanding example; with the aid of a works instrument recently introduced the testing can be done with surprising speed by an intelligent but unskilled lad after only a few days' practice.

Different chemical elements burn with flames of different colours. Thus strontium burns with a bright red flame, copper with a green, sodium with a vivid yellow flame, and so on. If these flames are visually examined after their light has been passed through a prism, the colours are seen to be due to brilliant coloured lines which are really images of the slit of the instrument, through which the light is first passed. Each such coloured line is due to radiations of light having different wave-lengths, the measurement of which—made with the spectroscope—gives an infallible clue to the identity of the substance. Metals which, like incandescent steel, burn "white" have a very complex spectrum, but nevertheless contain coloured lines which can be quickly identified with a modern instrument.

Hence it is not difficult to understand that such a chemical "stethoscope" is finding general adoption in engineering and metallurgical fields, especially as great improvements in construction and design during the last few years have made available works instruments which are portable and simple to use, and give a high order of accuracy in both qualitative and quantitative work.

It was stated recently at the Institute of Metals by Mr. F. Twyman, F.R.S., that the consistency of spectro-chemical analysis of non-ferrous alloys is from 2.5 to 7.5 percent in the percentage of minor constituents, according to the nature of the alloy. In the case of steels, it is possible within a minute or so of obtaining the sample to discriminate between two steels containing only 0.24 and 0.19 per cent of vanadium. Rough and quantitative measurements of manganese in steel between 0.6 and 1.4 per cent, and the estimation of the manganese in a sample in less than one minute with an accuracy sufficient for prescribing the most suitable heat treatment, are other examples of the capabilities of the spectroscope. The extensive applications which are being made at the present time are quite remarkable, the accuracy of spectro-chemical analysis having increased by some four times during the last five years.

In the Spekker Steeloscope, a workshop spectroscope designed for the rapid estimation of nickel and other metals in steel and for sorting and checking steel stores generally, a small piece of the alloy to be tested is used as the negative pole of an electric arc. The light from the arc is spread out by prisms within the instrument and is seen in the eye-piece as a series of coloured lines. If the presence of molybdenum, for example, is being looked for, a slide on the eye-piece is moved along until it clicks into a position marked for this metal, when one of its distinctive lines will be seen in the middle of the field. The quantity present in the steel is gauged by the brightness of the coloured lines as compared with neighbouring lines due to the iron; by comparison with standard samples the amount can be estimated very quickly.

In a communication from the Spectrographical Section of the Naval Ordnance Inspection Laboratory, Sheffield, to the Iron and Steel Institute it has been stated by Mr. F. G. Barker that several samples of brass are often received together for complete analysis to a specification which limits the impurities to very small amounts. Whereas the chemical analysis of a batch of a dozen samples would occupy one man about a week, the spectroscopic method enables the work to be done within three hours.

ROCHESTER, N.Y., AND THE SMOKE PROBLEM

By Ernest B. Brundage

The Smoke Ordinance for Rochester, N.Y., was adopted in 1914. There have been no amendments to date. The legality of the ordinance was soon questioned by two proved bad offenders, and they lost their cases in court. Since then no one has been fined or jailed for violation of the Smoke Ordinance. However, many prosecutions have been started after several written notices have been sent to an offender of violations. As soon as a violator complies with the Smoke Ordinance the prosecution proceedings are dropped.

At the turn of the present century this city burned mostly anthracite and a small amount of coke for the heating of homes, churches, schools, apartment houses and small stores. The public utility, factories and the few large buildings burned soft coal. Because of the difference in price, anthracite costing nearly twice as much as bituminous coal, there was and has been a continuous desire to burn the cheaper fuel. It was evident that civic pride would not deter people from burning good bituminous coal in an objectionable manner. Hence, the Smoke Ordinance.

As stokers were developed and other mechanical methods of firing were devised which increased the efficiency of the heating plants and made only what might be considered a reasonable amount of smoke, the owners started to install the new equipment.

The following shows a trend in the City of Rochester:

Year	Number of Mechanical pieces of Equipment installed to burn soft coal. Mostly underfeed stokers	Of these installations the following numbers changed from anthracite, oil, gas, utility steam, coke to soft coal
1937	60	16
1938	95	32
1939	35	12
1940	56	21

At the end of 1940 there were 860 installations of underfeed, side feed, overfeed and pulverized fuel installations in Rochester burning mostly high volatile bituminous coal.

During prosperous times there have been as many as four men assisting with the smoke problem at the same time. For the past several lean years, one inspector has had to handle the entire work for a city of 340,000 people. In spite of that, in 1937 a system was started and since maintained for measuring the air pollution through solid deposit and the requiring of permits for the installation of soft coal burning equipment has been another step forward in our attack of the problem.

NEW BRITISH STEEL

From Robert Williamson, London, Eng.

A new shock-resisting steel has been produced in England after two years' intensive research.

Some years ago the makers introduced a metal combining the strength of high tensile steel with the ductility of mild steel. It was used for many purposes, notably for 8,000 railway wheel centres for London's tube trains and for ship's davits.

But whereas it permitted davits to be loaded up to 25 per cent greater than before, now davits made from the new steel for special duties have recently been passed for a further increase of up to 15 per cent loading for the same frame size.

In addition to the properties of the other, the new steel has a yield point of 60 per cent., or more, of the ultimate tensile strength and a resistance to shock of not less than 20-ft. lb.—two to three times the normal figure for carbon steel castings of this tensile strength. Uses to which this new shock-resisting steel has so far been put include excavator castings and automatic couplers for railway rolling stock.

MEASUREMENTS OF TEMPERATURE

From *Trade & Engineering*, (London), April, 1941

There are three principal methods of measuring temperature electrically. The first is based on the variation of the electrical resistance of a metal with its temperature, the second on the electromotive force set up in an electrical circuit comprising two dissimilar metals when the two junctions of those metals are at different temperatures, and the third on the fact that the intrinsic brilliancy of a luminous body depends on its temperature. Devices operating on the first principle are known as resistance thermometers and those on the second as thermo-electric or radiation pyrometers accordingly as the active junction is directly exposed to the measured temperature, or is placed at the focus of a mirror which receives radiant energy from the source of high temperature to be measured. Devices operating on the third principle are called optical pyrometers; an image of the source of high temperature is focused on the filament of an electric lamp and the temperature is measured by the current in the filament of the lamp that is required to make its brightness exactly match that of the image. Radiation and optical pyrometers have an inherent accuracy inferior to that of the more directly operating resistance and thermo-electric devices.

The resistance thermometer is the most versatile of electrical temperature measuring devices. The resistance of the thermometer coil is measured by comparing it with that of electrical components consisting of alloys having resistances that are unaffected by temperature change. The electrical power for operating the indicating instrument depends not only on the change of resistance of the thermometer coil but also on the electrical power put into the whole circuit, and by increasing this power input the instrument power can be made ample for indicating small temperature changes of the thermometer coil without sacrifice of robustness of construction. The resistance thermometer suffers from the drawback that an external source of power is necessary, and its accuracy depends on the constancy of the current drawn from this source; the equipment must therefore include some device either for compensating for changes of the input current or for maintaining this current at a constant value.

The thermo-electric thermometer or pyrometer is the simplest of all devices for the electrical measurement of temperature because it produces the electrical power required for operating the indicator. As the indicator is responsive to a temperature difference, either one junction of the dissimilar metals of the circuit must be maintained at a constant datum temperature, or the mechanical zero of the indicator must be maintained by hand or automatic adjustment at a value corresponding to this inactive junction temperature. The power available for measuring temperatures under 500 deg. F. is so small that specially delicate construction of the indicator is required. Although the resistance thermometer is generally more convenient for measuring moderate temperatures, the thermo-electric method is usefully applied for measuring the internal temperature of large electrical machines, because the junctions are so compact that they can be built into the windings.

The highest accuracy and the greatest range of temperature measurement by the thermo-electric method are given by the use of junctions or couples composed of rare metals such as platinum and rhodium. For temperatures up to 1,200 deg. F. base-metal couples are used, not only because they are cheaper but also because they give more power for instrument operation than do rare-metal couples. The life of a base-metal couple exposed to a temperature of about 1,200 deg. is necessarily limited, and towards the end of the life of a couple its accuracy is likely to fall off seriously.

As inaccuracy in a thermo-electric pyrometer is difficult to detect, special interest attaches to the results of an investigation recently carried out by the United States National Bureau of Standards on the useful life of base-metal couples of three types under various temperature conditions. Iron-Constantan couples maintain good accuracy with 1,000 hours' exposure to temperatures up to 1,200 deg. F. With higher temperature the electrical indication tends to be low and the life to become less, failure taking place after 12 hours' exposure to 2,000 deg. and after 300 hours' exposure to 1,600 deg. Similar but somewhat better results were obtained with Chromelo-Constantan couples. Couples of Chromel-Alumel gave a useful life of 100 hours up to 2,000 deg. F., with a tendency for the electrical indication to be high with temperatures above 1,200 deg.

The results of this investigation show that the conditions in which a base-metal couple are used should not be changed if the highest accuracy is required. A couple that will give accurate results for temperatures below 1,000 deg. should not be exposed to any higher temperature, else the accuracy at moderate temperatures around 500 deg. may suffer. The position of a couple in a furnace should never be altered after it has been installed. It is even inadvisable to remove a couple for calibration in a laboratory furnace.

The accuracy of the indication of a thermo-electric pyrometer depends jointly on the accuracies of the couple and of the indicating instrument, and freedom from error cannot be inferred from good condition of the instrument. The Bureau of Standards investigation shows that users of couples for temperatures above 1,000 deg. should realize that the useful life is terminated not by actual failure but by falling-off of accuracy.

AIRCRAFT ARMOR

By HORACE J. ALTER

From *Army Ordnance*, (Washington, D.C.), March-April, 1941

The Protection of Flying Personnel from Hostile Fire

The strategic value of the airplane as a military weapon was discovered soon after its first successful flight. Its value as a long-range artillery weapon exceeds that of any gun in efficiency and destructive effect. The continued development of bomber and pursuit has resulted in a race similar to that which goes on between armor-plate and projectile manufacturers. Each seeks to develop a better airplane to force the other out of the sky. Every means to keep the airplanes flying is used, and protection for personnel and equipment is now provided on all fighting airplanes.

Steel plate as a protective covering has been used for over a century and a half, but the development of light armor plate 1 to 1½ inches or less thick has been limited to the years following the World War. It was developed during that conflict for use on tanks and armored cars, and its continued development has followed the demand for increased speed in these vehicles, which requires light plate. Soon after airplanes were flying over the Western Front, pilots were asking for something to protect the seat of their pants against the fire of ground troops and something at their backs to protect them from the hostile airplanes on their tail. They used stove lids, gun shields, car doors or any piece of heavy metal lying around loose. The development of armor plate for aircraft use soon followed, but the work was not continued in the years following the close of the war.

Armor is used to protect the airplane's operating personnel and vital flying and fighting equipment. Service tests prove that a combat crew trained and working together reaches a high degree of efficiency. The loss of a member of the crew is followed by a decrease in efficiency and a temporary reduction in morale. Important mechanisms, bombing apparatus, electrical equipment, etc., must be protected in order that the airplane may fulfill its mission against all obstacles. The fuel and oil tanks must be protected to sustain flight and prevent explosions. Protection also must be provided for the electrical, hydraulic, and control systems. The use of protective armor has a marked effect upon the psychology and morale of the combat crew by relieving the nervous tension and strain which exist when the crew is exposed to direct machine-gun and cannon fire.

Airplanes may be subjected to several different types of ammunition fire. They may be fired upon by ground troops, anti-aircraft batteries, and hostile airplanes. Ground troops used caliber .30 or .50 ball, tracer, and armor-piercing ammunition, depending upon the type of weapon used. The guns of hostile aircraft may use caliber .30 or .50 ammunition or light cannon with 20-or 37-mm. explosive shells. Three-to five-inch shells are used by antiaircraft batteries, and it is entirely feasible that airplanes may soon carry cannon of large bore.

The modern airplane is so constructed that little if any serious damage can be done to the structure by small-bore ammunition. In some cases the structure has survived hits by large shells and the airplane has still continued in flight. However, since the structure and covering of the airplane is not sufficient protection for personnel and equipment against small-bore ammunition and shell fragments, additional means in the form of armor plate must be added.

Attacks on the airplane can be launched from several directions simultaneously, but it cannot be attacked by more than one airplane at a time from any one direction. Hostile aircraft attack may be complemented by antiaircraft and ground-troop fire. Aircraft attacks are most probable from the rear hemisphere, from about fifteen degrees below to about forty-five degrees above the horizontal. With the advent of the multiseat fighters, attack from the forward lower hemisphere is feasible. Antiaircraft fire from large guns may be effective in any direction, but usually strikes from below. It is essential that the crew and mechanisms be protected from as many directions as possible.

There are certain advantages which occur and which may be taken into account when designing armor plate for airplanes: (1) The major portion of gunfire is directed at angles less than normal to the surfaces of the airplane; (2) The relative distance between airplanes in combat allows the pilot time to manoeuver away from the fixed guns of an opponent; (3) The speed of the airplane relative to the speed of the bullet and rate of fire of the gun is so high as to give a wide dispersion of hits and the spacing between shots is increased as the ratio of speeds increase.

It is seen that, given sufficient velocity, ordinary ball ammunition will penetrate armor plate as readily as armor-piercing. The particular velocity at which a plate just resists penetration by the bullet is called the ballistic limit of the plate. Penetration is also dependent upon the striking angle of the bullet-penetration being greatest at normal angles of impact and least when the angle of impact approaches zero.

It is seen that the attacking airplane controls three factors which affect the penetration of the projectile; namely, (1) The velocity of the bullet, determined by the powder charge and length of the gun barrel; (2) The caliber of the bullet, determined by the bore of the gun, which is indirectly influenced by the size of the airplane; (3) The weight and thus the trajectory of the bullet.

The factors which the attacked airplane controls and which can be designed into the airplane by the armor plate designer are: (1) The thickness of armor plate; (2) The type of plate and its ballistic properties or resistance; (3) The angle of impact of the bullet upon the plate. This is determined by figuring from which angles the airplane is most likely to be attacked.

In the design of plate for aircraft use, advantage may be taken of the fact that penetration under glancing impact is resisted by thinner plate than under normal impacts. The effect of impact at normal angles is limited to an area approximately three calibers in diameter, thus putting a high stress in the plate. Under the glancing impact, the effect is distributed over an area from two to five calibers long by two to three calibers wide, depending upon the bullet-impact angle. The effect of tumbling or turning the bullet is to increase the angle of impact.

If it is assumed that the resistance of the plate is the maximum obtainable, the thickness of the plate varies for different sections of the airplane. The gauge of plate is proportional to the angles at which the plate is mounted. For armor installed on the upper surface of the wing, where the angles of impact are more likely to be zero, the plate will be thin, while for a section at the rear of the fuselage, where the bullets will strike at more normal angles, the plate will be thick. Where the bullets are likely to pass through structure or equipment before hitting vital parts or personnel, advantage may be taken of the tumbling effect of the member and a thin plate installed.

There are two general types of light steel armor plate. First, there is a face-hardened plate in which the face exposed to gunfire has a greater hardness and resistance to penetration than the remainder of the plate. The exposed face is heat-treated and hardened to give a compact physical structure, while the remainder of the plate is made very tough and ductile.

Then there is homogeneous plate—a type which has a uniform and consistently hard and compact structure from face to rear. In some cases, ductility and toughness are sacrificed to secure good ballistic properties. The plates show tendencies to throw buttons, spall and shatter when subjected to bursts of machine-gun fire due to the vibration which is set up in the internal molecules of the plate. Since aircraft plate would not be subjected to concentrated bursts, vibration and shattering are not likely to occur.

Present combat ranges for airplanes are approximately one hundred yards or more. Homogeneous or face-hardened plate one-quarter of an inch thick will stop complete penetration of a caliber .50 armor-piercing bullet when the angle of obliquity, the angle between the flight path of the bullet and a normal to the plate, is sixty-five degress or less. One-half inch plate will stop armor-piercing caliber .50 bullets at twenty degrees. Good plates of either type shatter the projectile without appreciable signs of cracking or shattering. Most of the armor-piercing cores break into small fragments upon striking the plate.

Flexible mountings, such as springs or rubber pads, show little or no improvement and may be injurious by producing a racking effect; that is, tearing the plates loose from their fastening bolts.

Bullet-proof glass is also used for armoring purposes. The hard surface of glass makes it a good protective plate. Bullet-proof glass is used in airplane windshields where the angle of impact is very low about forty-five degrees or less, and where a glancing blow causes the bullet to ricochet. When the bullets strike at angles more nearly normal, the surface is starred and the glass powdered or splintered and slivered. The bullet core is imbedded between the layers of glass and the plastic binder. The area affected varies from six to ten inches, although visibility is still possible through the outer regions of the affected area.

Bullet-proof glass two inches thick will stop penetration of caliber .30 ball ammunition at normal impacts. Glass three inches thick will stop caliber .50 bullets.

Armor in the pilot's compartment should protect his head, back, and seat. Bullet-proof glass should protect him from fire coming from the forward hemisphere. Where possible, all equipment in the pilot's compartment should be placed to form protection and baffles. It must be remembered that a preponderance of attacks are most likely to occur from the rear at angles normal or nearly normal. It is essential that plate protecting against gunfire from this quarter be heavier than that protecting against gunfire from the forward quarter.

From Month to Month

News of the Institute and other Societies, Comments and Correspondence, Elections and Transfers

THE PRESIDENT'S TOUR

In the vernacular of the political press to the south of us, President Mackenzie took a "swing" around the maritime branches during the month of May. He visited Halifax, Moncton and Saint John, holding branch meetings in each city and a Council meeting in Saint John. In Halifax, his alma mater Dalhousie presented him with an honorary Doctor of Laws, and in return received from him the convocation address.

Throughout the trip he was accompanied by Vice-President K. M. Cameron, J. A. Vance, R. L. Dobbin, G. A. Gaherty and the general secretary. At Saint John, J. B. Challies and Huet Massue joined the group to take in the Council meeting. This splendid support was a real tribute to the president, and added much to the interest and value of his visits to the branches.

In each city the president found a warm welcome, not only was he greeted as the Institute head, but also as a friend. Born in New Brunswick and educated in Nova Scotia he is at home in both provinces, and is among friends no matter where he pauses. He found the branches active and thriving, and was particularly impressed with the progress that has been made in Nova Scotia towards a common membership between the Association and the Institute.

It is evident that presidential visits are a welcome stimulus, and that meetings of council create a favourable influence within the regions where they are held. Such events make great demands in time and money, and the Institute is fortunate that in its choice of presidents it has found so many who can and do make these sacrifices for the good of the profession.

It is to be hoped that notwithstanding the importance of Dr. Mackenzie's work at Ottawa, he will be able to visit other branches and that on such occasions he will again be supported by officers of the Institute and of branches.

A.R.P. AND THE INSTITUTE

It is possible that air-raid precautions have been discussed in several branches of the Institute across Canada, but only two have reported their interest to Headquarters. Some time ago the Montreal Branch set up a committee, and recently word has come from the Saint John Branch that a committee has been set up there at the request of the city's committee for A.R.P. to organize for demolition work.

Realizing that the growing interest in this work in Canada was a matter of concern to engineers, the Institute has received authorization from the Ministry for Home Security to circulate in this country the splendid bulletin prepared by the Research and Experiments Branch of that department. In the United Kingdom this information is distributed by the Institution of Civil Engineers.

These bulletins cover such topics as:

- Bulletin No. C. 1—New Design Methods for Strutting of Basements, Etc.
- Bulletin No. C. 2—Consolidation of Earth Covering on Anderson Shelters.
- Bulletin No. C. 3—The Propping of Reinforced Concrete Beams.
- Bulletin No. C. 4—The Protection of Glass in Hospitals.
- Bulletin No. C. 5—Steps that should be taken to increase the Resistance of "Umbrella" type Roofs to Collapse due to Air Attack.
- Bulletin No. C. 6—Damage to Cast Iron Pipes in Works.
- Bulletin No. C. 7—The Protection of Factory Glazing.
- Bulletin No. C. 8—Structural Damage Caused by Recent Air Raids to Some Single Storey Buildings.
- Bulletin No. C. 9—The Protection of Plate Glass Windows.
- Bulletin No. C. 10—Flexible Substitutes for Glass.
- Bulletin No. C. 11—Chemical Fire Extinguishers. (Their application to incendiary bombs and resultant fires.)
- Bulletin No. C. 12—Single Storey Wartime Factory Design.
- Bulletin No. C. 13—Obscuration, Ventilation and Protection from Glass in Large Buildings.
- Bulletin No. C. 14—Refuge Room Dormitories. (A sequel to "Your Home as an Air Raid Shelter.")
- Bulletin No. C. 15—Strengthening Steel Framed Shed Buildings Against Collapse (due to air attack).
- Bulletin No. C. 16—Notes on Indoor Shelters.

And will be of invaluable assistance in the study of and preparation for such visitations in this continent.

The printing and distribution involves a task of substantial preparation and it is not possible as yet to announce the procedure. It is hoped that details can be announced in the next number of the *Journal*. In the meantime it is thought advisable to inform members that the material published up to the present is now at Headquarters and that future publications will be sent regularly as issued.

The material on hand also includes fifty-four bulletins issued by the British Standards Institution known as the A.R.P. Series.

QUEBEC "WINGS FOR BRITAIN"

In a recent issue of the *Montreal Star*, an editorial reference was made to the contribution received by "Wings for Britain" from the Corporation of Professional Engineers of Quebec. This is a piece of news of interest to the whole profession, and the *Journal* is glad to reprint herewith the entire editorial in tribute to the Corporation.

"The solidarity with which all sections of the Canadian community stand behind the war effort was effectively demonstrated yesterday afternoon when, on behalf of the Corporation of Professional Engineers of Quebec, its president, Dr. Olivier Lefebvre, presented a cheque for $2,000 to 'Wings For Britain,' the organization which is providing funds for many fighter planes. This is a bilingual organization, and some of the most distinguished French-Canadian and English-speaking engineers comprise its membership. Its gift, then, was a tribute offered on behalf of a profession which is contributing very largely in other ways toward the general war effort. An engineer, General McNaughton, commands the Canadian forces overseas, and in many other capacities the profession is placing its talents at the disposal of the Government.

"In his presentation address Dr. Lefebvre paid a remarkable tribute to the British people, using words which undoubtedly express the views of his compatriots throughout the Province. 'We all appreciate,' he said, 'that in the present war our liberty and all that makes life worthwhile are at stake. The British Empire alone, with the aid of the United States, is defending our liberty. The courage, determination and will to win shown by English-speaking people have won the admiration of the whole world.' And, in tendering the cheque to Mr. Joseph Simard, a member of the general committee of 'Wings For Britain,' he added the fervent hope that the money 'would serve to aid Great Britain and her Allies to defend the cause of democracy, and all that they stand for.'

"In accepting the gift on behalf of the committee, Mr. Simard took occasion to supplement Dr. Lefebvre's remarks with a statement particularly appropriate at this time. 'This shows,' he said, 'once more that Canadians of the Province of Quebec are anxious to participate in any undertaking indispensable for the pursuit of the war to a victorious peace. The insinuations made by certain persons regarding the French-Canadian population are not justified, and for my part I have yet to meet one of my fellow-citizens who is not wholehearted in the ends which we pursue.'

"The gift was unsolicited, as the small gathering was informed, and was therefore made as a spontaneous gesture of appreciation. Such gifts serve further to bind the community together in the common effort."

THE CENTENARY OF QUEEN'S UNIVERSITY

In 1841, a rented frame house on a side street of Kingston, two professors and ten students. In 1941, a beautiful campus, situated close by the shore of Lake Ontario, containing thirty-three buildings with adequate equipment, worth $5,000,000; an endowment fund of $4,000,000; a staff of three hundred and fifty; an intramural and extramural student registration of four thousand; and an alumni body of fourteen thousand.

Such has been the development of Queen's University at Kingston in the hundred years that have passed since Queen Victoria, on October 16, 1841, granted a royal charter to the small colonial college that was eventually to become one of Canada's greatest seats of learning.

Queen's University is today an institution of which every Canadian may be justly proud. In this, her centenary year, Queen's can look back upon a record of pioneering service and educational achievement that Canada could ill have spared.

Founded by the Presbyterian Church in Canada for the primary purpose of training ministers for the widely scattered areas of Upper Canada, Queen's activities were confined at first to theology and arts. After a few years the teaching of medicine was begun, and eventually a Faculty of Applied Science was organized. In all of these fields, Queen's University has done, and is still doing, great work.

Not the least important of Queen's contributions to Canadian life has been in the realm of engineering. Established in 1893 under the auspices of the Ontario Government, the School of Mining at Kingston was the first institution of its kind in Canada. It rapidly proved its worth, shortly became affiliated formally with Queen's and finally developed into the present Faculty of Applied Science of the University. Many hundreds of engineers have gone forth from Queen's to fill posts of trust and responsibility from coast to coast in Canada, and elsewhere throughout the world.

Queen's hundredth year is being marked by a series of conferences of learned societies and organizations at the University during the summer months, and by a special Centenary celebration from October 16 to 18. Some of the high-lights of the programme are as follows:

A service of thanksgiving and remembrance.

A series of addresses—by some of the most eminent scholars of England, Canada and the United States—on the progress of theological thought, of the humanities and social sciences, of medicine, of science and applied science, and of business and finance during the past hundred years.

A Centenary Convocation, at which a number of honorary degrees will be conferred and at which the University's Centenary Poem will be presented.

A special Convocation at which an honorary degree will be conferred upon His Excellency the Earl of Athlone, Governor-General of Canada and Rector of Queen's.

The programme also includes: a Centenary banquet; a combined alumni-student ceremony, at which His Excellency the Governor-General will deliver his Rectorial Address, and at which the "Story of Queen's" will be told; a University reception; an alumni dance; and various other graduate and student functions.

As Queen's University moves on into her second century, she takes with her the good wishes of the whole of Canada —that her service in the future may be as fruitful as that of the past.

THE BY-LAWS

Some time ago in accordance with By-law No. 75 Council authorized the secretary emeritus to reword and rearrange the by-laws of the Institute. This work has been underway for over a year and at last all the requirements as stipulated have been met and the new booklet has just appeared. Copies will be sent to all officers and to branch secretaries. Any member who is interested may secure a copy without cost simply by writing Headquarters. All the material appeared in the August, 1940, number of the *Journal*.

The new arrangement will be found more logical and more useful. The many amendments made during recent years had caused some vagueness and inconsistency with other portions that had not been altered. It is believed this has now been overcome without in any way altering the original intention or purpose of the by-laws.

WARTIME BUREAU OF TECHNICAL PERSONNEL

The mailing of questionnaires to engineers, chemists and architects is now under way. As there are forty thousand to be mailed, it has been decided to send out only a thousand a day. This spreading out is necessary in order to give the office staff an opportunity to keep up with the returns.

The first mailings will cover the Quebec and the maritime provinces. Ontario will follow, and the four western provinces will be next. This order has no significance, but is simply the result of the way the lists were received from the Bureau of Statistics. Attention is called to it now, so that persons will not become unduly disturbed if these forms do not arrive immediately.

Accompanying the questionnaire is a postage-free return envelope, an explanatory letter, and a list of classifications. Each person is asked to classify himself according to the lists, and also to state whether or not he is prepared to transfer from his present occupation to one of more wartime significance, providing that satisfactory arrangements can be made with his present employer.

As there are almost no engineers out of work to-day, it is evident that the increasing needs of war industry will have to be met by transferring or borrowing men from industries of less national importance. Herein lies the real work of the Bureau—to locate the required men and to negotiate for their transfer or loan.

It seems evident that in the list of 40,000 names secured from the national registration, there must be many who do not rightly qualify for that classification. It is expected that many thousands will be eliminated in the re-classification that will be done when the forms are returned; but on the other hand, many useful persons may be uncovered who possess "near" engineering qualifications, and who have called themselves engineers or chemists at the time of registration for lack of a more precise classification.

You are urged to give your questionnaire careful and early attention. It is hoped that everyone will return the required information without regard to whether or not he is at the moment engaged in urgent and vital work. A complete record in one office will not only assist with the war effort now, but will be valuable to the whole profession in the future.

ERRATUM

In the discussion on Mr. Runciman's paper "Earth's Crust Resistance and Lightning" which appeared in the April issue, a line was dropped from the next before last paragraph on page 179. The paragraph should read: "To answer Mr. Buchanan's point, in reference to reduced insulation, it should be kept in mind that the minimum insulation for a 220 kv. line in wet weather could be about six suspension units, whereas we use fourteen and sixteen units, and some other companies, eighteen to twenty-four units." etc.

INSTITUTE MEDAL RECEIVED BY LIEUT.-GENERAL McNAUGHTON

The announcement of the recent presentation of the Sir John Kennedy Medal to Lt.-General McNaughton in London was pretty well distributed by the press but Headquarters has received a report direct from the Institution of Electrical Engineers which gives more detail. The original letter, the photographs and the address referred to have not arrived at time of going to press. Doubtless they are on a slower mail.

The Institute is very pleased to read of the splendid ceremony, and to acknowledge the kindly greetings of a sister society. The desire to foster closer collaboration between engineering groups finds a ready response throughout this organization. It is a pleasure to look forward to the resumption of negotiations at the conclusion of the war.

The following is printed from carbon copies which have come by air mail.

THE INSTITUTION OF ELECTRICAL ENGINEERS

London, 22nd May, 1941.

L. Austin Wright, Esq.,
The Engineering Institute of Canada, Montreal.

Dear Mr. Wright:—

I now have much pleasure in sending you the enclosed report of the proceedings at our Ordinary Meeting on 8th May when the Sir John Kennedy Medal was presented to General McNaughton.

You will see that reference is made to an address to your Institute and I should explain that the Council felt that they would like you to have for retention in your archives a record of the circumstances under which the presentation ceremony was carried out. They also felt that General McNaughton might like to have a copy and authority was therefore given by the Council at their meeting held earlier in the day for the signing and sealing of two copies of the address, one of which I now send to you with this letter. I also enclose three photographs that were taken at the presentation ceremony.

To complete the record of the events arising out of the presentation I should refer to the Council luncheon held at the Waldorf Hotel immediately preceding the Ordinary Meeting. A list is given below of all those who were present, and you will see that it contains the names of several distinguished Canadians as well as Lord Hankey, the Chancellor of the Duchy of Lancaster, and the Rt. Hon. Sir Andrew Duncan, the Minister of Supply, and representatives of leading sister Institutions in this country. In response to a speech of welcome delivered at this luncheon by the president, Mr. Vincent Massey replied in general terms on behalf of the guests and with particular reference to General McNaughton, his remarks being very much appreciated by all present.

In conclusion, I am asked to express once again the Council's keen pleasure at having had the opportunity of this association with you in giving honour to a great scientist and a great soldier.

Yours sincerely,
(Signed) W. K. BRASHER,
Secretary.

EXTRACT FROM THE PROCEEDINGS OF THE INSTITUTION
966TH ORDINARY MEETING, 8TH MAY, 1941

Mr. J. R. Beard, M.Sc., (President): "My first duty this afternoon, and it is a most agreeable and unusual duty, is to present, on behalf of the Engineering Institute of Canada, their Sir John Kennedy Medal to Lieut.-General Andrew George Latta McNaughton, C.B., C.M.G., D.S.O., M.SC., LL.D., D.C.L., General Officer Commanding the Canadian Forces in Great Britain. We esteem it a great privilege that this presentation should have been entrusted to us, more especially as General McNaughton is one of our members.

For some time past we, in common with the Institutions of Civil and Mechanical Engineers, have wished to foster closer collaboration with the representative engineering institutions in the Dominions and this was actively in hand until necessarily interrupted by the outbreak of war. We intend to take it up again when the war is over and meanwhile this function to-day helps to keep the spirit of co-operation alive.

"Three years ago the Engineering Institute of Canada celebrated its Jubilee and representatives of our Institutions under the leadership of Sir Alexander Gibb went to Canada to offer our congratulations. We were ably represented by my immediate predecessor, Mr. Johnstone Wright, who brought back most happy memories of Canada and an increased enthusiasm for the encouragement of co-operation between our Institutions.

"The Sir John Kennedy Medal is awarded when occasion merits to Corporate Members of the Engineering Institute of Canada 'in recognition of outstanding merit in the profession or of noteworthy contribution to the science of engineering' and I understand that this is only the fifth or sixth award which has been made. General McNaughton fully meets those requirements, in addition to having given most distinguished service to Canada in wider fields.

"Born in Saskatchewan in 1887, General McNaughton graduated in electrical engineering at McGill University, where he was subsequently on the teaching staff and in private practice. From his undergraduate days he had taken the keenest interest in military science and by 1913 was a Major commanding a field battery in the Militia. During the 1914-1918 war he gave distinguished service in France and was wounded at Ypres. Later he rose to be Lieut.-Colonel in charge of a field artillery brigade in the 2nd Canadian Division, fought through the battles of the Somme and became counter battery staff officer of the Canadian Corps; he was again wounded at Soissons in 1918 while attached to the French Army. Just prior to the end of the war he was General Officer Commanding Canadian Corps Heavy Artillery at the early age of 31. Apart from the several honours and distinctions which I have enumerated, he was mentioned three times in despatches.

"On his return to Canada, General McNaughton became successively Director of Military Training, Deputy Chief of the General Staff and, in 1929, Chief of the General Staff, with the rank of Major-General, which I understand is the highest military appointment in Canada. During this period he continuously stressed the rapidly increasing importance of the engineer in modern warfare, a view which has been fully justified in recent months. He was also active in afforestation.

"In 1935 he became president of the Canadian National Research Council, a position which he still occupies, and his energy did much to promote the constructive application of science to industry.

"In electrical engineering his development of the cathode-ray direction finder, in co-operation with Col. W. A. Steel, is well known. At the Research Council he promoted work on high-voltage investigations and not only equipped the laboratories for this purpose but took an active part in planning the experimental programme. In 1939 he was appointed by the Canadian Government as technical adviser to accompany a delegation of Canadian manufacturers to Great Britain in order to investigate the possibility of producing munitions in Canadian plants.

"Throughout his military career General McNaughton has always directed his attention especially to the scientific and engineering side. Signals, radio, aircraft, artillery and mechanization have been his chief interests. In many other directions he has played an active part, such as in the St. Lawrence waterways and air transport.

"Soldier, scientist and skilful administrator, a Canadian with a true understanding of the place Canada holds in world affairs and with a broad vision of the future which its potential resources may enable it to attain, General McNaughton has devoted his life in large measure to the development of Canada, the promotion and application of engineering science and the advancement of his chosen profession.

"We had hoped to have with us this afternoon Mr. Vincent Massey, the High Commissioner for Canada, but unfortunately though he had fully intended to come, he has at the last minute been called to a very urgent appointment and has had to forego giving us the pleasure of his presence. We have with us to-day, however, the former Prime Minister of Canada, the Rt. Hon. Mr. R. B. Bennett, who is very well known to us over here and who, as you know, has taken up his residence among us. We are also pleased to welcome several distinguished technical officers of the Canadian Forces.

"Our Council feel that they would like to make a record of this occasion by presenting to the Engineering Institute of Canada an address stating the circumstances of this presentation and their pleasure at being invited to make it. A copy of the address is also being handed to General McNaughton."

The President then, amid applause, handed to General McNaughton the Sir John Kennedy Medal of the Engineering Institute of Canada and a copy of the address.

Lieut.-General A. G. L. McNaughton: "I know you will forgive me if my remarks on this occasion are very brief, because you will understand that the high honour which I have received to-day from the Engineering Institute of Canada, through the agency of The Institution of Electrical Engineers, goes right to my heart. I feel very much that the recognition which has been given to me is to a very large extent a recognition of that great institution, the National Research Council, with which I have the honour to be associated and to which I was sent by the Rt. Hon. Mr. Bennett, whose presence here to-day I deeply appreciate.

"I have sought all my life to have an opportunity of taking part in actual development work and construction work in engineering, but it always seems that as soon as one starts an active project of investigation or research something happens in the world and one is drawn away to outside activities.

"Twice in my life, once at McGill and then at the Research Council, I have gone deeply into the field of high-voltage research, but no sooner had I got the equipment assembled on those two occasions than war in Europe broke out. I can assure you, however, that Mr. Ballard and my other associates in Canada who are continuing to use and develop the Research Council's laboratory are keeping me informed of what is going on, and as soon as the war is brought to a satisfactory conclusion—I have no doubt about its ultimate result—I want to continue my work there with the beautiful apparatus that we have got together operating at millions of volts with much power behind them and at many frequencies. I hope some day to have the privilege of presenting a paper to this Institution."

Attendance at Council Luncheon

Sir E. V. Appleton, D.S., F.R.S., (Secretary of The Department of Scientific and Industrial Research); The Rt. Hon. R. B. Bennett, K.C.; Prof. S. Chapman, M.A., D.Sc., F.R.S., (I.E.E. Kelvin Lecturer, 1941; Chief Professor of Mathematics, Imperial College, South Kensington, London); Mr. E. Graham Clark (Secretary, The Institution of Civil Engineers); Sir Henry Dale, C.B.E., F.R.S. (President, The Royal Society); The Rt. Hon. Sir Andrew Duncan, G.B.E. (Minister of Supply), Honorary Member I.E.E.; Prof. A. C. Agerton, M.A., F.R.S. (Secretary, The Royal Society); Dr. A. P. M. Fleming, C.B.E., M.Sc. (Faraday Medallist I.E.E., 1941; Past President I.E.E.); Mr. J. S. Forrest, M.A., B.Sc. (Winner of Cooper's Hill War Memorial Prize and Medal, awarded by I.E.E. for 1940); Colonel J. Genet, M.C., M.E.I.C. (Chief Signals Officer, Canadian Corps.); The Rt. Hon. Lord Hankey, G.C.B., G.C.M.G., G.C.V.O. (Chancellor of The Duchy of Lancaster); Brigadier C. S. L. Hertzberg, M.E.I.C. (Chief Engineer, Canadian Corps); Professor A. V. Hill, O.B.E., F.R.S. (Secretary, The Royal Society); The Hon. Vincent Massey (High Commissioner of the Dominion of Canada); Lieut.-Ceneral A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.E.I.C. (Commander of the Canadian Forces in Great Britain); Mr. J. E. Montgomrey (Secretary, The Institution of Mechanical Engineers); Sir Archibald Page (Chairman, Central Electricity Board; Past President I.E.E.); Mr. W. Stanier (President, The Institution of Mechanical Engineers); Brigadier G. R. Turner, M.E.I.C. (Canadian Corps.); *President* Mr. J. R. Beard, M.Sc. (Senior Partner, Messrs. Merz & McLennan, Consulting Engineers); *Past Presidents* Mr. J. M. Donaldson, M.C. (General Manager, Northmet Power Company); Lt. Col. K. Edgcumbe, T.D. (Director, Everett Edgcumbe & Co. Ltd., Electrical Measuring Instrument Makers); Mr. F. Gill, O.B.E. (Chairman Standard Telephones & Cables; Vice-President and Director, International Standard Electric Corporation); Mr. J. S. Highfield (Consulting Engineer); Mr. P. V. Hunter, C.B.E. (Director, Joint Manager and Chief Engineer, Callender's Cable & Construction Co.); Sir George Lee, O.B.E., M.C. (formerly Engineer-in-Chief, G.P.O., London); Dr. Clifford C. Paterson, O.B.E. (Director Research Laboratories, General Electric Co. Ltd.); Dr. Alexander Russell, M.A., F.R.S. (Advisory Principal, Faraday House, Electrical Engineering College, London); Prof. W. M. Thornton, O.B.E., D.Sc., D. Eng. (Emeritus Professor of Electrical Engineering, Armstrong College, Durham University); Mr. Johnstone Wright (Chief Engineer, Central Electricity Board); Mr. H. T. Young, (Managing Director, Messrs. Troughton & Young, Ltd., Electrical Contractors); *President-Designate:* Sir Noel Ashbridge, B.Sc. (Eng.) (Chief Engineer, British Broadcasting Corporation); *Vice-Presidents:* Colonel A. S. Angwin, D.S.O., M.C. (Engineer-in-Chief, C.P.O., London); Dr. P. Dunsheath, O.B.E., M.A. (Director and Chief Engineer, Messrs. W. T. Henley's Telegraph Works Co. Ltd.); Mr. V. Z. de Ferranti, M.C. (Chairman, Messrs. Ferranti, Ltd.); Professor C. L. Fortescue, O.B.E., M.A. (Professor of Electrical Engineering, City and Guilds College, London); *Honorary Treasurer:* Mr. E. Leete (Director, London Electric Wire Co. & Smiths Ltd. and The Liverpool Cable Co. Ltd.); *Secretary I.E.E.* Mr. W. K. Brasher, B.A.

CORRESPONDENCE

10, Climie Place, Kilmarnock, Scotland.
26th March, 1941.

The Secretary,
The Engineering Institute of Canada,
Montreal.

Dear Mr. Wright,

I read (with some blushes) in the February *Journal* your reference to my little contribution to the war effort.

There was, however, a little misunderstanding as I am still on the staff of Messrs. Glenfield and Kennedy Ltd., and my particular war work is carried on outside of business hours and is entirely voluntary.

We, in this county, greatly appreciate the great contribution Canada is making towards the winning of the war.

As so many airmen are being trained in the Dominion and as the Observer Corps to which I belong is a part of the Royal Air Force, it might be of some interest to you to know a little of our organization and work, especially as I am sure there are many of my fellow members in the Air Force.

The Observer Corps had been in existence since the 1914-18 war as a branch of the special constabulary, but on the outbreak of this war was taken over by the R.A.F.

Our badge depicts a watcher on the shore, watching for the Spanish Armada, his torch is lighted, ready to set fire to the warning beacon on the hill behind him. The Corps motto is "Forewarned is forearmed."

The posts are established throughout the British Isles and are so located that the area for which each group is responsible is overlapped by the adjoining posts, and as the whole country is covered some of our posts are in rather out-of-the-way places.

The post consists of a small stockade of timber, earthwork or sandbags and in this stockade is placed our spotting instrument mounted on its tripod.

There is also a small hut or shelter where the observers coming on to the 3 a.m. to 7 a.m. duty may sleep during the early part of the night. The two Observers on duty must, however, remain in the open stockade.

The instrument has a circular table which carries an ordnance map of the area, protected by a celluloid covering drawn to a scale of 1 in.-1 mile and divided into squares of two kilometre side.

At the Observer Corps post shown here are an engineer aged 54 and a farmer aged 60: they are being relieved by an artist aged 47 and a stockbroker aged 57.

The squares are numbered and at my post our area is bounded by a circle of 16 miles diameter. The instrument proper has a carriage, pivoted at the centre and free to rotate on rollers around the table. On the carriage is mounted a height bar, sighting arm and traversing slide for the pointer and so geared that when the estimated height of the visible plane is set on the height bar and the plane taken into the sights of the instrument, the pointer has come to rest over the numbered square, above which the plane is flying.

The progress of the plane is reported continuously while it is within sight or hearing of the post.

Each post is in direct telephonic communication with the "centre" where reports from all posts are received and where on a large map of the whole section of country, markers are placed by "plotters" who are thus able to follow the course of all planes, friendly or hostile. Each plotter at "centre" plots for a group of 3 to 6 adjacent posts and as our phones are interconnected, each post hears the plots from his neighbours as they are passed through to centre and so planes can be passed on from post to post, enabling checks and corrected heights to be obtained. From the centre our plots are passed direct to the fighter command.

When a plane is heard but cannot be seen a "sound plot" on a 10 mile circle is passed to centre. A typical single plot would be "Plane(s) seen (number and type), height 5,000 ft., square 9281, flying west."

There are numerous methods of checking heights by cross plots from adjacent posts, etc., and it will be realized that if a plane can be either seen or heard, its position is definitely known to fighter command which is in communication with our fighters in the air.

The R.A.F. are dependent on the Observer Corps for the location of all planes over the country by day and night.

At my post there are three "full time" observers who take all duties from 7 a.m. to 7 p.m. from Monday to Saturday, on watch, two at a time, each working eight hours per day and 48 hours per week. All night duties and Sunday work is undertaken by the voluntary members who work in pairs for four hours at a time and who put in 8 to 12 hours duty per week. The posts are thus manned continuously by two observers, and all planes, friendly or hostile, are plotted and passed through centre to fighter command. The work is interesting but exacting, as one must be able to recognize a plane as soon as it is seen and there are about 400 types.

There is much of the organization which I cannot write about, but the few details I have given may be of interest to you. Our work has been described in the press and by broadcast many times so that my rather rambling notes can hardly be looked upon as military secrets.

We take a longing for Canada, and feel a bit homesick at times, but perhaps when this turmoil is over we may again renew old friendships.

With kindest personal regards,

Yours very truly,

(*Signed*) R. M. Herbison, m.e.i.c.

MEETING OF COUNCIL

Minutes of a regional meeting of the Council of the Institute held at the Admiral Beatty Hotel, Saint John, N.B., on Saturday, May 17th, 1941, at 2.15 p.m.

Present: President C. J. Mackenzie in the chair; Past President J. B. Challies (Montreal); Vice-President K. M. Cameron (Ottawa); Councillors, S. W. Gray (Halifax), H. Massue (Montreal), H. F. Morrisey (Saint John), G. E. Smith (Moncton), J. A. Vance (Woodstock), and General Secretary L. Austin Wright. There were also present: Past Vice-President R. L. Dobbin (Peterborough), Past-Councillors A. Gray (Saint John), S. Hogg (Saint John), G. G. Murdoch (Saint John), G. Stead (Saint John), J. Stephens (Fredericton), F. P. Vaughan (Saint John); G. A. Gaherty, chairman of the Committee on Western Water Problems; F. O. Condon, chairman of the Moncton Branch; and the following members of the executive of the Saint John Branch, J. P. Mooney, F. A. Patriquen (chairman), D. R. Smith, A. O. Wolff and V. C. Chesnut.

In the absence of the chairman of the Finance Committee, the general secretary presented the report of the committee. In commenting on the financial statement up to the end of April he pointed out that the income of the Institute was slightly ahead of the same period last year, and that expenditures were running at approximately the same level. The Finance Committee reported financial affairs to be in a satisfactory condition.

The reports from branches relative to the fund for repairs to the headquarters show that all branches have agreed to undertake a collection of funds. Some branches have already made returns on the basis of a dollar per member, and others have reported that their collections are already in excess of that amount. The Montreal Branch reported by telegram to the president that their fund was already in excess of five thousand dollars.

The secretary also read a letter from the vice-chairman of the annual meeting committee of the Hamilton Branch in which it was announced that a further sum of twenty-two dollars had been voted by the branch executive towards the building fund. The branch has already sent in its check for the full amount on the basis of a dollar per member.

The president commented on the fine arrangements which had been made for the annual meeting in Hamilton, and stated that many features were presented which should be considered by every branch holding an annual meeting. It was his opinion that the Hamilton meeting had been exceptionally well run.

The secretary read a letter from the Engineers' Council for Professional Development pointing out that Dr. Challies' term as a member of the executive of that organization representing the Engineering Institute of Canada expires this fall, and asked Council to name a representative for the next three years. In view of Dr. Challies' close association with this activity, he was requested by Council to accept the office for a further period of three years. This Dr. Challies agreed to do. At the president's request, he then outlined some of the work which was being done by E.C.P.D., and emphasized the values which membership in this body would bring to the members of the Institute.

The question of admitting enemy aliens into membership of the Institute was given a great deal of consideration. Many councillors took part in the discussion, and the fact was disclosed that the Federal Government has refused naturalization papers to such persons as long as their country was at war with Canada. It was the opinion of Council that the Institute could not very well admit such persons to membership in view of the Government's policy. It was also pointed out that the qualifications and the loyalty of most of the persons who were applying were beyond dispute, but in view of the fact that Institute membership might be of assistance to enemy agents, and might well be sought for such purposes, it was decided as a protective measure that applications from such persons should be refused for the duration. The secretary was instructed to explain the circumstances to applicants, and to ask them if they would hold their applications until after the war.

Mr. Cameron commented on the pleasure it had given him to attend the monthly, and, in some cases, the annual meeting of the maritime branches. He thought that if notice of annual meetings of branches were distributed more widely, members from other branches would be glad to attend. He commented on the cordiality and hospitality which he had experienced at each branch, and the pleasure which it gave him to support the president on his maritime tour.

Dr. Challies reported that, as chairman of the Institute's committee on professional interest, and in company with Messrs. Gaherty, Vance, and Wright, he had met with the council of the Association of Professional Engineers of the Province of New Brunswick on Saturday morning, and the details of the proposed agreement were discussed. The council of the Association met again after lunch, and he had just been informed that further progress had been made and that all matters had been ironed out sufficiently that he was confident that a final agreement would shortly be reached between the two bodies. He hoped that the time was not far distant when the president could again return to Saint John in order to participate in the ceremony of signing an agreement. He also expressed the hope that on such an occasion the president would again be supported by a substantial delegation from the provinces west of New Brunswick.

The president expressed his pleasure at this announcement, and said that he would be very happy to come back to Saint John for the ceremony. He also commented on the support which he had received as prseident from the past-presidents. He thought that the Institute was unique in that past-presidents did not lose interest as soon as their term of office was over, but continued to be interested in Institute affairs, and to support the president and council throughout their lifetime. Such support was extremely valuable to the sitting president, and was very much appreciated.

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

Admissions

Members	9
Juniors	1
Students	3
Affiliates	3

Transfers

Junior to Member	1
Student to Member	1
Student to Junior	5

In conclusion, Mr. Cameron expressed the thanks of the president's party for the splendid hospitality which had been extended by the members of the Saint John branch. He also congratulated them on the appointment of their new chairman, Mr. Frank Patriquen. In reply, Mr. Patriquen stated that the whole branch was very pleased to have had a regional meeting of council and that they would be even more pleased if the ceremony could be repeated again in the future.

The meeting adjourned at 4.15 p.m.

ELECTIONS AND TRANSFERS

At the meeting of Council held on May 17th, 1941, the following elections and transfers were effected:

Members

Courchesne, Charles Edouard, Land Surveyor (Laval Univ.), asst. district engr., Provincial Highway Dept., Quebec.

Johnston, Bruce Henry, B.A.Sc (Univ. of Toronto), Montreal district mgr., Moloney Electric Co. of Canada, Ltd., Montreal.

Michaud, Joseph Sylvio Andre, B.Sc.A., (Ecole Polytechnique), asst. engr., heating divn., Directorate of Works & Bldgs., R.C.A.F., Ottawa.

Phillips, Sidney, (Faraday House) of Niagara Falls, Ont.

Pritchard, William Robert, B.A.Sc. (Univ. of Toronto), repair supervisor, Bell Telephone Co. of Canada, Montreal.

Rankin, Robert Arthur, M.Sc., M.Eng., (McGill Univ.), partner, Robt. Rankin & Co., Montreal.

Robinson, Clesson Thomas Miller, B.Sc. (Queen's Univ.), engineer, Paper Mill, Corner Brook, Nfld.

Smith, Walter H., (Toronto Tech. Sch.), chief engr., T. Eaton Co. Ltd., Toronto.

Wales, Charles Clarke, B.A.Sc. (Univ. of Toronto), vice-president and general manager, Hamilton Bridge Co. Ltd., Hamilton, Ont.

Affiliates

Hayhurst, William James, (Queen's Univ.), Armour Plate Dept., Dominion Foundries, Ancaster P.O., Ontario.

Peace, John Thomas, (Central Technical Sch., Toronto), R.S.M., 1st Battalion, R.C.E. Overseas.

Juniors

Martin, Arthur Ley, B.Sc., (Univ. of Manitoba), draughtsman, Aluminum Company of Canada, Montreal.

Narsted, George Kendall, B.Eng. (McGill Univ.), machine tool dsgr., Eaton Wilcox Rich Co., Windsor, Ont.

Transferred from the class of Junior to that of Member

Graham, George, B.Sc., (Univ. of Sask.), consulting engr. to and fire protection engr. for Can. Under. Assoc., and insurance companies.

Transferred from the class of Student to that of Member

Brossard, Leo, B.Sc.A., (Ecole Polytechnique) and M.Sc. (McGill), lecturer, Bureau of Mines, Quebec.

Transferred from the class of Student to that of Junior

Dussault, Jean Edouard, B.Sc.E. (Ecole Polytechnique), res. engr., Dept. of Transport, Pointe aux Trembles, Que.

Leroux, Jacques, B.Sc.E., (Ecole Polytechnique), res. engr., i/c constrn. Mont Joli Aerodrome, Mont Joli, Quebec.

Lochhead, John Starley, B.Eng. (McGill Univ.), shop foreman of small welding and detail department, Dominion Bridge Co. Ltd., Montreal.

Martin, Clifford Davison, B.Eng. (Nova Scotia Tech. Coll.), sales engr., Northern Electric Co. Ltd., Halifax, N.S.

Perry, George Thomas, B.A.Sc. (Univ. of Toronto), asst. to Director, Divn. of Mechanical engrg., National Research Council, Ottawa.

Students Admitted

Bruce, Gordon Wyndham, (Univ. of N.B.), R.C.M.P. Barracks, Fredericton, N.B.

Hayman, William Morris, (McGill Univ.), 3843 Royal Avenue, Montreal, Sub-Lieut., R.C.N.V.R.

Lutes, Eric MacPherson, (Univ. of N.B.), Lady Beaverbrook Residence, Fredericton, N.B.

Personals

News of the Personal Activities of members of the Institute, and visitors to Headquarters

A. O. Dufresne, M.E.I.C., has been appointed Deputy Minister of the Department of Mines of the Province of Quebec. Since 1929 he had been Director of the Quebec Bureau of Mines. Mr. Dufresne was graduated in 1911 from the Ecole Polytechnique as a mining engineer, and after post graduate work at McGill University he obtained his degree of Master of Science in 1913. From 1914 to 1929 he was engaged in private practice as a mining engineer and prepared several reports on mining properties.

J. A. Vance, M.E.I.C., councillor of the Institute for the London Branch has been appointed chairman of the Victory Loan Committee for Oxford County in Ontario.

M. E. Hornback, M.E.I.C., has been appointed assistant chief engineer of the Aluminum Company of Canada, Limited, Montreal. Born at Chillicothe, Mo., U.S.A., he was educated at the University of Missouri where he was graduated in 1912. For fifteen months after graduation he was employed as a draughtsman and designer on reinforced concrete railway structures with Chicago, Milwaukee and St. Paul Railway, Chicago, Ill., until February 1914, when he went with the Condron Company of Chicago as a structural engineer on the design of industrial buildings. In 1915, he joined the staff of John S. Metcalf Company, Chicago, as a designer of grain elevator structures. In 1917, Mr. Hornback came to Montreal with the firm of Metcalf and for the following twenty years, until 1937, he was connected with the design and construction of most of the grain elevators in this country. For a few months in 1938 he was employed with Marine Industries Limited and later in the same year, he was field engineer with E. G. M. Cape & Company of Montreal on the construction of concrete wharf cribs. He joined the staff of Aluminum Company of Canada in 1939 as an engineer in the Montreal office.

F. L. Lawton, M.E.I.C., has been appointed assistant chief engineer of the Aluminum Company of Canada, Limited, He was graduated in electrical engineering from the University of Toronto in 1923 and after graduation spent two years with the General Electric Company at Schenectady, N.Y. In 1925 he became engaged, as assistant to the electrical engineer, with the Quebec Development Company and the Duke-Price Power Company. From 1927 to 1930 he was assistant to the superintendent of operation. In 1930 he became electrical engineer with Duke-Price Power Company Limited, now Saguenay Power Company Limited, and in 1938 he was promoted to chief engineer of the Saguenay Power Company Limited, at Arvida, Que.

G. B. Lomer, M.E.I.C., has accepted a position as assistant to the chief engineer with Canadian Car Munitions Limited at St. Paul L'Ermite, Que. He has had extensive experience in the design and maintenance of industrial plants.

R. E. Heartz, M.E.I.C., chairman of the Montreal Branch of the Institute, is at present on the staff of Wartime Merchant Shipping Limited at Montreal. Mr. Heartz is the assistant chief engineer of Shawinigan Engineering Company.

George H. Midgley, M.E.I.C., of Dominion Bridge Company Limited, has been loaned to Wartime Merchant Shipping Limited, Montreal, for several months in connection with their work, after which he will return to Dominion Bridge Company Limited to continue his former duties as sales engineer.

H. A. Wilson, M.E.I.C., has been appointed plant engineer with Canadian Car Munitions Limited at St. Paul L'Ermite, Que. Shortly after joining the firm last year, he had been made chief machine and tool designer. A graduate in mechanical and electrical engineering of the University of Toronto, he has had extensive industrial experience with the following firms: J. C. Wilson Manufacturing Company, Glenora, Ont., Nash Engineering Company of South Newark, Conn., Canadian Fairbanks Morse Company Limited, Montreal, and lately with Stephens Adamson Manufacturing Company of Canada Limited at Belleville, Ont.

F. A. Patriquen, M.E.I.C., is the newly elected chairman of the Saint John Branch of the Institute. He was graduated in electrical engineering from the University of New Brunswick in 1930 and obtained his degree in civil engineering the following year. From 1931 to 1937, he was employed with the National Harbours Board at Saint John, N.B., as a junior engineer. Since 1938, he has been with the Department of Public Works of Canada, at Saint John, first as a draughtsman and now as a junior engineer.

I. F. McRae, M.E.I.C., has been appointed manager of the Peterborough works of the Canadian General Electric Company. Having received his education at Vancouver, B.C., Mr. McRae has been with the company continuously since 1925 when he was an apprentice in the test department. He spent a short time at the Davenport works of the company. After a period of two years in the test department at Peterborough, he was transferred to the engineering department. In 1937 he was appointed assistant to the works manager.

P. W. Greene, M.E.I.C., is now employed on the staff of Dry Dock Engineers, New York City, in the capacity of designing engineer.

H. I. Mulligan, M.E.I.C., is now employed with the New Brunswick Electric Power Commission at Newcastle Creek, N.B. Since his graduation in civil engineering from McGill University in 1926 he has been engaged on several construction projects both as designer and field engineer.

Alexander Scott, M.E.I.C., is now division engineer with the Canadian National Railways at Halifax, N.S. Previously he occupied the same position at Charlottetown, P.E.I.

Lieutenant R. C. Farrow, M.E.I.C., is now serving overseas with the 1st Canadian Survey Regiment. Previous to his enlistment he was district engineer with the Water Rights Branch of the Province of British Columbia.

C. G. J. Luck, M.E.I.C., has been appointed assistant engineer with the National Harbours Board at Churchill, Man.

H. B. R. Craig, M.E.I.C., has joined the staff of the Hydro-Electric Power Commission of Ontario.

H. L. Schermerhorn, M.E.I.C., county engineer and road superintendent, Lennox and Addington Counties, Ont., has received a commission as lieutenant in the Royal Canadian Engineers.

T. Linsey Crossley, M.E.I.C., of Defence Industries Limited, was recently honoured by the Technical Section of the Canadian Pulp and Paper Association by being elected an Honorary Life Member for services in the educational development of the industry.

G. W. Painter, Jr.E.I.C., of the Canadian General Electric Company, Toronto, has received a commission with the First Armored Division Workshop, R.C.O.C.

Major J. G. Spotton, M.E.I.C., has recently been promoted to Major and appointed to command a battery in the 3rd Division. Previous to his enlistment, Major Spotton was

F. A. Patriquen, M.E.I.C.

M. E. Hornback, M.E.I.C.

F. L. Lawton, M.E.I.C.

located in Toronto where he carried on a business of manufacturers' representative in the field of electrical and mechanical engineering equipment.

M. C. Archibald, Jr.E.I.C., has joined the staff of the Montreal Engineering Company Limited at Montreal. After his graduation in electrical engineering from Nova Scotia Technical College in 1933 he was engaged for two years in the newspaper business. From July, 1935, to January, 1936, he was employed by the Maritime Electric Company at Charlottetown, P.E.I. In 1936 he joined the staff of the Public Utilities Commission at Woodstock, Ont., a position which he retained until his recent appointment.

Warren Raynor, Jr.E.I.C., is now located at Amherst, N.S., with the Canadian Car & Foundry Co. Ltd., as a tool designer. He has been with the company since 1940, first at Fort William and lately at Montreal. After his graduation in mechanical engineering from Queen's University in 1939 he served for a year as a demonstrator in the mechanical engineering department at Queen's.

W. G. McKay, S.E.I.C., is now employed with the Department of National Health at St. Catharines, Ont., as an assistant engineer. He was previously a demonstrator in the department of civil engineering at Queen's University where he was graduated in 1940.

H. I. Hamilton, S.E.I.C., is employed in the production department of R.C.A. Victor Company Ltd., at Montreal. He was graduated from Queen's University this spring in mechanical engineering.

Henri Audet, S.E.I.C., is the newly elected president of the students' association at the Ecole Polytechnique, Montreal.

J. G. Pierce, S.E.I.C., has accepted a position with Falconbridge Nickel Mines, at Falconbridge, Ont., upon his graduation from Queen's University last month.

J. R. Dunn, S.E.I.C., has joined the R.C.N.V.R. as a Sub-Lieutenant. Previous to his enlistment he was with Canadian General Electric Company at Toronto. Sub-Lieutenant Dunn was the winner of the John Galbraith Prize of the Institute in 1939.

VISITORS TO HEADQUARTERS

A. H. Gregory, S.E.I.C., from Winnipeg, on April 28th.

J. A. McCoubrey, M.E.I.C., Hadley & McHaffie, from Toronto, Ont., on April 28th.

J. T. Thwaites, M.E.I.C., engineer on switching equipment, Canadian Westinghouse Company Ltd., from Hamilton, Ont., on April 30th.

L. C. Turner, S.E.I.C., from Saskatoon, Sask., on May 10th.

J. D. Rice, Jr.E.I.C., International Petroleum Company Ltd., from Negritos, Peru, on May 12th.

Henrik Mugaas, M.E.I.C., Lamaque Gold Mines Ltd., from Val d'Or, Que., on May 13th.

J. A. Vance, M.E.I.C., general contractor, from Woodstock, Ont., on May 18th.

R. L. Dobbin, M.E.I.C., general manager, Peterborough Utilities Commission, from Peterborough, Ont., on May 18th.

I. M. McLaughlin, S.E.I.C., from Amherst, N.S., on May 19th.

K. M. Cameron, M.E.I.C., chief engineer, Department of Public Works, from Ottawa, Ont., on May 22nd.

O. W. Smith, M.E.I.C., Department of Public Works, from Victoria, B.C., on May 27th.

W. Burri, M.E.I.C., from Port Hope, Ont., on May 27th.

Obituary

Justus Mitchell Silliman, M.E.I.C., died at his home in Kingston, Ont., on April 26th, 1941, after a long illness. He was born in Easton, Pennsylvania, on September 8th, 1885, and was educated at Lafayette College, Easton, where he received the degree of civil engineer in 1907. Upon graduation he came to Canada and joined the Canadian Pacific Railway as an instrumentman. In 1911 he became resident engineer on construction of the South Ontario Pacific Railway. From 1913 to 1915 he was located in Montreal. Later he became district engineer of construction for the Canadian Pacific Railway, and was located at Brantford, Ont. In 1923 he returned to the Montreal office as an assistant engineer. In 1926 he was appointed division engineer at Sudbury, Ont., a position which he retained until his retirement in 1934. He had been living at Kingston, Ont., for the last seven years.

Mr. Silliman joined the Institute as a Student in 1907, and he was transferred to Associate Member in 1912.

News of the Branches

Activities of the Twenty-five Branches of the Institute and abstracts of papers presented

BORDER CITIES BRANCH

W. P. Augustine, m.e.i.c. *Secretary-Treasurer*
J. B. Dowler, m.e.i.c. - *Branch News Editor*

On April 25th, a meeting of the Border Cities Branch was held in the Prince Edward Hotel. This began with a dinner at 6.30 p.m. Following was a very interesting paper presented by Mr. Cyril R. Cooper, general manager of the Windsor Elementary Flying Training School on the subject of the **British Commonwealth Air Training Plan.** G. E. Medlar was chairman and Mr. Cooper was introduced by J. Clark Keith.

The speaker outlined the object of the plan and its vast size stating that it has been called "Canada's greatest single enterprise." In personnel it is equal to the Canadian Pacific Railway. The early problems of development were covered, the factors affecting selection of sites for schools, and their present extent and use.

The organization and control of the plan were explained along with the equipment used. Then in some detail the speaker followed the career of a man from the time he enlists.

An interesting discussion followed the delivery of the paper after which a vote of thanks to the speaker was moved by E. M. Krebser and the meeting adjourned.

EDMONTON BRANCH

B. W. Pitfield, jr.e.i.c. - *Secretary-Treasurer*
J. F. McDougall, m.e.i.c. *Branch News Editor*

The final dinner meeting of the 1940-41 session of the Edmonton Branch was held on April 22nd. Chairman E. Nelson presided.

After dinner the meeting was called to order and the annual elections took place. The following officers were elected: Chairman, R. M. Hardy; Vice-Chairman, D. A. Hansen; Secretary-Treasurer, F. R. Burfield; Executive, J. A. Carruthers, C. W. Carry, D. Hutchison, B. W. Pitfield, E. R. T. Skarin, W. F. Stevenson, Julian Garrett and E. Nelson, Ex-officio.

The chairman next introduced the speaker of the evening, Mr. D. Hutchison, manager of the Mackenzie River Transport, Hudson's Bay Company. Mr. Hutchison's topic **Compressed Air Its Application in Industry and Effect on Workmen.**

He stated that although compressed air has many applications in engineering he would confine his paper to the use of compressed air in underwater construction. Many foundations could not be constructed, especially in water-bearing strata, without the aid of compressed air. A unique job was done on the Michigan Northern Power Plant several years ago where inclined buttresses were built under twenty feet of water and driven sixty feet to rock. Mr. Hutchison described this work very fully and showed several slides. He had been employed in this job as a diver and had many interesting experiences to relate.

He stated that caisson disease had been until comparatively recently the stumbling block in underwater work. For the last century, work has been carried out with compressed air. At first, pressures were limited to one or two atmospheres, because at higher pressures workmen developed caisson disease which often resulted in death. Successful experiments on the cause and treatment of this disease were performed by Dr. Haldane and the British Admiralty. They proved that caisson disease is caused by the absorption of nitrogen in the blood at high pressures. It was established that saturation and desaturation took about the same time. Based on this, and the assumption that certain parts of the body became 100 per cent saturated in 40 minutes and other parts 50 per cent saturated in 75 minutes, a decompression chart was devised which was considered conservative. This table is now in use in the British Admiralty and in practically all world navies.

By constant development and study the limit of compression today is about 125 lb. per sq. in. in a flexible diving suit. Work was carried out at this pressure during the salvaging of the German Fleet at Scapa Flow. A United States diver at Honolulu descended 306 ft. while salvaging gold bullion from the Laurentic.

Sir Robert Davis' invention of the submersible decompression chamber has alleviated the decompression problem.

In conclusion, he stated, "If we engineers want to avoid legislation that tends to make the work prohibitive from an economic standpoint, our duty is to familiarize ourselves with requirements for safe practice and co-ordinate with contractors and owners."

After a long and interesting discussion period a hearty vote of thanks was tended the speaker. Mr. Hardy thanked the retiring chairman for his excellent work during the year. The meeting adjourned at 9.30 p.m.

HALIFAX BRANCH

S. W. Gray, m.e.i.c. - *Secretary-Treasurer*
G. V. Ross, m.e.i.c. - *Branch News Editor*

Journal readers are aware of the recent honour conferred on our president, Dean Mackenzie, at the convocation exercises of Dalhousie University. President Mackenzie was accompanied to Halifax by Vice-President K. M. Cameron, general secretary, L. Austin Wright, Councillor James Vance, Ross Dobbin, and G. A. Gaherty.

To welcome these guests, the Halifax Branch held a dinner meeting at the Halifax Hotel on May 12th at which 95 members and guests were present. Father Burns, professor of philosophy at Saint Mary's College, was the guest speaker.

Chairman S. L. Fultz introduces the president whose right hand indicates that he is clearing his throat. On his right are Father Leo Burns, Ken Cameron, W. P. Copp, J. B. Hayes.

Father Burns discussed the social reconstruction which took place following the last war and the more difficult problems which will follow the present one. He urged engineers to do their part and keep the ideals of democracy in view. The "isms" which have spread over so much of the world are the result of mistakes which threaten all democractic systems. People must be educated to make of democrary a state based on Christianity, not just a political creed. Canada's past war problems will be great and we must take care that in giving our leaders the right to rule, we do not transfer to the state our individual rights.

President Mackenzie spoke briefly on the contribution of engineers and research workers to the war work. He paid tribute to the unknown engineers and scientists who were at work in the services during peace time and said few people realize how much they had accomplished, but up to the present time scientific or technical men have had very little voice in the direction of the policies of our

The president speaks. The others are, from left to right, Chairman Fultz, Lorn Allan, president of the Association of Professional Engineers of Nova Scotia and Captain F. H. Jefferson.

Facing the camera is Sam Gray, Councillor and Secretary-Treasurer of the branch—and taking it seriously. Next, is a rear view of Geoff Gaherty with Ross Dobbin looking over his shoulder.

governments. He stated that this fact is being realized and corrected in Great Britain and believes the change is one of great importance.

An insight into the problems and progress of the Wartime Bureau of Technical Personnel was given by L. Austin Wright. He asked for an accurate and prompt response to the questionnaire which will soon be distributed to all Canadian engineers.

The final feature of the evening was the motion picture of the Tacoma bridge collapse. A large number of guests were present, chiefly from the services. S. L. Fultz was chairman.

At the graduation exercises of the Nova Scotia Technical College on May 22, the Institute prize was awarded to Harold T. Rose, of St. Johns, Newfoundland. Presentation was made by P. A. Lovett.

HAMILTON BRANCH

A. R. Hannaford, m.e.i.c. - *Secretary-Treasurer*
W. E. Brown, jr.e.i.c. - *Branch News Editor*

A joint meeting of the Branch was held with the Toronto Section of the American Institute of Electrical Engineers in the Westinghouse Auditorium on the evening of April 18th. The speaker, Mr. C. A. Powel, manager of the Engineering Department, Westinghouse Electric and Manufacturing Company, Pittsburgh, and a Member A.I.E.E., addressed the meeting on the subject, **Electricity in National Defence.**

Mr. Powel said that the immediate problem before the United States is to establish the means of producing weapons of war—more factories, munitions, machine tools, steel and electricity.

The major factories are making considerable direct war material for the Army and Navy but another great contribution, at the moment, is the supply of normal products to others who are expanding their facilities to provide the sinews of war.

To illustrate his address, the speaker showed slides of turbo-generators, hydro-electric generators and other apparatus important to power distribution in factories turning out defence products. One slide showed a 40,000 hp. motor recently completed by the Westinghouse to drive a fan to create a 400-mile per hour gale for certain war purposes.

Mr. Powel told of having seen, in Germany, in 1938, large transformers which had been built by the order of the Government in standardized form. He related how the three large electrical concerns of Germany had been made to pool their resources to complete this transformer. The transformer is mounted on railway trucks and is instantly available anywhere in the country.

W. A. T. Gilmour, chairman of the Hamilton Branch, opened the meeting and introduced Dr. J. H. Thomas, chairman of the Toronto Section of the American Institute of Electrical Engineers. Dr. Thomas introduced the speaker, who, previous to his present position, has seen service in France, Japan, England and the United States. He was born in 1884 in Rouen, France, of Welsh parentage and was educated in Switzerland.

After a very interesting general discussion, S. Shupe moved a vote of thanks to the speaker.

KINGSTON BRANCH

J. B. Baty, m.e.i.c. - *Secretary-Treasurer*

In order to give a larger number of science students the opportunity of hearing Mr. Otto Holden, Chief Hydraulic Engineer of the Hydro-Electric Power Commission of Ontario, and on account of the brief period of time which the speaker could spend in Kingston, a joint meeting with the Queen's University Engineering Society (student organization) was arranged, in place of the usual dinner meeting, for Thursday evening, March 13th.

Approximately sixty members of the two organizations gathered in the amphi-theatre of the Medical Building at Queen's University to enjoy Mr. Holden's lecture on **The Ogoki River and Long Lake Diversions.** Professor D. S. Ellis, member of Council, took charge of the meeting and introduced the speaker in the absence of the chairman, T. A. McGinnis.

Normally the waters of the Ogoki River, which lies to the north of Lake Nipigon, and that of Long Lake, some distance further east, flow north into James Bay. Studies made by the engineers of the Commission indicated that it would be quite feasible to divert water from both these bodies into channels which would carry it into Lake Superior and where it could be used in the power plants at the Sault, then at Niagara and later along the St. Lawrence if it were so desired.

Prospective shortage of power more or less compelled the Commission to proceed with the project which now is practically complete. The result is that an increased flow over that defined by the international treaties, already in force, is availbale for the Canadian plants on the international rivers. The United States magnanimously agreed that this power might be immediately available for use in these plants.

Mr. Holden described in detail the topographical features involved in the scheme, and then discussed some interesting structural and hydraulic details in relation to the dams and weirs required. He explained a very interesting economic study which was made in order to determine how far the diversion of water should go, so that the greatest good might be derived from it.

One point of particular interest was the care taken in all the designs so that if it should ever be deemed expedient to redivert the water again into its original channels to the north, it could be done at once.

Following the explanation of the project, Mr. Holden showed several reels of motion pictures, in technicolour, of the various points of interest. These portrayed magnificently the colour and movement in the forests, streams and lakes of that country during the early summer.

At the conclusion Murray Luscombe, president of the Engineering Society, expressed to Mr. Holden the deep appreciation of the audience for his very interesting talk, and also for the personal sacrifice which he made in coming to Kingston when his own work was so heavy.

LAKEHEAD BRANCH

H. M. Olsson, m.e.i.c. - *Secretary-Treasurer*
W. C. Byers, jr.e.i.c. - *Branch News Editor*

The regular monthly meeting of the Lakehead Branch was held in the City Council Chambers in the Whalen Building, Port Arthur, on March 20th at 8.15 p.m. The meeting was attended by twenty-five members and guests. The vice-chairman, B. A. Culpeper, presided at the meeting in the absence of H. G. O'Leary. G. R. Duncan introduced the speaker of the evening, Mr. R. B. Chandler, manager of the Port Arthur Public Utilities Commission, who spoke on **The Ogoki and Long Lac Diversions.**

The speaker reviewed the water power resources of Canada. Ontario and Quebec, the most thickly populated and highly industrialized provinces, contain about 60 percent of the water power resources. Canada's potential water power is 44,126,000 hp. of which, in 1940, only 19.4 per cent had been developed.

Ontario with potential waterpower totalling 9,200,000 hp. has 28.2 per cent installed turbine capacity, one-half of this installed capacity being operated by the Hydro-Electric Power Commission.

To keep up with increasing load conditions the Hydro engineers have investigated the feasibility of diverting water from inaccessible watersheds to others more favourable to development. Since July, 1939, 1,000 cu. ft. per sec. have been diverted from Long Lac at the headwaters of Kenogami River, a tributary of Albany River emptying into James Bay, and made to flow south into Lake Superior. Two concrete dams were required to control the tributary watershed. One dam is located at the height of land, 15 miles north of Long Lac, on the Kenogami River, being 68 ft. high and 296 ft. long and impounds an area of 62 sq. mi. The second dam is located five miles south of the upper end of Long Lac and is used to regulate the flow into a new channel to Lake Superior which also provides an economical transport for pulpwood. Long Lac being 425 ft. above Lake Superior provides a potential power of 20,000 ft. The cost was about $1,300,000.

The possibility of diverting the Upper Ogoki River into Lake Superior was first suggested to the Hydro by Mr. R. Keemle, a Canadian engineer. It was later found economically feasible to develop. The development includes the construction of a main dam at Waboose Rapids on the Ogoki River, to raise the water level sufficient to divert the river flow above this point across the height of land from Mojikit Lake and other adjoining lakes, through a series of small lakes into Seymour Creek flowing into Lake Nipigon. A control dam will be located near the entrance to South Summit Lake and several new channels provided between lakes to Seymour Creek. The estimated cost is $5,000,000. The main dam will be 50 ft. high with crest width of 1,700 ft. The drainage area of the Ogoki River above Waboose Rapids is about 6,000 sq. mi. with runoff about 4,000 cu. ft. per sec.

The water from the Ogoki River reaching the Great Lakes would mean an additional turbine capacity of 352,000 hp. made available.

The apparent economic benefits are: (1) Increase in power resources with an annual revenue of about $7,000,000; (2) More timber resources made available; (3) Benefit to shipping on Great Lakes of about $1,000,000 annually, by increase of water level of 2 to 2½ in.

In the Thunder Bay system the present safe operating capacity is 110,000 hp. and with the added flow from the Ogoki River, 120,000 hp. could be supplied without materially increasing the capital investments in the present generating plants and transmission lines.

Mr. Bird gave a vote of thanks to the speaker and a period of discussion followed.

LONDON BRANCH

H. G. Stead, jr.e.i.c. - *Secretary-Treasurer*
A. L. Furanna, s.e.i.c. - *Branch News Editor*

The regular monthly meeting of the Branch was held on Thursday, April 17th, 1941. This meeting was arranged by the Junior Engineers Committee of the Branch and presided over by its chairman, M. C. Archibald. Papers were presented by three of the Junior members, H. G. Stead, chief engineer for E. Leonard & Sons, H. F. Hertel of the Department of Public Works, and A. L. Furanna of the Public Utilities Commission.

Mr. Stead spoke on the **Progress and Development of Power.** He traced the growth of this industry from its infancy in the time of James Watt to its present prominence in the modern world of machines.

A very timely subject was chosen by Mr. Hertel, **Some Things That Might Help Win the War.** In his paper Mr. Hertel stressed the value of deception and camouflage. He also proposed some new methods of armour design which were intended to reduce the effectiveness of enemy fire.

Mr. Furanna's paper was on **London's Low Voltage Network System.** He gave a general description of the system with particular emphasis on those features which guarantee the network's excellent performance.

The discussion which followed each of the papers was evidence of the great interest taken by the senior members.

Mr. H. F. Bennett closed the meeting. He thanked the young men for their efforts and expressed the hope that in the future the Junior Engineers would take an active part in the Branch affairs.

MONCTON BRANCH

V. C. Blackett, m.e.i.c. - *Secretary-Treasurer*

On April 22nd the Tacoma bridge films were shown at a joint meeting of Moncton Branch and the Engineering Society of Mount Allison, held in the Science Building of the University at Sackville. About 150 were in atttendance, composed of branch members, engineering students and the technical staff of the Robb Engineering Company,

At head table we have the president, Chairman Condon, Councillor George Smith and Vice-President K. M. Cameron.

Amherst, N.S. C. J. Fear, president of the Engineering Society, was in the chair.

Before the films were screened, C. S. G. Rogers, bridge engineer, Atlantic Region, Canadian National Railways, reviewed the main features of suspension bridge design and methods used to overcome defects inherent in that type of structure. Ample provision had been made in the Tacoma

Left to right: R. L. Dobbin, H. J. Crudge, J. A. Vance, C. S. G. Rogers and E. Larracey. On Mr. Dobbin's right was Mr. E. L. Miles, who does not appear in the photograph.

design against sidesway, said Mr. Rogers, but the collapse of the bridge was caused by vertical undulations, and apparently no system of diagonal stay cables to prevent this had been included in the design. In the opinion of the speaker, two main cables per side, with different sags, would have gone a long way towards dampering the undulations and saving the bridge.

The showing of the films was followed by a lengthy discussion. A vote of thanks to Mr. Rogers was moved by Dean H. W. McKiel.

The Presidential Visit

On May 14th, the Moncton Branch was honoured by a visit from the president of the Engineering Institute of Canada, Dr. C. J. Mackenzie. Travelling with the president were Vice-President K. M. Cameron, General Secretary L. Austin Wright, Councillor James Vance and the Chairman of the Peterborough Branch, R. L. Dobbin. In the afternoon, the presidential party, accompanied by branch

From right to left: J. E. Gibault, V. C. Blackett, sec.-treasurer of the Moncton branch, G. L. Dixon, president of Association of Professional Engineers of New Brunswick, A. R. Bennet, E. R. Evans, T. H. Dickson, E. B. Martin.

officers and Councillor G. E. Smith, visited the Moncton Airport and Air Training School. They were then taken to what the president later described as our "crazy" magnetic hill. Visitor's comments were extremely guarded, as automobiles, with engines dead, coasted uphill (?) and water in the ditches ran in the same direction. Apparently it was not safe to motor in that vicinity without a level.

In the evening, a dinner meeting was held at the Riverdale Golf Club. F. O. Condon, chairman of the branch presided, and at the conclusion of the dinner, called upon C. S. G. Rogers to introduce the president. In his address, Dr. Mackenzie spoke of the advantages of membership in the Institute. He emphasized the personal contacts made possible and declared that therein lay the real value of Institute connection. Explaining the work of the National Research Council, of which he is the acting head, the president told of the important part played in working out problems in the designing of equipment for the armed forces of the nation in their fight against Axis aggression.

Left to right: N. B. Eagles, E. M. Nason, R. H. Emmerson, R. W. Laskey, E. B. Martin.

General Secretary Wright dealt with the work being carried out in connection with the organization of the Wartime Bureau of Technical Personnel, of which he is assistant director. The function of the Bureau will be to provide wartime industry with skilled engineers, who by their present employment have been trained to take an active and useful part in the wartime industry of the nation.

Heard in lighter and humourous vein, were K. M. Cameron, James Vance, R. L. Dobbin and T. H. Dickson.

Nominations were then called for branch officers for 1941-42. F. O. Condon was nominated to act as chairman for a second term. H. J. Crudge was named vice-chairman, and V. C. Blackett, Secretary-Treasurer. E. R. Evans and E. B. Martin were nominated to fill two vacancies on the Executive Committee.

MONTREAL BRANCH

L. A. Duchastel, m.e.i.c. *Secretary-Treasurer*

On February 20th, Mr. R. L. Martin spoke on the **Development of Transport Mechanization** and illustrated his talk by lantern slides. A courtesy dinner was offered the speaker who is now serving with the Inspection Board, Department of National Defence, in Ottawa.

Mr. E. W. Knapp described a system for locating faults in transmission lines in a talk entitled **Transmission Line Fault Location** given on February 27th. He explained the electrical theory and by means of slides illustrated the results obtained in practice.

The assistant to the president and director of public relations of General Motors of Canada, Mr. R. D. Kerby, spoke on **Automotive Industries War Effort** on March 6th and supplemented his talk with a film entitled "Motors on the March." The evening was preceded by a courtesy dinner.

On March 13th, **Destruction Forces, Damage and Repair** was the subject of a paper by Mr. John Dibblee, assistant chief engineer of the Hydro Electric Power Commission of Ontario. The paper dealt with the destructiveness of the forces of nature in relation to hydro-electric plants and transmission lines and the methods employed to repair the damage. A courtesy dinner was given in honour of the speaker.

Methods now in use by the Department of Highways of Ontario for utilizing steel sheet piling and steel bearing piles for bridge foundations, thereby dispensing with expensive coffer-damming and unwatering operations, were described on March 20th by Mr. A. Sedgwick in a paper entitled **Departures in Bridge Foundation Construction.** The talk was preceded by a courtesy dinner.

Utilization of the Power Resources of the Upper St. Maurice River was the subject of a talk delivered by Mr. E. V. Leipoldt on March 27th. The author reviewed the electrical development of power on the St. Maurice river and its bearing on the design of the more recently constructed plants.

On April 3rd, **War Time Communications** were discussed by Messrs. G. L. Long and J. L. Clarke of the Bell Telephone Company. A comparison was made between communication facilities used for war purposes in the past and their modern counterparts in use to-day.

Improving Operations in Industrial Plants was the subject of a talk given on April 17th by Mr. W. T. Johnson of the George S. May Company, Management and Industrial Engineers of New York. A courtesy dinner was held at the Windsor Hotel.

On April 24th, Mr. Roy A. Crysler, of the Canada Cement Company, Toronto, gave a paper entitled **Soil-Cement Paving** which was illustrated by a coloured movie of the soil-cement runway construction at Camp Borden, Ontario. A courtesy dinner was tendered the speaker before the meeting.

On April 17th a drive was started by the Montreal Branch to collect $4,000 amongst its members to defray part of the cost of repairs to the foundations of headquarters building. The response has so far been excellent and at the time of writing the objective is in view.

Junior Section

On March 17th, Mr. W. B. Morrison addressed the Junior Section on **Some Aspects and Problems of Television Broadcasting.** Last year, Mr. Morrison gave a number of demonstrations on Television Broadcasting, after spending six months at Camden, N.J., on experimental research.

Mr. A. Monti gave **A Simple Explanation of Ship Model Testing** on March 31st. His paper dealt with the principles, use and procedure of hull model testing and pertaining problems. A description was given of the work conducted by the author, at the Hydraulic Laboratories of l'Ecole Polytechnique, on a hull model of a torpedo boat.

NIAGARA PENINSULA BRANCH

G. E. Griffiths, m.e.i.c. - *Acting Secretary-Treasurer*
C. G. Cline, m.e.i.c. - *Branch News Editor*

The Ontario Chapter of the American Society for Metals and the Niagara Peninsula Branch of the Institute held a joint dinner meeting at the Leonard Hotel, St. Catharines, on May 16th, with an attendance of 180. Messrs. H. Thomasson, chairman of the Ontario Chapter, and A. L. McPhail, vice-chairman of the Niagara Peninsula Branch, acted as joint chairmen for the meeting. The speaker, Mr. O. W. Ellis of the Ontario Research Foundation, described certain researches on **Forgeability**, as applied to both ferrous and non-ferrous metals, using 27 lantern slides to show the results obtained. It is expected that his paper will be printed in an early issue of the *Journal*. The speaker was introduced by Mr. N. Metcalfe. Mr. J. W. Watson, chairman of the entertainment committee of the Ontario Chapter, provided also a movie talkie, "Tobacco Weather," supplied by Tuckett Tobacco Co., which showed the growing and processing of tobacco in Ontario. The attendance prize, donated by the Canadian Westinghouse Company, was won by Mr. A. L. McPhail.

PETERBOROUGH BRANCH

A. L. Malby, jr.e.i.c. - *Secretary-Treasurer*
E. Whiteley, s.e.i.c. - *Branch News Editor*

At their final technical meeting for the 1940-41 season, on April 24th, members of the Peterborough Branch heard an excellent paper by their secretary, Mr. A. L. Malby, on the subject, **Carrier Current for Peak Load Control.** A brief summary follows.

The flat-rate water heater has become very popular as a profitable form of off-peak power consumer. Quite early in its use, however, it was found that some control was needed to remove the heaters during peak periods. A pilot wire system is expensive for the number of heaters found on an average distribution system so the carrier current control was developed. In this, a high frequency impulse is transmitted over the distribution lines of such a low voltage that the ordinary loads on the system do not absorb appreciable power from the high frequency source, but tuned relays respond to the impulse and control the water heaters.

Experiments have shown the best carrier frequencies to be less than 1,000 cycles per second. Higher frequencies are desirable from the standpoint of the source of the frequency for then vacuum tube oscillators can be used. But at economical frequencies of this kind the response of distribution systems varies with the load on the system. Many installations now use 720 and 480 cycles with a small alternator as the source of power.

Several types of relay are used. All employ tuned circuits or tuned reeds as the frequency selective element. The latter have been popular in Europe. In Canada, however, the tuned circuit relay is now used a great deal. Mr. Malby then demonstrated the type of relay used by the Peterborough Public Utilities Commission, using impulses sent out from their central sub-station in a pre-arranged order.

There are several methods of superimposing the carrier on systems and these were explained with illustrated slides. Finally a few views of installations gave all a picture of the actual equipment used in this work. Mr. Malby has done a great deal in the development of this equipment for a number of Canadian cities, which probably accounts for the interesting story he told and the way he could tell it.

SAINT JOHN BRANCH

V. S. Chesnut, m.e.i.c. - *Secretary-Treasurer*

The Saint John Branch held its Annual Meeting and Dinner at the Admiral Beatty Hotel on Friday, May 16th. The attendance at the meeting was 10 and 43 attended the dinner.

The business meeting was held at 5 p.m. and the following officers were elected: Chairman, F. A. Patriquen; Vice-Chairman, D. R. Smith; Secretary-Treasurer, V. S. Chesnut; Executive, H. P. Lingley and W. B. Akerley.

An Engineers' Demolition Committee was appointed to act in conjunction with the Air Raids Precaution Committee of the City of Saint John.

At the dinner, the branch was honoured by the presence of the president of the Institute, Dr. C. J. Mackenzie. Other guests were K. M. Cameron, vice-president for Ontario, councillors J. A. Vance and Huet Massue, General-Secretary L. Austin Wright, R. L. Dobbin, chairman of the Peterborough Branch, G. A. Gaherty, a member of the Finance Committee, Capt. J. E. W. Oland, D.S.C., R.C.N., officer in charge of the Naval Control Service at Saint John and Brigadier G. G. Anglin, D.O.C. Military District No. 7.

Retiring Chairman J. P. Mooney poses with the newly elected chairman, F. A. Patriquen, and Sec.-Treasurer Victor Chesnut.

Dr. Mackenzie emphasized the necessity for unity in the engineering profession, and said that "the struggle against disunity is the greatest problem in the world today, and it is a struggle which the engineering profession must win in order to keep the mechanized materials of war moving across the Atlantic to embattled Britain." He referred to

Head table, left to right: Dr. C. J. Mackenzie, F. A. Patriquen, K. M. Cameron, A. A. Turnbull, Brigadier G. G. Anglin, J. A. Vance.

The army and navy were out in force. Left to right: Alex. Gray, Capt. J. E. W. Oland, Lt. Anderson, Brigadier G. G. Anglin, Capt. G. Y. Dow, Lt. G. A. Mackie, Lt. W. B. Akerley, Lt. D. Adams.

Left to right: Brigadier G. G. Anglin, K. M. Cameron, Alex Gray.

Doc Smith talks with L. F. Harding while F. P. Vaughan eavesdrops in the background.

Left to right: J. A. Vance, Oscar Wolff, Geoff Stead.

Commander Oland "tells all" to the amazement of Geoff Gaherty.

At Fredericton Junction, left to right: Prof. John Stevens, University of New Brunswick, G. A. Gaherty, J. A. Vance, J. B. Challies, C. J. Mackenzie, O. Wolff, on steps of car, R. L. Dobbin, T. C. MacNabb of C.P.R.

the men of the merchant marine as the greatest heroes of the war and said that "with the help of these gallant men of unconquerable spirit, together with unity in our profession and nation, we will win this engineer's war," and that the time it will take and the price to be paid is immaterial.

Mr. Wright spoke of the work of the Wartime Bureau of Technical Personnel, which was set up by the Dominion Government as a means of classifying the qualifications of the technically trained men of the country. It is hoped, by this means, that more effective use may be made of these men in the war effort.

The other guests were introduced by the chairman, and spoke informally.

On the following day, May 17th, a regional council meeting was held, to which the branch executive and senior members of the branch were invited.

ST. MAURICE VALLEY BRANCH

C. G. de Tonnancour, s.e.i.c. - *Secretary-Treasurer*

The St. Maurice Valley Branch of the Institute held a very successful meeting on April 29th at the Laurentide Club in Grand'Mere with an attendance of approximately ninety members and friends.

The guest speaker was Dr. P. T. Pratley, noted author on bridge design who gave a brief outlook on the design of suspended bridges, in a very witty and understandable way. He indicated to his audience what were, in his opinion, the weak points in the Tacoma Bridge which led to its ultimate destruction.

The queer and absolutely incredible behaviour of "Galloping Gurtie", which he had described, was shown to the audience by the means of two sensational motion picture films, which the Institute had recently acquired.

Dr. Pratley then proceeded with slides and some of his own films to illustrate the design and erection of a similar structure, the Lion's Gate at Vancouver, which he designed. These depicted very well the various problems which confront the engineers in this type of work and how they were solved successfully.

The speaker was introduced by E. B. Wardle and thanked by Professor H. O. Keay.

SAULT STE. MARIE BRANCH

O. H. Evans, Jr.E.I.C. - *Secretary-Treasurer*
N. C. Cowie, Jr.E.I.C. - *Branch News Editor*

The fourth general meeting for the year 1941 was held in the Grill Room of the Windsor Hotel on Tuesday, April 22nd, when twenty-three members and guests sat down to dinner. The business portion of the meeting began at 8.00 p.m. with E. M. MacQuarrie presiding.

The chairman called upon the speaker of the evening, Judge J. H. MacDonald, who had for his topic, **The St. Lawrence Deepening and Its Possibilities.**

In his opening words the judge said it was always a pleasure for him to meet with engineers as they had a different aspect on life than the legal profession. The law could not claim the exactitude of science but its rules were based on the lengthy experience of human nature.

He felt that with the completion of the St. Lawrence Waterway, the products of the interior could reach the markets of the world more readily and cheaper, also imports could be brought to the heart of the continent in a more convenient manner.

He then visualized new industries, particularly ship building on the 8,300 mile shore line of the Great Lakes which would bring increased prosperity to the people of Canada and United States. He felt that even if the St. Lawrence Seaway was not justified as an economic project, the total cost would be in the neighbourhood of $350,000,000, it was justified as a defense measure as it would enable us to build cruisers, destroyers and all but the largest vessels, thousands of miles inland where the building of them would be less likely interferred with by hostile aircraft.

In the discussion that followed J. L. Lang objected to the building of the Seaway at the present time. He felt that we could bend our endeavours to more timely matters. He felt that all our energies would be required to win the war.

The chairman thanked the speaker on behalf of the branch. On motion of K. G. Ross, the meeting adjourned.

WINNIPEG BRANCH

C. P. Haltalin, M.E.I.C. - *Secretary-Treasurer*
T. A. Lindsay, M.E.I.C. - *Branch News Editor*

The Winnipeg Branch met on Thursday, April 3rd, 1941, in the Theatre of the University of Manitoba, to see two very interesting and unusual coloured movies, contributed through the courtesy of the Department of Mines and Natural Resources, Province of Manitoba.

The first movie, **Base Line Survey,** was prefaced with remarks by Mr. H. E. Beresford, director of Surveys. The film showed operations of the survey party, while running the base line from the principal meridian to a point some 140 miles west.

This survey was made in January, 1940, and the picture gave some idea of the problems involved in maintaining a mobile camp unit hundreds of miles from civilization, in the dead of winter. A Provincial Government Forestry Service plane attended the party, and was used to transport supplies and equipment. A two-way radio set provided communication with the outside world.

In the discussion which followed the showing of the film, Professor G. H. Herriot questioned Mr. Beresford regarding the cost of the completed survey. Mr. Beresford stated that the base line survey in question was performed very economically at a cost of $65.00 per mile.

The Hon. J. S. McDiarmid, Minister of Mines & Natural Resources, gave a running commentary on the second film, **The Summerberry Fur Rehabilitation Project.**

Mr. McDiarmid explained that the Summerberry marshes include a large tract of land lying to the east of the Pas. Many years ago this region was a productive fur bearing territory, but due to the receding water table and continued drought, the shallow lakes and creeks had dried up, and left the marshes devoid of practically all vegetable and animal life. Trappers, who found their only means of subsistence reduced to the vanishing point, were forced to go on relief. In order to alleviate this situation, the Natural Resources Branch made quite an intensive study of the marshes and decided to undertake their restoration. It was found that by diverting the flood waters of the Saskatchewan river into the Summerberry river, the marshes could be flooded, and sufficient water could be retained throughout the summer to make a natural habitat for the muskrat.

A construction programme was launched, control dams were constructed, and canals cut at predetermined locations. During the past few years 140,000 acres of dried-out marsh land has been re-flooded, and as a result there has been an extraordinary increase in the wild life of the area. The abundance of vegetation has provided an ideal home for the muskrat, and the fact that the area has been closed to trappers up until 1940 has given the rats an opportunity to multiply.

The movie showed interesting pictures of the marshes before and after the project was started, illustrated how the area is patrolled and administered, displayed typical trapping operations, and also pictured some of the finer details of skinning and stretching the pelts. In 1940 the first fur harvest was taken from the Summerberry area, and yielded 120,000 pelts, which were sold at public auction for approximately $170,000. In harvesting this muskrat crop, 275 trappers were employed, and these men received the proceeds of the fur sale less the cost of administration and a portion which is set aside to repay the original capital investment.

Mr. McDiarmid claimed that the scheme had been very successful, especially from the point of view of providing a livelihood for the trappers in that district.

Mr. E. V. Caton moved a hearty vote of thanks to Mr. McDiarmid and the staff of the Natural Resources Branch, and the meeting then adjourned for refreshments.

Library Notes

Book notes, Additions to the Library of the Engineering Institute, Reviews of New Books and Publications

ADDITIONS TO THE LIBRARY

TECHNICAL BOOKS

Concrete Products and Cast Stone:

By H. L. Childe, London, Concrete Publications Limited, 1940. 263 pp., 6½ by 9¾ in.

Cracking Art in 1939:

Published by Universal Oil Products Company, Chicago. 617 pp.

Electromagnetic Devices:

By Herbert C. Roters, New York, John Wiley & Sons, Inc., 1941. 561 pp. 6 by 9¼ in., $6.00.

Engineers' Manual of Statistical Methods:

By Leslie E. Simon, New York, John Wiley & Sons, Inc., 1941. 231 pp. 6½ by 9¾ in., $2.75.

Hydraulic Measurements:

By Herbert Addison, New York, John Wiley & Sons, Inc., 1941. 301 pp. 5½ by 8¾ in., $5.00.

Non-Ferrous Production Metallurgy:

By John L. Bray, New York, John Wiley & Sons, Inc., 1941. 430 pp. 6 by 9¼ in., $4.00.

Public Works Engineers' Yearbook, 1941:

Published by American Public Works Association, Chicago, 404 pp. 5½ by 8¾ in.

REPORTS

Bell Telephone System:

Insulating paper in the telephone industry; note on theoretical and observed distributions of repetitive occurrences; diffusion of sulphur in rubber; location of hysteresis phenomena in Rochelle salt crystals; description of the C-5 carrier telephone system; dielectric properties of organic compounds; new broadcast-transmitter circuit design for frequency modulation; neutron studies of order in Fe-Ni Alloys; decade of progress in use of electronic tubes—part 1, communication. Monographs B-1260-B-1268.

Canada Department of Mines and Resources—Mines and Geology Branch:

Investigations in ore dressing and metallurgy, July to December, 1939. Ottawa, 1941.

Canada Department of Mines and Resources—Mines and Geology Branch —Geological Survey—Memoirs:

Palaeozoic geology of the Toronto-Hamilton area, Ontario; Pictou coalfield, Nova Scotia; Jacquet river and Tetagouche river map-areas, New Brunswick; Nelson map-area, east half, British Columbia. Memoirs 224, 225, 227, 228.

Canadian Engineering Standards Association:

Canadian electrical code, part 11—essential requirements and minimum standards covering electrical equipment. Specification No. 1 construction and test and power-operated radio devices. Section B—conductively coupled (transformerless) type. Ottawa, 1941, C22.2 No. 1 (B)-1941. Canadian electrical code, part 2, essential requirements and minimum standards covering electrical equipment, construction and test of armoured cables and armoured cords, No. 51. Canadian electrical code part 2, essential requirements and minimum standards covering electrical equipment, construction and test of service-entrance cables, No. 52.

Illinois State Water Survey—Bulletin:

Water resources in Peoria-Pekin district. Bulletin No. 33, Urbana, Illinois, 1940.

United States Department of the Interior—Bureau of Mines—Bulletin.

Reconnaissance of gold mining districts in the Black Hills, S. Dak.; fire-retardant treatments of liquid-oxygen explosives; quarry accidents in the United States during the calendar year 1938. Bulletin 432, 429, 427.

United States Department of the Interior —Geological Survey Bulletin.

Spirit leveling in Texas, part 2, Panhandle 1896-1939; sub-surface geology and oil and gas resources of Osage County, Oklahoma; structural control of ore deposition in the Uncompahgre district Ouray County, Colo.; quicksilver deposits of the Mayacmas and sulphur bank districts California; chromite deposits of the eastern part of the still-water complex, Stillwater County, Montana; tungsten deposits in the tungsten hills, Inyo County, California; tungsten deposits of the Benton Range, Mono County, California. Bulletins, 883-B; 900-F; 906-E; 922-L; 922-N; 922-Q; 922-S; 925-A.

United States Department of the Interior —Geological Survey Water-Supply: Paper:

Summary of records of surface waters of Washington, 1919-35; surface water supply of the United States 1939, part II, Pacific slope basins in California; surface water supply of the United States, 1939, part 14, Pacific slope basins in Oregon and lower Columbia River basin; water levels and artesian pressure in observation wells in the United States in 1939. Papers, 870, 881, 883, 886.

United States Department of the Interior —Bureau of Mines—Technical Papers:

Coke-oven accidents in the United States; increasing the concentration of sulphur dioxide in the effluent gases from dwight-Lloyd sintering machines treating lead products; thermodynamic properties of gypsum and its dehydration products; production of explosives in the United States; splint coals of the Appalachian region; their occurrence, petrography, and comparison of chemical and physical properties with associated bright coals; carbonizing properties and petrographic composition of lower banner-bed coal from Keen mountain mine, Buchanan county, Va., and the effect of blending this coal with Pittsburgh-bed (warden mine) coal; characteristics of fuel pitches and their explosibility in pulverized form; hydrogenation and liquefaction of coal. Papers, 623, 624, 625, 627, 615, 616, 617, 622.

United States Work Projects Administration—Bibliography of Aeronautics:

Supplement to part 17—diesel aircraft engines, 1940; supplement to part 29—lubricants, 1941.

PROCEEDINGS AND TRANSACTIONS, ETC.

Canadian Institute of Mining and Metallurgy.

Directory section, list of members, 1941.

American Institute of Mining and Metallurgical Engineers, Inc.

Transactions of the Canadian Institute of Mining and Metallurgy and of the Mining Society of Nova Scotia, 1940.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet the books are not in the Institute Library, but inquiries will be welcomed at headquarters, or may be sent direct to the publishers.

Air Raid Precautions Handbook No. 11, CAMOUFLAGE OF LARGE INSTALLATIONS

His Majesty's Stationery Office, London. 15 pp., illus., 6½ x 4 in., paper, (obtainable from British Library of Information, 50 Rockefeller Plaza, New York, $.10).

This pamphlet describes in general terms the measures which may be taken by way of camouflage to render factories and other buildings less distinguishable from the air. Illustrations and color plates are included.

AIRPLANE METAL WORK. Vol. 3:—Airplane Sheet Metal Pattern Development and Template Making.

By A. M. Robson. D. Van Nostrand Co., New York, 1941. 102 pp., illus., diagrs., tables, 9½ x 7 in., paper, $1.25.

Intended both for mechanics actively engaged in the aircraft industry and for prospective mechanics in training, this book is designed to provide a correlation of the fundamentals of general sheet-metal pattern development to the aircraft industry. Resulting from the author's practical experience, it covers basic operations, calculations, actual pattern development and comprehensive lists of tools and shop equipment.

(The) ANODIC OXIDATION OF ALUMINIUM AND ITS ALLOYS

By A. Jenny, translated by W. Lewis. Chemical Publishing Co., New York, 1940. 231 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $6.50.

This monograph deals with the electrolytic and chemical production of protective films on aluminum and its alloys, and with their uses in practice. An introductory study of the relevant electrochemical theory is presented. The original text, as translated from the German, has been supplemented with additional information.

CHEMICAL WARFARE

By C. Wachtel. Chemical Publishing Co., Brooklyn, N.Y., 1941. 312 pp., diagrs., tables, 9 x 5½ in., cloth, $4.00.

This currently important topic is covered in all of its ramifications. The history of the subject, including the men responsible for its development, is briefly presented; the various classifications of gases by composition and physiological effects are given in detail; and statistics and other pertinent material are included. Both the practical military application of the gases and protection against them are considered.

COMPOSITION OF FURNACE ATMOSPHERES RESULTING FROM PARTIAL COMBUSTION OF GASEOUS FUELS

(American Gas Association Testing Laboratories, Bulletin No. 11).

Cleveland, Ohio, 1940. 91 pp., illus., diagrs., charts., tables, 10 x 7 in., paper, $1.25.

Four progress reports and some new data

are summarized in this bulletin which deals specifically with studies of the composition of flue gases resulting from combustion of different types of fuel gases with a deficiency of air. The test equipment and procedure are described, results are discussed, and a practical interpretation of the data is presented.

DESIGN FOR INDUSTRIAL CO-ORDINATION

By R. W. Porter. Harper & Brothers, New York and London, 1941. 249 pp., diagrs., charts, 9½ x 6 in., cloth, $3.00.

This book, the work of a management consultant of long experience, shows how and why the structure of business organization and the elements of co-ordination which make it function efficiently form a technical design within which management must operate for best results. The problems of industrial management are classified, and twenty-one elements of performance are given upon which the author bases the effectiveness of the general pattern. A late chapter indicates ways to measure results.

DESIGN OF MACHINE ELEMENTS

By V. M. Faires. rev. ed. Macmillan Co., New York, 1941. 490 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $4.00.

PROBLEMS ON THE DESIGN OF MACHINE ELEMENTS

By V. M. Faires and R. M. Wingren. Macmillan Co., New York, 1941. 147 pp., illus., diagrs., charts. tables, 8½ x 6 in., paper, $1.40.

The beginning chapters of this textbook cover briefly the general topics of materials and their properties, stress analysis, tolerances and fatigue. Although the conventional method of grouping the subsequent design material is generally followed, the simpler machine elements have been considered first to allow the subject to be studied concurrently with strength of materials. The new edition has been considerably revised in accordance with recent developments. A companion volume contains nearly 1,200 problems illustrating points made by the text.

DYKE'S AUTOMOBILE AND GASOLINE ENGINE ENCYCLOPEDIA

By A. L. Dyke. 19th ed. Goodheart-Willcox Co., Inc., Chicago, 1941. 1,483 pp., illus., diagrs., charts, tables, 10 x 7 in., cloth, $6.00.

A remarkably comprehensive collection of information on automobiles and internal-combustion engines is presented in this manual for the use of students, repairmen and owners. Topics covered include the principles, description and operation of all mechanical, propulsive and electrical parts of an automobile, maintenance, testing and repair, specifications and definitions. There is new material on aircraft engines and their accessories, automotive Diesels, fluid drive, automatic transmissions and other recent developments. A wealth of illustrations and ninety pages of general and supplementary index increase the utility of the book.

ELECTROMAGNETIC DEVICES

By H. C. Roters. John Wiley & Sons, New York, 1941. 561 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $6.00.

The fundamentals, characteristics and designs of electromagnets are presented for graduate students and practical engineers. The first eight chapters develop the background theory and methods applicable to all types of magnetic circuits and non-rotary electromagnetic devices. In the last six chapters these principles are applied to a variety of problems, first in general terms, then in detailed, numerical solutions. Special attention is paid to magnetic leakage and non-linear relationships.

ELEMENTARY AERODYNAMICS

By D. C. M. Hume. Pitman Publishing Corporation, New York and Chicago, 1941. 136 pp., diagrs., charts, tables, 8½ x 5½ in., cloth, $1.50.

This textbook for beginning students presents the fundamentals of air flow, forces on a wing, control methods, analyses of basic manoeuvres and performance characteristics. There is a set of test questions for review purposes.

FLUID MECHANICS

By G. N. Cox and F. J. Germano. D. Van Nostrand Co., New York, 1941. 274 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $3.00.

This practical textbook on the behavior of fluids is intended to prepare engineering students for problems encountered in the industrial field, and covers both liquids and gases. The text is divided roughly into five parts: hydrostatics, measurement, transportation and dynamics of fluids, and centrifugal pumps. The necessary basic theoretical treatment is included, and there are many problems from actual practice.

Great Britain, Dept. of Scientific and Industrial Research, BUILDING RESEARCH. WARTIME BUILDING BULLETIN No. 13. THE FIRE PROTECTION OF STRUCTURAL STEELWORK

His Majesty's Stationery Office, London, 1941. 13 pp., diagrs., tables, 11 x 8½ in., paper, (obtainable from British Library of Information, 50 Rockefeller Plaza, New York, $.30).

Amplifying certain points brought out in Bulletin No. 10, this pamphlet shows how to determine the degree of protection required for structural members, and discusses various methods available for treating both old and new structures.

HIGH-SPEED COMPRESSION-IGNITION ENGINE

By C. B. Dicksee. Blackie & Son, London and Glasgow; Interscience Publishers, New York, 1940. 331 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $4.50.

The principles governing the operation of high-speed compression-ignition engines are dealt with in detail, including discussions of associated problems. The early chapters present the fundamental chemical and thermodynamical theory. There is a particularly large chapter on fuel injection.

THE HIGH-SPEED INTERNAL-COMBUSTION ENGINE

By H. R. Ricardo, revised by H. S. Glyde. Interscience Publishers, New York; Blackie & Son, Ltd., London and Glasgow, 1941. 434 pp., illus., diagrs., charts, tables, 10 x 6½ in., cloth, $7.50.

This comprehensive, authoritative work upon the characteristics and design of high-speed internal-combustion engines has been revised again to conform with current practice. There has been some addition and deletion in the standard material on engine design and fuel behavior, while other parts, the chapter on high-speed Diesels in particular, have been completely rewritten.

HIGHWAY SAFETY AND AUTOMOBILE STYLING

By A. W. Stevens. Christopher Publishing House, Boston, Mass., 1941. 155 pp., diagrs., 8 x 5 in., cloth, $1.75.

The author describes the general conditions of highway travel, points out various factors of importance in causing accidents, and suggests remedies. The emphasis is on the redesign of automobiles to put the driver at the very front of the car, in order to increase visibility. The conclusions are the result of a six-year investigation of the problem.

HISTORY OF MAGIC AND EXPERIMENTAL SCIENCE, Vols. 5 and 6: The Sixteenth Century.

By L. Thorndike. Columbia University Press, New York, 1941. Vol. 5, 695 pp.; Vol. 6, 766 pp., 9 x 5½ in., cloth, $10.00 per set of 2 Vols.

With these two volumes, covering approximately the period from 1500 to 1630, Professor Thorndike completes his monumental study of magic and experimental science during the first sixteen centuries of the Christian era. In his integration of the two fields, in his exposition of the inter-relations of science and society and in the considerable amount of new material presented, the author has produced a valuable work for scholar and historian. A general index to the whole series, occupying some 150 pages, is included in the sixth and last volume.

INSTRUMENTS, Pt. 2 (Aeroplane Maintenance and Operation Series, Vol. 15).

Ed. by E. Molloy and E. W. Knott. Chemical Publishing Co., Brooklyn, N.Y., 1941. 132 pp., illus., diagrs., 9 x 5½ in., cloth, $2.00.

Continuing a series on airplane maintenance and operation, this volume describes the operation, installation and maintenance of the various instruments (indicators, compasses, etc.), manufactured by the Kelvin, Bottomley and Baird Company. There is a long chapter dealing with the Smith automatic Pilot, and a brief description of electrical temperature measuring instruments is given.

MATERIALS OF INDUSTRY

By S. F. Mersereau, with an introduction by A. L. Colston. rev. and enl., McGraw-Hill Book Co., New York and London, 1941. 578 pp., illus., diagrs., maps, tables, 8½ x 5½ in., cloth, $2.00.

This textbook is intended to give students in technical and vocational high schools some knowledge of the main facts of industry, including the distribution and production of raw materials, their general properties, transportation, conversion into commercial products and economic importance. The principal products of forestry, mining and chemical industry are described clearly and simply. Glossaries of terms and brief bibliographies are included.

MODERN PRACTICE IN LEATHER MANUFACTURE

By J. A. Wilson. Reinhold Publishing Corp., 1941. 744 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $9.50.

The object of this comprehensive treatise is to present what is considered the minimum that a tanner should know in order to conduct a modern business successfully. To this end the more important phases of leather manufacture, such as preparing, tanning and finishing procedures, and the structure and properties of leather, are given in detail. Other topics covered include sources of hides and other materials, government regulations, hide damages, purchasing, marketing and other economic factors. The complex chemical reactions in tanning are discussed in non-technical language. Full bibliographies, a glossary of terms and many microphotographs are included.

NON-FERROUS PRODUCTION METALLURGY

By J. L. Bray. John Wiley & Sons, New York, 1941. 430 pp., diagrs., charts, tables, 9 x 6 in., cloth, $4.00.

Intended as a basic college text, this book deals in alphabetical order with the non-ferrous metals. It gives brief information about their history, economics, properties, marketing, uses and ores, and the working essentials of production and refining practice. Space is also given to slags and fluxes, secondary metals and the marketing of bullion, ores and concentrates. Suggested references accompany each chapter.

Pennsylvania State College, Engineering Experiment Station Bulletin No. 54. OXYGEN-BOOSTING OF DIESEL ENGINES FOR TAKE OFF

By P. H. Schweitzer and E. R. Klinge. State College, Pa., 1941. 29 pp., illus., charts, diagrs., tables, 9 x 6 in., paper, $.50.

This pamphlet describes an investigation to determine the effect of feeding oxygen into the intake air of a diesel engine. Results are given, and special reference is made to the use of this procedure in the case of airplane diesels during take-off time when extra power is necessary for a few minutes.

PIT AND QUARRY HANDBOOK with which is consolidated the DIRECTORY of Cement, Gypsum, Lime, Sand, Gravel and Crushed-Stone Plants. 34 ed. 1941.

Complete Service Publishing Co., Chicago, Ill., 1941, 856 pp., illus., diagrs., charts, tables, 11 x 8 in., cloth, $10.00.

Nearly 600 pages of the current edition of this annual are devoted to technical information concerning processes, practices, machinery and materials in the non-metallic mineral industries. There is a directory of cement, gypsum, lime, sand, gravel and crushed-stone plants, arranged both alphabetically and geographically. Condensed machinery catalog, a list of trade associations and technical societies, statistical information, trade names and a buyers' guide are also included.

PREVENTION OF THE FAILURE OF METALS UNDER REPEATED STRESS, a Handbook prepared for the Bureau of Aeronautics, Navy Department.

By the Staff of Batelle Memorial Institute. John Wiley & Sons, New York, 1941. 273 pp. illus., diagrs., charts, tables, 9½ x 6 in., cloth, $2.75.

Believing that lack of knowledge or appreciation of engineering principles among designers and builders of aircraft is responsible for many fatigue failures, this summary has been prepared. It brings together in convenient form the available information concerning the engineering principles involved in the precautions through which fatigue failures may be prevented, as they appear in published literature and the files of the Bureau of Aeronautics and the National Bureau of Standards. There is a good bibliography.

PROCEDURE HANDBOOK FOR AIRCRAFT STRESS ANALYSIS

By W. L. Nye, D. Hamilton and J. P. Eames. Aviation Press, San Francisco, Calif., 1940. 334 pp., illus., diagrs., charts, tables, $4.00.

This textbook was compiled to present as simple a treatment as possible on the subjects of strength of materials and stress analysis as applied to the present-day airplane. It deals with the fundamentals of aircraft stress analysis and presents examples which are currently encountered in conventional airplane design work. Particular attention is given to the solution of beams by polar diagrams, the shell type of structure and the theory of joints.

PSYCHROMETRIC NOTES AND TABLES

By E. Torok. rev. ed. North American Rayon Corporation, 261 Fifth Ave., New York, 1941. 125 pp., charts, tables, 7 x 5 in., lea., $2.50.

This handbook for textile manufacturers, engineers and students presents the necessary information, accompanied by practical examples, for the solution of psychrometric problems. There is also a chapter containing tables of heat-transmission coefficients for building materials.

PUBLIC UTILITY ECONOMICS

By C. W. Thompson and W. R. Smith. McGraw-Hill Book Co., New York and London, 1941. 727 pp., illus., maps, charts, tables, 9½ x 6 in., cloth, $4.50.

Designed as a textbook for advanced students in economics and commerce, this book relates the field of public utilities to the broader area of economics of which it is a part. Thus the book seeks to acquaint the student with the place which public utilities occupy within our economic structure, and with the special problems of price control, service supervision, security regulation, etc.

REFRIGERATION FUNDAMENTALS

By G. Holman. Nickerson & Collins Co., Chicago, Ill., 1940. 175 pp., diagrs., charts, tables, 9½ x 6 in., cloth, $2.00.

Written by an operating engineer for other operating engineers, this outline of refrigeration theory and practice begins with simple discussions about such physical phenomena as temperature, heat, pressure and energy. Basic refrigeration processes are carefully described, and there are helpful practical suggestions on operating technique.

STRUCTURAL DRAFTING

By C. T. Bishop. John Wiley & Sons, New York, 1941. 287 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $3.50.

This book has been prepared especially to meet the requirements of engineering students and structural draftsmen. It corresponds in scope to the duties of the structural-steel draftsmen in the preparation of detailed working drawings for the members of steel structures. Drawings for concrete and timber structures are also discussed briefly, and billing practice is covered. There are many detailed illustrations, and a glossary of engineering terms is provided.

TECHNOLOGY AND SOCIETY, the Influence of Machines in the United States

By S. M. and L. Rosen, with an introductory chapter by W. F. Ogburn. Macmillan Co., New York, 1941. 474 pp., illus., charts, tables, maps 9 x 5½ in., cloth, $3.00.

The interrelations between technology and the social scheme as they affect present-day life are presented in a simple, balanced manner. In addition to the four main sections, dealing respectively with the technologic base and economic, social and political effects, there is a general introductory chapter and a final summing up. The book is intended particularly for undergraduate students, both in the social sciences and engineering. Suggestions for further reading are included.

TEMPERATURE MEASUREMENT

By R. L. Weber. Edwards Brothers, Inc., Ann Arbor, Michigan, 1941. 171 pp., illus., diagrs., charts, tables, 11 x 8½ in., paper, $2.50.

This book presents the substance of a course offered for juniors by the physics department of the Pennsylvania State College. Part I covers in a concise manner the theoretical basis for all the important methods of temperature measurement. Part II contains a comprehensive group of tested illustrative laboratory experiments. Literature references and review exercises are included.

(The) WORLD AND THE ATOM

By C. Moller and E. Rasmussen, with foreword by N. Bohr. D. Van Nostrand Co., New York, 1940. 199 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, $2.75.

The development of modern atomic physics from the end of the last century to 1938 is briefly described for the layman. The major part of the book has been kept as simple as possible, and general physical concepts have been included wherever necessary. The book has been translated and revised from the original Danish, and is the product of the joint work of an experimental physicist and a theoretical physicist.

BIBLIOGRAPHY ON INDUCTION HEAT TREATMENT

The Engineering Societies Library has prepared a list of selected references on the heat treatment of metals by induction heating. Forty papers of importance are listed, selected from domestic and foreign periodicals, dealing with the metallurgical problems involved, the design of heating coils and electrical circuits, and with typical actual installations.

Members of the Founder Societies may obtain copies by sending $1.00 to the Engineering Societies Library, 29 West 39th Street, New York. The price to others is $1.25.

PRELIMINARY NOTICE

of Applications for Admission and for Transfer

May 29th, 1941

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, 1941.

L. Austin Wright, General Secretary.

*The professional requirements are as follows:—

A **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 examinstions 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 attainment 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

GOROWSKI—CHARLES S., of 1457 Mansfield St., Montreal, Que. Born at Winnipeg, Man., Feb. 26th, 1913. Educ.: B.Sc. (Elec.) Univ. of Manitoba, 1934. May and June 1940, engr., levelling work for W. E. Seely, M.E.I.C.; July to Dec., 1940, engr. on C.N.R. Tunnel, Durite Co. of Quebec; Dec. 1940 to date, engr., Canadian Associated Aircraft Ltd., Montreal.

References: E. P. Fetherstonhaugh, N. M. Hall, G. H. Herriot, W. F. Riddell, W. E. Seely.

GRAVEL—MAURICE, of Beauport, Que. Born at Quebec City, Dec. 6th, 1911. Educ.: B.Sc.A., I.C., Ecole Polytechnique, 1938. 1937, surveying, Mont Laurier Road, Que. Govt.; 1938-41, res. engr. Prov. Road Dept., Quebec Govt.

References: A. Circe, R. A. Lemieux.

HANLON—JOHN EDWARD, of 1230 Fort St., Montreal. Born at Guelph, Ont., Sept. 15th, 1895. Educ.: B.A.Sc. (Honors) Univ. of Toronto, 1915. 1915-16 asst. engr., Hollinger Gold Mine; Mar. 1916 to July 1919, overseas, Canadian Engineers; May 1920 to Dec. 1922, ch. engr., Surf Inlet Gold Mining Co., Surf Inlet, B.C., i/c all engrg. and underground work; 1923-26, designer and dftsmn., Amer. Tel. & Tel. Co., New York; 1926-27, designer and dftsmn., N.Y. Edison Co.; 1927-28, designer and dftsmn. American Cyanamid Co.; Oct. 1928 to Apr. 1931, designer and dftsmn., Public Works Engrg. Corp. Ltd., New York; 1932-36, partner of M. Corey, Vancouver, B.C., developing mining claims, also some work with C.P.R., constrn. engrg.; 1936-38, Mgr., The Blockhouse Dome Mine, Blockhouse, N.S.; 1938-39, mgr. Algold Mine, now closed; Feb. 1940 to Oct. 1940, dftsmn. and design, C.N.R., Montreal; 1940 to date, strct'l. dftsmn., Aluminum Co. of Canada, Montreal.

References: H. H. James, S. R. Banks, D. G. Elliot, V. Andersen, M. E. Hornbsch.

HEBERT—ADJUTOR J. G., of Plessisville, Que. Born at Quebec City, Oct. 21st, 1897. Educ.: Que. Tech. Sch. (special course mech. engrg.) 1912-15; I.C.S. (mech. engrg.) 1916 to date. Member Amer. Soc. of Mech. Engrs. 1940. 1915-17, machine dsgr., road machinery and ammunitions, General Car & Machinery Works, Montmagny, Que.; 1917-1918 machine dsgr. for ammunitions, P. Lyall & Sons, Montreal; 1918, mach. dsgr., ammunitions, Lymburner Ltd., Montreal; 1919, dsgr. and checker on mech. equipment, Northern Elec. Co., Montreal; 1919-21, dsgr., Riordon Co., Temiskaming; 1922-23, i/c Engrg. Dept., Quebec Govt. Road Dept., Quebec; 1923-27, asst. mill engr., Bonaventure Pulp & Paper Co., Chandler, Que.; 1927-28, dsgr., International Fibre Co., Gatineau, Que.; 1928-29, mech. dsgr., and estimator, Ottawa Car & Mfg. Co., Ottawa; 1929-36 asst. mill engr., Bonaventure Pulp & Paper, Chandler, Que.; 1936-37, dsgr., Ontario Psper Co., Thorold, Ont.; 1937-38, asst. to plant engr., Gaspesia Sulphite Co., Chandler, Que.; 1938 to dste, designing engr. Plessisville Foundry at Plessisville, Que.

References: J. A. Beauchemin, G. L. Freeman, L. S. Dixon, W. S. Kidd, A. Cunningham, R. H. Farnsworth, J. Simmers, C. J. Pimenoff, J. H. Summerskill.

MATTHEWS—CLIFFORD BRUCE, of Belleville, Ont. Born at Lakeport, Ont., Dec. 16th, 1910. Educ.: Colborne High School, home study of mathematics, surveying, applied mechanics, strength of materials; 1929-31, C.N.R., 1931-41, Corp. of City of Belleville, asst. to city engr., and foreman of P.W.D. (Asks for Affiliate.)

References: D. W. Bews, W. L. Langlois, F. S. Lazier, E. R. Logie, C. A. Mott.

MIDDLETON—JOHN, of Ottawa, Ont. Born at Bilboa, Spain, (British by birth), March 31st, 1891; Educ.: 1911-14, Technical College, Greenock, Scotland, (Night Sch.) completed 2nd, 3rd, 4th yrs. Naval Architecture; 1914-19, overseas; 1919-21, Technical College, Greenock, Naval Arch., (refresher) and metallurgy; 1907-11, apprtce. plater, H. & C. Grayson, shipbuilders, Liverpool; 1911-14, apprtce. dftsmn. and 1919-23, dftsmn., Scotts & Co., Shipbuilders, Greenock, Scotland; 1923-26, dftsmn., Dominion Bridge Co. Lachine; 1926-27, ch. dftsmn. Southern Shipyard, Newport News, U.S.A.; 1927-36, dftsmn. and estimator, Robt. Mitchell, Montreal; 1936-37, dftsmn., Csnadian Vickers, Montreal; 1937-39, dftsmn., Lambert & German, Montreal; July 1939-to Dec. 1940, princ. dftsmn., and 1941 (Jan.) to date asst. engr., Dept. of National Defence, Ottawa.

References: G. L. Stephens, A. D. M. Curry, B. R. Spencer, P. F. Stokes, F. Irvine.

STICKNEY—WILLIAM RALPH., of Walkerville, Ont. Born at Elora, Ont., Dec. 1st, 1911. Educ.: B.A.Sc. (Chem.), Univ. of Toronto, 1936. R.P.E. of Ontario, 1939; 1936-37, Electroplating Dept., Ford Motor Co. of Can.; 1937-39, Dfting. Dept., and 1939 to date, welding engr. with the Canadian Bridge Co., Walkerville, Ont.

References: P. E. Adams, C. M. Goodrich, F. H. Kester, E. M. Krebser, R. C. Leslie, J. R. Stewart.

WRIGLEY—FREDERICK RICHARDSON GORDON, of Pointe-a-Pierre, Trinidad, B.W.I. Born in Huddersfield, England, Aug. 1st, 1907. Educ.: Rugby, Tech. College 1925-30 and 1934-35, Higher National Certificate in Elec'l. Engrg., 1935; City & Guilds Final Grade Certificate, Elec'l Engrg.; Assoc. Member Institution of Electrical Engrs., 1938; 1925-30, apprtce. with British Thomson Houston Co. Ltd.; 1930 (Mar. to Nov.) asst. erecting engr., British Thomson Houston Co., on Grid substations; Dec. 1930 to Nov. 1934, with Anglo Iranian Oil Co. Ltd. as follows: asst. engr., South Persia, incl. 18 mos. i/c and mtce. engr. in Tembi, and 2 yrs. constrn. and mtce., and asst. engr. i/c of district; Dec. 1934 to Apr. 1935, returned to College; Sept. 1935 to Aug. 1939, power station supt., Pointe-a-Pierre Refinery Power Sta. of Trinidad Leaseholds Ltd. At present refinery elect'l engr. of Pointe-a-Pierre Refinery, i/c of all elec'l plant, constrn., mtce. and oper.

References: J. H. Reid, R. W. Emery, L. R. Gransaull, P. R. Gransaull, W. E. Weatherbie.

FOR TRANSFER FROM STUDENT

BALDWIN—WILLIAM ALANSON, of High Falls, Que. Born at Ottawa, Ont., Feb. 12th, 1906. Educ.: B.Sc. (Elec.), McGill Univ., 1929. 1928 (summer), elec'l. install'n., Paugan Falls, Candn. Westinghouse Co.; 1929 (7 mos.), apprtce. course, Canadn. Westinghouse Co., Hamilton, Ont.; 1930 (10 mos.), foreman on elec'l. install'n of psper mill, James Maclaren Co., Masson, Que.; 1930 to date with Maclaren Quebec Power Co. as follows: 1930-32, oper. and mtce., High Falls; 1932-35, elec'l instll'n and oper. at Masson; 1935 to date supt. of High Falls Generating Sta. (St. 1929).

References: C. V. Christie, W. S. Kidd, J. C. McIntosh, J. Palmer, G. A. Wallace, J. E. Dion.

DUNN—JOHN RANKIN, Sub-Lieut., R.C.N.V.R., Halifax, N.S. Born at Moose Jaw, Sask., Aug. 21st, 1916. Educ.: B.A.Sc. (Elec.) Univ. of Toronto 1938; 1934 (summer), mtce. and operation of steam-turbo-alternator power plant, National Light & Power Co., Moose Jaw; 1935-36 (summers), mtce. of automatic telephone exchanges, Sask. Govt. Telephones; with General Electric Co. Ltd. as follows: June, 1938 to May, 1939, testman, Peterboro and Toronto; May 1939 to June 1940, apprtce. engr.; June 1940 to Oct. 1940, sales promotion, and Oct. 1940 to May 1941, asst. engr., Davenport Works, Toronto. At present R.C.N.V.R. (St. 1939).

References: E. A. Allcut, B. I. Burgess, W. T. Fanjoy, J. S. Keenan, G. R. Langley, I. F. McRae, C. E. Sisson, H. R. Sills, W. J. Smither, W. J. T. Wright.

HOWARD—ALBERT WARREN, of 3180 Van Horne Ave., Montreal, Que. Born at Calgary, Alta., Nov. 27th, 1913. Educ.: B.A.Sc., Univ. of Toronto, 1935. 1933 (summer), West Kootenay Power Co.; 1934 (summer), Calgary Power Co.; 1935-40, junior engr., Calgary Power Co.; at present asst. elec'l. engr. with Montreal Engineering Co. (St. 1931).

References: G. H. Thompson, H. B. Sherman, J. K. Sexton, J. H. McLaren, H. J. McLean, H. B. LeBourveau.

(*Continued on page 323*)

Employment Service Bureau

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party. Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted upon request after a lapse of one month. All correspondence should be addressed to THE EMPLOYMENT SERVICE BUREAU, THE ENGINEERING INSTITUTE OF CANADA, 2050 Mansfield Street, Montreal.

SITUATIONS VACANT

GRADUATE MECHANICAL ENGINEER in good health, energetic, to work with large industrial concern in British Guiana. Applications should be sent to Box No. 2328-V.

CONSTRUCTION MAN with experience in heavy construction for either a long or short term contract in British Guiana. Applications should be addressed to Box No. 2330-V.

GRADUATE ENGINEER with at least two years practical experience in a tool room to act as an instructor in the Apprentice School of a large industrial concern. Apply Box No. 2344-V.

REQUIRED a number of experienced concrete detailers, designers and draughtsmen for work on industrial plants and power developments. Apply Box No. 2351-V.

MECHANICAL DESIGNING DRAUGHTSMAN with experience for permanent position with firm engaged in war work. Apply Box No. 2375-V.

ARCHITECTURAL DRAUGHTSMEN required immediately by large industrial concern for their Montreal office. Apply Box No. 2376-V.

SITUATIONS WANTED

GRADUATE ELECTRICAL ENGINEER, University of Toronto, five years experience drafting and design in connection with electrical instruments and small motors. Also experienced in design of small jigs and fixtures and general machine design. Desires permanent position. Apply to Box No. 1486-W.

GRADUATE MECHANICAL ENGINEER, M.E.I.C., 14 years' experience as factory manager in machine tool factory and as consulting industrial engineer in widely diversified metal working trades improving factory and office methods specially cost accounting, desires permanent position. Apply to Box No. 1730-W.

WANTED

Would purchase complete surveying equipment in good condition. Write, giving complete list with catalogue numbers and sale price. State where delivered. Box No. 43-S.

A.I.E.E. SUMMER CONVENTION

With the 1941 Summer Convention of the American Institute of Electrical Engineers only a month away, plans for the meeting are now practically completed and the Royal York Hotel reports that many reservations have already been received.

The programme of inspection trips has been slightly enlarged since it was first drawn up, and a new trip has been arranged for delegates interested in highway lighting to travel out along the Queen Elizabeth Way on the evening of Wednesday, June 18th. This modern four-lane highway is the longest stretch of highway lighting in the world, and the Wednesday evening inspection trip should be a popular one.

Complete details of the technical programme are not yet available, but it may reliably be stated that papers by seven Canadian engineers are to be included in the programme. Three of these Canadian papers come under the heading of "Power Transmission and Distribution." James W. Speight, of the Hydro Electric Power Commission of Ontario, will give a paper on "Conductor Vibration—the Theory of Torsional Dampers," and Gordon B. Tebo, also of the Ontario Hydro, will give one on "Measurements and Control of Conductor Vibration."

Another interesting paper to be heard at a Power Transmission and Distribution session will be one on "The 220,000-Volt System of the Hydro Electric Power Commission of Ontario." This is to be a joint presentation by A. H. Frampton and E. M. Wood.

The Canadian paper to be presented at the Land Transportation Session is that on "Glass-Bulb Mercury-Arc Rectifiers for Traction Service" by Charles E. Woolgar, of the Northern Electric Co. Ltd.

Other Canadian papers which will likely be presented are: "Canadian Broadcasting Systems" by A. Frigon, Canadian Broadcasting Corporation; "Mechanical Simplicity of Air-Blast Circuit Breakers" by H. W. Haberl, Montreal Light, Heat & Power Consolidated; and Otto Jensen I-T-E Circuit Breaker Co.; "A Distribution System for Wartime Plant Expansion" by J. L. McKeever, Canadian General Electric Co. Ltd.

PRELIMINARY NOTICE (*Continued from page 322*)

MONAGHAN—CECIL, of 10726–106th Street, Edmonton, Alta. Born at Edmonton, Feb. 5th, 1916. Educ.: B.Sc. (Elec.) Univ. of Alberta, 1939. 1938 (6 mos). surveyor, City of Edmonton; 1940, Apr. to Dec., jr. engrg. clerk, and 1941, Jan. to date, senior engrg. clerk, City of Edmonton Electric Light & Power Dept. (St. 1939).

References: W. E. Cornish, H. R. Webb. R. M. Hardy.

MYERS—GORDON ALEXANDER, of Clarenville, Nfld. Born at Bay Roberts, Nfld., April 19th, 1915. Educ.: B.E. (Elec.) N.S. Tech. Coll. 1936. 1936 (summer) paving inspr., Milton Hersey Co. Ltd.; 1936 (Sept. to Dec.) second i/c of survey for Highroads Divn., Nfld. Govt.; 1937 (Jan. to July) and Oct. 1939 to Apr. 1940 own radio business, repairs and sales; 1937 (Aug. to Oct.) chemist, and 1938 (May to Oct.) chief chemist, Colas Nfld. Ltd., Clarenville, mfrs. of asphaltic paving emulsions; Nov. 1937 to Apr. 1938, and Nov. 1938 to Apr. 1939, electrician, Nfld. Airport, inst'lln. opera. and mtce.; May 1940 to date acting mgr. and res. engr. Colas Nfld. Ltd. i/c of machinery, mfg. processes and all mtce., and i/c of extension to plant. (St. 1937).

References: F. C. Jewett, M. F. MacNaughton, G. H. Burchill, Lt.-Col. Ball.

McKIBBON—KENNETH HOLDSWORTH, Major, of Kingston, Ont. Born at Port Arthur, Ont., Dec. 11th, 1915. Educ.: B.Sc. (Mech.) Queen's Univ., 1938. 1936-37 (summers), Apr. 1938 to Jan. 1939, Ordnance mech'l. engr., (4th class) at Kingston and Petawawa Military Camps; Jan. 1939 to Feb. 1940, O.M.E. (4th class), and asst. district O.M.E.; 1940 to date, district O.M.E., No. 3, and O.M.E. (3rd class). (St. 1935).

References: N. C. Sherman, L. F. Grant, D. S. Ellis, L. M. Arkley, H. H. Lawson, L. T. Rutledge.

WONG—HENRY GOE, of 1090 Chenneville St., Montreal, Que. Born at Montreal Dec. 27th, 1913. Educ.: B.Eng., McGill Univ., 1935. 1935-39, res. engr., Avon Gold Mines, Ltd., Oldham, N.S.; 1939, field engr. Belmont Constrn. Co. Ltd., Montreal; 1940 dftsmn., Canadian Car Munitions Ltd., St. Paul L'Ermite, Que.; 1940, field engr., Atlas Constrn. Co. Ltd., Montreal; 1941, dftsman., Federal Aircraft Ltd. (St. 1934).

References: A. Olsen, R. A. Young, H. R. Montgomery.

MOTORS

The various types of motors manufactured by Canadian Westinghouse Co. Limited, are illustrated and described in their new 16-page bulletin, H-7048. Construction features, typical specifications, and details covering stator winding and insulation are given.

SPECIAL IRON CASTINGS FOR HEAVY MACHINERY

An 8-page reprint from "Metals and Alloys" which is being distributed by E. Long Limited, Orillia, Ont., gives a pictorial account of the production of special iron castings for heavy machinery, using "Meehanite," a special cast iron made by a proprietary process.

SOUND ABSORBING MATERIAL

An attractive and interesting 12-page brochure has been published by Alexander Murray & Co. Ltd., Montreal, Que., entitled "Quiet Please," this publication features the company's acoustical material "Donnacousti," and contains information on sound, its characteristics, reactions, and methods for its absorption. It contains installation photographs and drawings and specifications. The product is made in Canada.

TRUCK MOUNTING ROTARY PUMPS

Bulletin 1505, published by Viking Pump Co. of Canada, Ltd., Windsor, Ont., gives dimensional specifications, illustrates and describes Viking Truck mounting rotary pumps for fire trucks and street washers.

WATER TEMPERATURE CONTROLS

Powers automatic thermostatic temperature controllers for use in showers and various industrial applications are described and illustrated in a 4-page folder, No. 3017, recently issued by Canadian Powers Regulator Co. Ltd., Toronto, Ont. This folder contains table of list prices, capacities, and shipping weights.

FENCE PRODUCTS

Catalogue, No. 25, is the designation of a new 44-page "General Fence Catalogue," covering the wide range of fence products and fence erection tools made by The Steel Co. of Canada, Ltd., Montreal, Que., and Hamilton, Ont. It is well illustrated and contains much useful information with specifications and many designs for fences for every purpose.

GRIT COLLECTOR AND WASHER

A 4-page folder, No. 1942, published by Link-Belt Limited, Toronto, Ont., describes and illustrates the "Link-Belt Straight-line Grit Collector and Washer" for collecting, washing and removing settled grit from sewage. This grit chamber equipment consists of a conveyor with pitched flights to turn the material over and over, and an inclined washing and dewatering screw into which the collector-conveyor discharges.

ASPHALT

Six new publications of The Asphalt Institute, New York, N.Y., have been made available to officials, engineers, technologists, and the industry. The titles are as follows:—

R.S. No. 6, "The Significance of Various Methods of Test Used on Asphaltic Paving Materials"; R.S. No. 7, "A Direct Method of Determining Thickness of Asphalt Pavement with Reference to Subgrade Support"; C.S. No. 54, "The Washington National Airport and Choice of Surfacing Types for Airports"; C.S. No. 55, "Specification for Asphalt Enamel Protective Coatings for Steel Water Pipe"; C.S. No. 56, "Asphalt for Heavy-Duty Highways"; Pocket Reference Manual for Highway Engineers. A new edition, 256 pages.

PORTABLE ELECTRIC TOOLS

Black & Decker Mfg. Co. Ltd., Toronto, Ont., have issued a 62-page catalogue which describes and illustrates the Company's many portable electric tools, attachments and accessories. Among these are included: drills, hole saws, tool chests, drill stands, screw drivers, nut runners, tappers, saws, hammers, lectroshears, die grinders, bench grinders, portable grinders, clean and shine shop, valve seat grinders, vacuum cleaners, valve refacers, valve lapper, valve shop, heat gun, glue pot, surfacer, sanders, buffers.

RESURFACING FLOORS

Entitled "Busy Factories Need Quick Repairs," a 4-page folder issued by Flexrock Company, Toronto, Ont., features the repairing and resurfacing of industrial and other floors with "Ruggedwear Resurfacer" and the Company's new special type "Grid Tamp" and "Power Float" developed for the rapid resurfacing of large floor areas.

SAFETY SAW

Stanley Works of Canada Ltd., Hamilton, Ont., in a new folder, No. 865, announces the complete line of "Stanley Electric Safety Saws" for builders, maintenance men and shippers. Saws with cutting capacities from 1⅞ ins. to 6 ins. are illustrated, described and priced. Stone saws are also shown.

CAST-IRON PIPE JOINT

Dresser Manufacturing Co. Ltd., Toronto, Ont., have published an 8-page catalogue, No. 413, which thoroughly illustrates and describes the new "Dresser Bellmaster Joint, Style 85," for cast-iron pipe. Includes specifications, tables of sizes and deflection. Features of the joint are—completely enclosed, corrosion-proof, factory assembled, armored gasket and installation time of 2 to 5 minutes.

CUPOLA AIR WEIGHT CONTROL

Bulletin B-268, issued by The Foxboro Co. Ltd., Montreal, Que., illustrates and describes the "Foxboro Air Weight Control" for foundries, by which a measured and uniform weight of air is delivered to the cupola regardless of temperature, barometer or characteristics of the operating equipment. This company is represented in Canada by Peacock Bros. Ltd.

DIAMOND TOOLS

Humorously illustrated, a 23-page booklet published by Canadian Koebel Diamond Tools, Ltd., of Windsor, Ont., describes thoroughly the care and maintenance of diamond tools.

ENGINEERING PROGRESS, 1940

The important part played by the electrical industry in the progress of engineering is described and illustrated under the headings, "Generation and Handling of Power," "Use of Power," "Illumination," "X-ray," "Domestic," "Research," in an interesting 40-page booklet being distributed by Canadian Westinghouse Co. Ltd., of Hamilton, Ont.

CORRECT CASTING DESIGN

An interesting reprint from "Product Engineering" has been distributed by E. Long Limited, of Orillia, Ont., dealing with the application of correct basic principles to the design of castings. This article gives details that promote production and quality.

ELECTRICAL EQUIPMENT

Canadian General Electric Co. Ltd., Toronto, Ont., have published an attractive 36-page brochure entitled "Pioneers of Progress" which outlines the development of the company from its earliest days to the present time and features its contributions to the electrical and mechanical industries of Canada. Each of its five factories are described and the products of these illustrated. Also many photographs are included showing "Electricity at Work in Industry."

ELECTRODES

A 32-page booklet issued by Canadian Liquid Air Co. Ltd., Montreal, Que., entitled "Alflex Electrodes for Every Arc-Welding Purpose," describes and illustrates these electrodes and contains factual data under the following headings:—Qualification of L.A. electrodes; weldability of metals and alloys; choice of mild steel electrodes; and lists of electrodes for mild steel, cast iron, special alloys and hard facing. Other useful information and engineering data are included.

ENGINEERING AND INDUSTRIAL SUPPLIES

A general catalogue of 150 pages, issued by Railway & Power Engineering Corp. Ltd., Toronto, Ont., is profusely illustrated and includes a wide range of equipment and supplies used in the Mining, Transit, Foundry, Electrical and Industrial fields. A few of the many items included are: Stainless and specialty steels, temperature and water controls, trucks, hoists, well boring equipment, pumps, railroad trucks, couplers, seating, lighting, door control engines, refractories, metallurgical alloys, electrical control panels and generator and motor supplies.

FEED WATER REGULATORS

Northern Equipment Co., Erie, Pa., represented in Canada by Peacock Bros. Ltd., have published an 8-page bulletin, No. 431, entitled "Operating Experience at Ruppert Brewery with Copes Flowmatic Regulator." Describes the brewery's modernized boiler plant and features the close boiler water level control being obtained.

GASKET MATERIAL AND SPECIALTIES

"Durabla" compressed, long-fibre homogeneous sheet packing for permanent gaskets; "Durabla" high pressure gauge glass; and "Durabla" pump valve service are described in a folder issued by Canadian Durabla Ltd., Toronto, Ont.

THE ENGINEERING JOURNAL

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* * *

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A TRANSMISSION LINE FAULT LOCATING SYSTEM

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One of the most vulnerable parts of a hydro-electric power system is the high voltage transmission line. Nature has endowed certain sections of our country with an abundance of water power. Very frequently, however, the source of power is located some distance from the load centre, which necessitates the use of transmission lines, often of considerable length. Nature is not so kind here, and the transmission engineer must cope with many difficulties caused by the elements such as lightning, wind, snow and sleet, etc. Many improvements have been made in the design and construction of transmission lines but, so far, a fault-proof line has not been built.

This paper relates to a system of locating faults in electrical transmission lines and the primary object of the scheme is to provide a system of a permanently supervisory character, which will operate automatically to record the effects of both transient and permanent faults in electrical transmission lines, whereby the approximate location of such faults may be determined in order to expedite inspection of the line at the fault point and effect repairs if necessary.

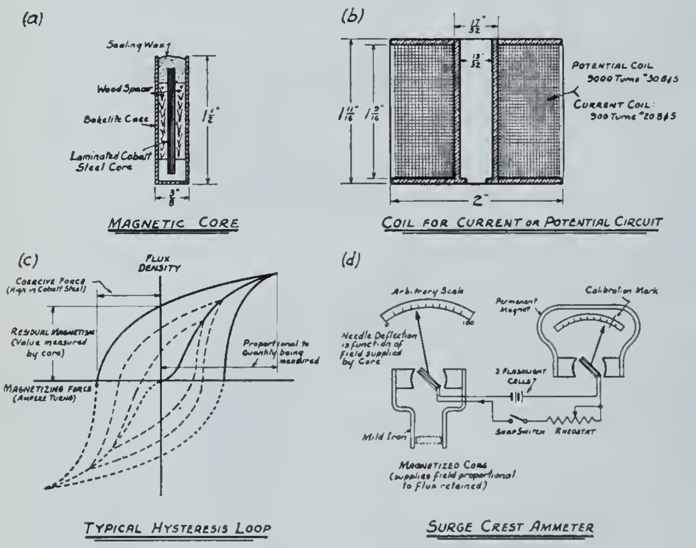


Fig. 1—Magnetic link, spool and ammeter.

The location, inspection and, if necessary, the repair of faults in electrical transmission lines have always been a serious problem for power companies and are becoming increasingly difficult by reason of the increasing lengths of the lines as power developments are located at progressively greater distances from centres of habitation. The transmission lines are frequently of great length, sometimes several hundred miles, and extend for a large part of their lengths through rough and unsettled country where patrolling is difficult and where the absence of exact knowledge greatly delays the finding and repairing of a fault. The faults herein dealt with are of two classes, namely: transient faults, where only minor damage is suffered and the line can be immediately returned to service without repairs being first necessary; and permanent faults, where the damage is such that the line cannot be returned to service until repairs have been made. In the first class may be included the effects of lightning, flashover due to atmospheric conditions, momentary short circuits due to wind driven matter or swinging conductors and the like. In the second class may be included broken conductors, fallen towers, broken poles or insulators and the like. The effects of transient faults, if not repaired, invite permanent faults and it is therefore almost as important to locate, inspect and, if necessary, repair transient faults as it is to locate and repair permanent faults. According to existing methods, the location of transient faults from a supply station is difficult or impossible, as the faults may be evident for only a very few seconds or even only a fraction of a second and the information available as to location usually determines it merely as somewhere within the length of line. Inspection is thus a time-consuming and highly unsatisfactory procedure and quite frequently the fault is never located. Permanent faults are, of course, easily observed but the delay before repairs can be made depends to a considerable extent upon the accuracy with which the location of the fault has been determined and upon promptness in informing repair men.

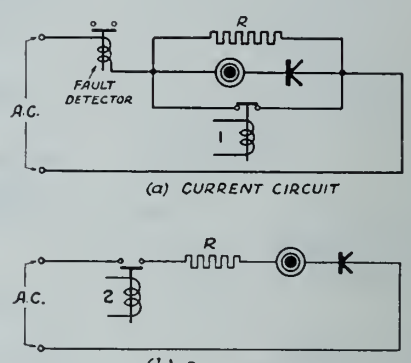


Fig. 2—Current and potential recording elements.

The present scheme consists of a supervisory system adapted to measure and record, at one or more points in the length of the line, variations in current and potential in the line, thereby providing data from which the location of a fault may be calculated with close approach to accuracy. Maintaining always the essentials of recording variation of current and potential, the scheme includes systems varying considerably in detail arrangement according to the line to be supervised and the conditions to be dealt with.

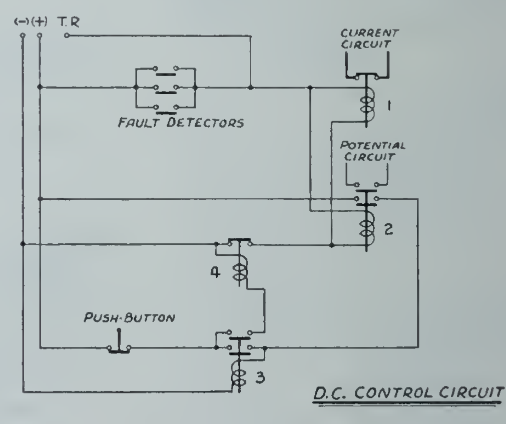


Fig. 3—Control circuits.

The desirability of having some effective means of locating transmission line faults has long been recognized, and many attempts have been made to develop such equipment. At the present time there are several methods of

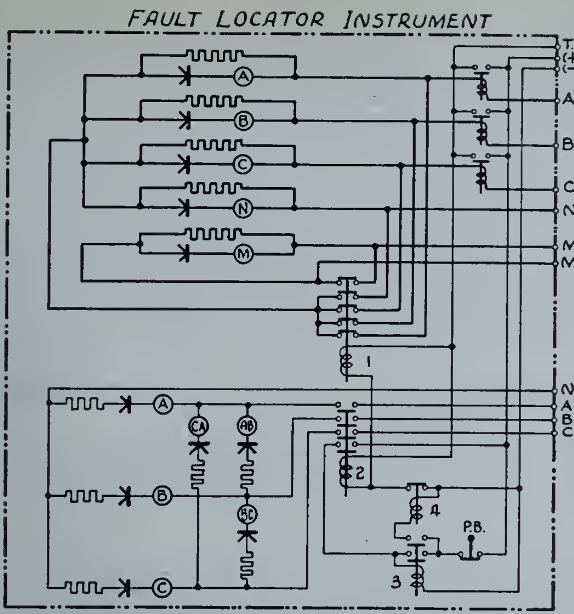


Fig. 4—Five current and six potential recording elements and circuits.

locating transmission line faults but none of these schemes have come into general use, which would seem to indicate that no scheme so far available combines all of the essential requirements. The scheme which has been evolved by the Shawinigan Water & Power Company has been developed primarily as a low cost arrangement, using standard equipment and designed to meet most of the essential requirements. It is not a precision instrument, and has certain limitations, but regardless of these facts, it is believed that it can be made to serve a useful purpose.

Theory and Operation

In general, the scheme consists of a a number of current and potential units. Each unit is composed of a number of turns of wire forming a coil wound on a suitable spool in such a manner that an electric current flowing through this coil produces a magnetic field. The centre of the spool in the present design is hollow and is arranged to hold a small, normally demagnetized, magnetic link. Associated with each coil is a rectifying unit to convert alternating current into direct current and the field thus produced in the coil is unidirectional, permitting the magnetic link to become magnetized. The degree of magnetism imparted to this link is a measure of the current which flows through the coil, and, therefore, a measure of the alternating current or

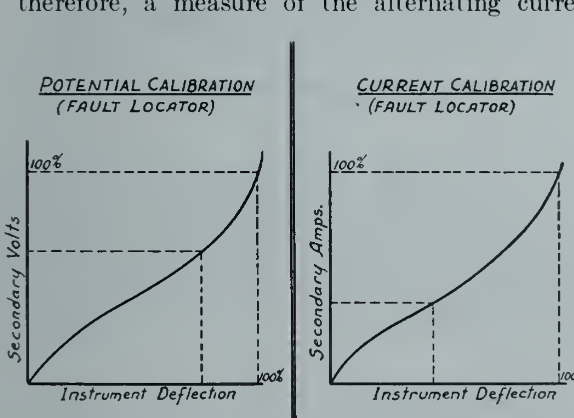


Fig. 5—Fault locator calibration curves.

potential impressed on the circuit, and having magnetized the link, a surge crest ammeter can then be utilized to determine the degree of magnetism. This can then be converted into current or potential by the use of a suitable calibration curve or table. The current and potential units are similar except that in the potential unit the magnetic circuit is provided with a series resistor, whereas the current unit is provided with a shunt resistor. In either case, the magnetic circuits are normally de-energized until the occurrence of a fault, when the magnetic circuits are automatically energized for a few cycles only. This is accomplished by means of a suitable relay arrangement to meet individual requirements and the recording units are blocked from further operation until de-magnetized links can be made available for additional records. In practice, two or more sets of links are provided, so that successive records may be obtained at short intervals by replacing the links as required. The complete instrument would have ten or more potential and current units to record all conbinations of potentials and currents required for fault location on the

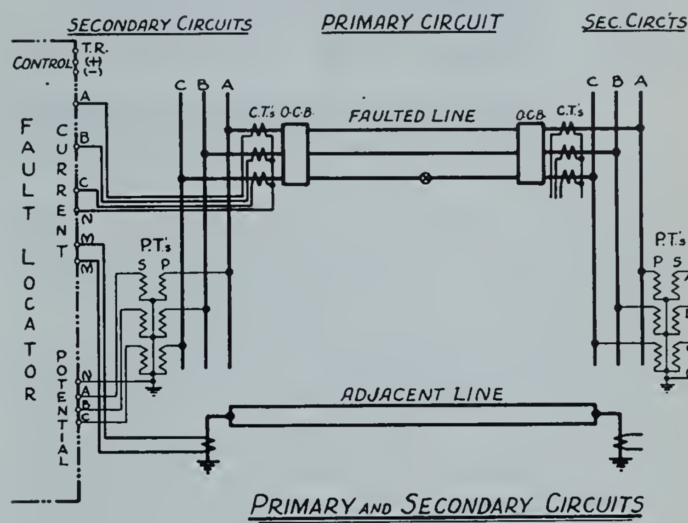


Fig. 6—Connection of fault locator to primary system through instrument transformers.

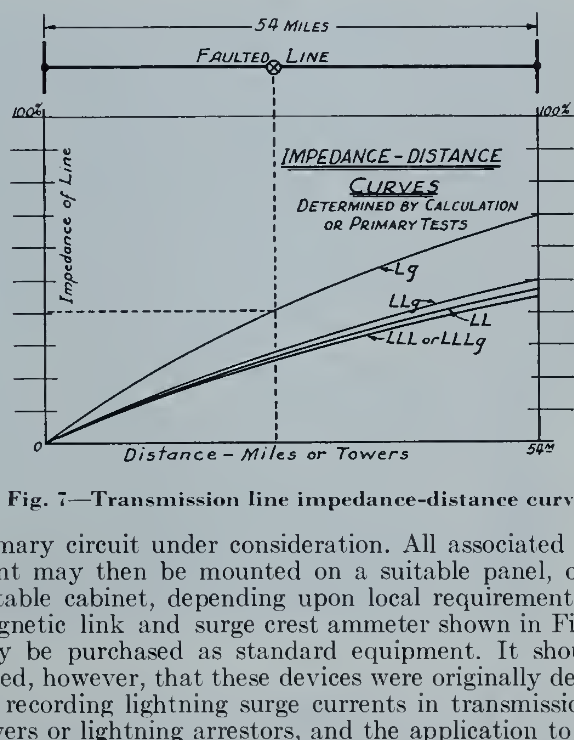


Fig. 7—Transmission line impedance-distance curves.

primary circuit under consideration. All associated equipment may then be mounted on a suitable panel, or in a suitable cabinet, depending upon local requirements. The magnetic link and surge crest ammeter shown in Figure 1 may be purchased as standard equipment. It should be noted, however, that these devices were originally designed for recording lightning surge currents in transmission line towers or lightning arrestors, and the application to transmission line fault location is a new development of the art, not previously undertaken. The surge crest ammeter is in principle a d-c milliammeter with a fixed direct current, using the magnetic link in place of the permanent magnet. In this manner the degree of magnetism is measured instead of the value of direct current.

The current and potential recording circuit, shown in Fig. 2, reveals the essential differences in these two recorders.

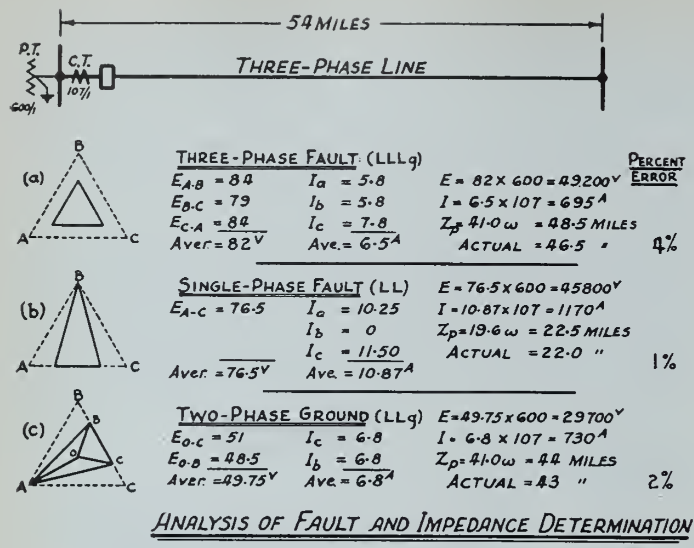


Fig. 8—Sample calculation using simple impedance method.

In both cases a potential is impressed on the recording element, forcing through the coil a pulsating direct current due to the action of the rectifying units. The arrangement of the relay circuits need not necessarily be as shown, but may vary depending upon local requirements.

In practice, the recording elements are energized for a few cycles only, usually from three to six half cycles. Figures 3 and 4 indicate the relation between the control circuit and recording elements. On the occurrence of a fault on the system, the control relays 1 and 2 are energized either from fault detector relays or from protection relays. This permits voltage to be impressed on the recording elements and at the same time energizes relay 3. As the contacts of relay 3 are closed, this relay is locked closed through the push button circuit, causing relay 4 to open the circuit to relays 1 and 2, thus removing the recorders from service and preventing them from being re-energized until the system is reset through operation of the push button. In practice, this would only be done after all the links have been removed and replaced with de-magnetized links.

In the arrangement under discussion, calibration curves showing the relation between surge crest ammeter reading and primary current and voltage are essential. Figure 5 ndicates the type of curve obtained from the available

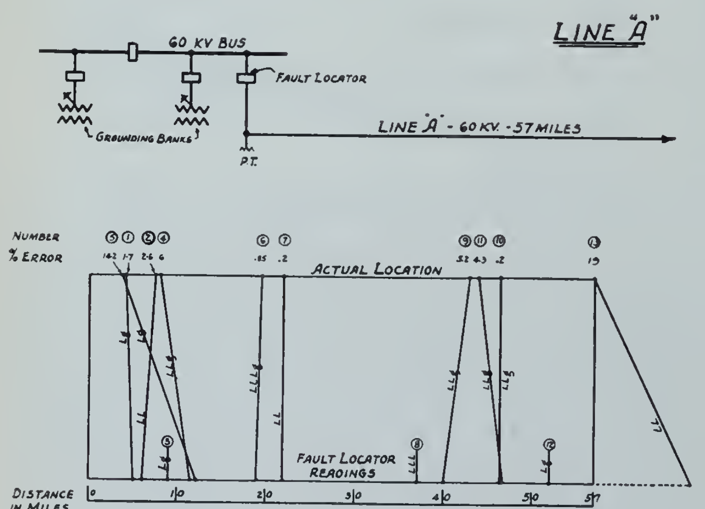
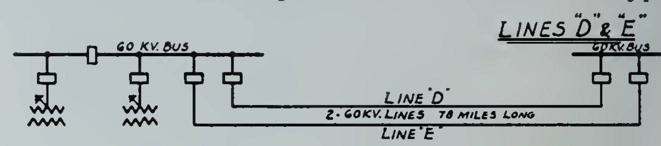


Fig. 9—Experience with original instrument on a radial 60 kv. line.

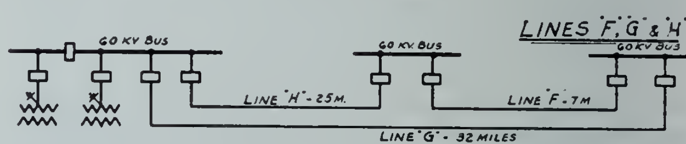
instruments. Figure 6 shows the method of connecting the fault locator into the primary circuits through instrument transformers. In some cases it might be advisable to install instruments at each end of the transmission line for greater accuracy. A recorder inserted in an adjacent parallel circuit may at times prove useful in case of ground faults. In this case the amount of induced current would be an indication of the length of parallel to point of fault and, therefore, an indication of fault location.

The impedance of a transmission line is dependent upon a number of factors. Most of these factors are constants for any given type of fault and the line impedance can, therefore, be calculated with a fair degree of accuracy. The curves shown in Fig. 7 were actually obtained by primary test on a radial, 60 kv. steel tower line operated from a delta system equipped with small grounding banks. It will be noted that the line impedance is different for each type



LINE NO.	TYPE OF FAULT	CALCULATED DISTANCE IN MILES	ACTUAL DISTANCE IN MILES	% ERROR	LINE NO.	TYPE OF FAULT	CALCULATED DISTANCE IN MILES	ACTUAL DISTANCE IN MILES	% ERROR
E	Lg	3·8	0	4·9	D	Lg	27	42	19
E	Lg	30.	NOT FOUND	—	D	Lg	39·5	41	1·9
E	LL	66.	69	3·9	D	Lg	38	68	38
E	Lg	58.	NOT FOUND	—	D	Lg	17	NOT FOUND	—
E	LL	75	76	1·3	D	Lg	13	NOT FOUND	—
E	Lg	75	74	1·3	D & E	Lg	4.0	2·5	2 0
E	Lg	3·5	3·0	0·6	D & E	LLg	33	41	10
D	Lg	15	17	2·6	D & E	LLL	35	NOT FOUND	—

Fig. 10—Experience with original instrument on two parallel 60 kv. lines.



LINE NO.	TYPE OF FAULT	CALCULATED DISTANCE IN MILES	ACTUAL DISTANCE IN MILES	PER CENT ERROR
F & H	Lg	8·5	NOT FOUND	—
G	Lg	14	NOT FOUND	—
G	Lg	20	NOT FOUND	—
G	Lg	15	NOT FOUND	—
G	Lg	3	6	9·4
H	Lg	8	8·5	1·7
H	Lg	12	NOT FOUND	—
H	Lg	8	9	3·1

Fig. 11—Experience with original instrument on three parallel 60 kv. lines.

of fault such as one, two- or three-phases-to-ground, phase-to-phase, or three-phase. No consideration has been given to power arc resistance or ground resistance in this instance. One method of determining the type of fault and calculating the impedance to the point of fault is illustrated in Fig. 8. Having calculated the impedance and type of fault, the curves of Fig. 7 may then be used to determine fault location.

Experience with Existing Fault Locators

The original instrument was initially installed during 1937 at the sending end of the 60 kv. radial line shown in Fig. 7 but was transferred to the terminal station bus during 1939. Figures 9, 10 and 11 indicate the general experience gained with this instrument during the four years under consideration.

In Fig. 9 is shown the experience on the line previously referred to. The horizontal base line represents the estimated

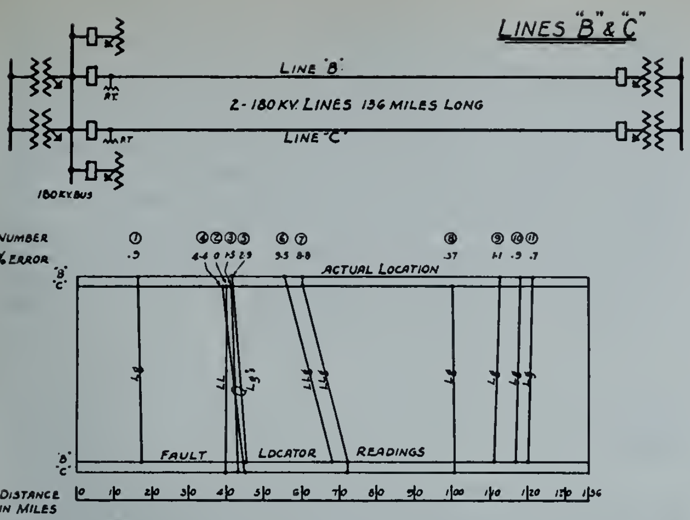
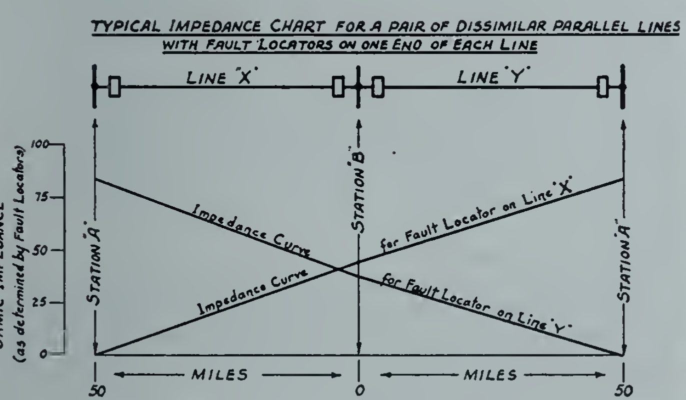


Fig. 12—Experience with two instruments of later design on two parallel 165 kv. lines.

fault location and the upper horizontal line represents the actual location of fault. It will be noted that there were 13 faults during the four year period, ten of which were actually located. In eight cases, the fault location was moderately accurate, but in two cases the estimated distance was quite inaccurate. In the case of fault No. 5, the line conductor broke and fell to the ground. It is not known if the measured impedance was too high due to measuring the arc resistance as the conductor was falling; or if the conductor fell to the ground before the record was taken, thus measuring the earth contact resistance in addition to the impedance of the conductor to the point of fault. In the case of fault No. 13, two conductors were blown together near the far end of the line during blasting. The instantaneous impedance relays could not operate, thereby leaving the short-circuit on the line for approximately 0.8 second. Before the fault locator was energized to complete the record, the arc had been blown out to a considerable length and the effect of arc resistance resulted in an increase of calculated impedance. One solution of this difficulty is to take the record before the arc has time to become extended.

The records obtained in Figs. 10 and 11 were during the period when the single instrument was connected to the 60 kv. bus to record faults on six separate lines. Due to the limited number of recording elements, it was arranged to record bus voltages, ground fault current and a limited number of phase currents. This tended to limit the records to one- and two-phase-to-ground faults only. Many of these single-conductor-to-ground faults were not located, possibly due to the limited fault current and fast clearing time which prevented serious damage to line material. All five of these lines were of steel construction with overhead grounding wires, so that ground fault resistances should have been moderately low.

The next step in this development consisted of installing four more instruments during 1939. Two of these were installed on one end of two parallel 180 kv. lines, 136 miles long and of a solidly grounded star system. A special formula was adapted to this system with fair success as indicated in Fig. 12, although some adjustment may be required in the case of two-conductor-to-ground faults.



TABULATION OF FAULTS

NUMBER OF FAULTS	TYPE OF FAULTS	PER CENT. LOCATED	AVERAGE % ERROR	PER CENT. NOT LOCATED
6	Lg	83	5.1	17
6	LLg & LL	50	1.2	50
10	LLLg & LLL	40	2.7	60
22	TOTAL	54	3.3	46

Fig. 13—Experience with two instruments of later design on two parallel 60 kv. wood pole lines.

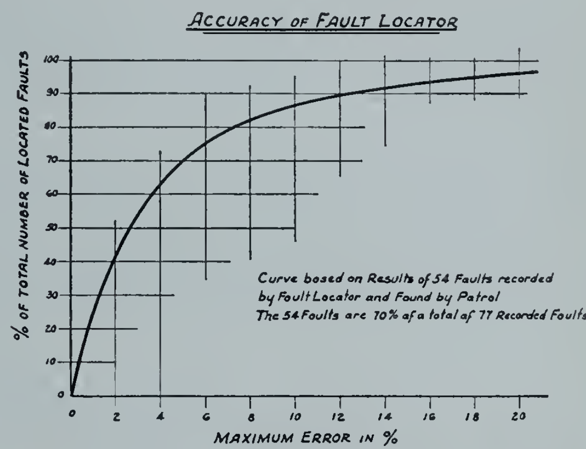


Fig. 14—Percentage error curve of located faults.

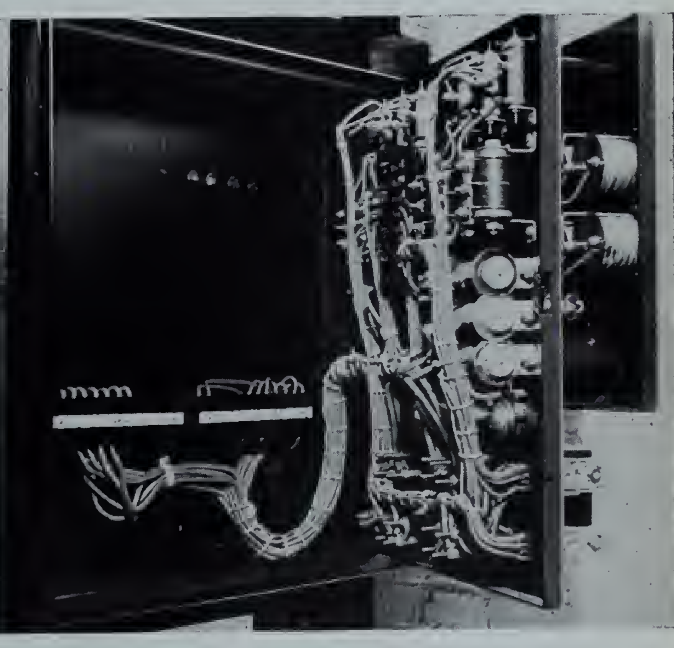


Fig. 15—Instrument of improved design recently placed in service.

Figure 13 indicates the experience with two similar instruments located at Station "A" on two parallel 60 kv. wood pole lines. These lines are not provided with either overhead or buried ground wires, so that one-conductor-to-ground faults would probably be influenced due to high ground resistance. There are, however, a number of distribution stations connected to each line, and the records include flashovers at these stations. In most cases where faults were located, this was done with a fair degree of accuracy.

However, many faults were not located, owing possibly to a number of conditions including limited fault current, fast clearing of faults and flashovers in mid-span.

The photograph shown in Fig. 15 illustrates a recent design of fault locator which has been constructed for general use. Four of these have been installed on four 110 kv. parallel lines, approximately 85 miles long, of a solidly grounded star system. The limited experience with these instruments would appear to indicate that satisfactory results will be obtained. Two additional instruments of this design are now being installed on a single 220 kv. line, approximately 100 miles long, of a solidly grounded star system. This will complete the installation of eleven instruments on various types of transmission lines with operating voltages ranging from 60 to 220 kv. and a total mileage in excess of 1,100 miles.

In conclusion, mention should be made of the co-operation and assistance rendered by the personnel of the Shawinigan Water & Power Company during the development, installation, testing and operation of these fault locators. This applies particularly to Mr. R. B. Reed, who has been closely associated with this work during the past three years. The Canadian General Electric Company have also materially contributed to the success of the general scheme in adapting the initial investigations to the design and construction of the latest instrument.

DISCUSSION

W. B. Brown, Jr.E.I.C.[1]

The author has capably discussed one device, the fault locator, used for locating the approximate point and type of faults on transmission lines. This device, conceived and built under his direction, has, as his records indicated, given satisfactory results for the lines analyzed.

As reference has been made to the part taken by our Company in improving the design, a few comments may be offered to supplement those of the speaker.

It is, as Mr. Knapp has stated, not a precision device, as there are certain factors which affect its application. The accuracy of such a device, and the ease with which results may be interpreted, measure its practical value. A number of such factors are:—

1. The equipment measures and records fault current and potential values which give, by subsequent calculations, total (line and fault) impedance. The factors noted below will introduce errors in the calculation of distance to point of fault:

(*a*) Tower footing resistance.

(*b*) Arc resistance.

(*c*) Resistance of earth return circuit.

Approximate values for these factors must be known except when they are known to be so small as not to affect the desired accuracy.

2. Harmonics. The device measures the peak instantaneous value of the wave, and since we are interested in values at fundamental wave frequency for impedance measurement, the wave shape affects its accuracy. Their relative importance as a source of error decreases with the higher frequencies. A 5 per cent. third harmonic in the voltage wave would produce a maximum error of approximately 3 per cent, while harmonics in the current wave are usually well damped by the inductive reactance of the power circuit. From this it may be seen that while wave form is a potential source of error, it will not materially affect results on the average system.

3. D-C Offset. Fault current frequently contains a d-c component of current; however, on most systems this decays to a small percentage of its original value in three to four cycles even with a 100 per cent offset wave. Since the a-c component only should be used for link magnetization, the current and potential elements should be inserted simultaneously in the circuit after this period.

4. When high-speed breakers and protective relays are used, the circuit may possibly be opened before the d-c component of total fault current has disappeared.

One method to reject this d-c component and use only the a-c component for link magnetization would be the use of a reactor, as well as a resistor, as a shunt for the current elements.

5. Recovery voltage. The potential elements must be removed from the circuit before the breaker contacts part. Since the elements must remain in the circuit for a minimum of 1½ cycles, this becomes a real problem when used on a circuit with high-speed breakers and relays. Electronic valves might prove to be the solution.

6. Auxiliary relay contacts in series with the potential elements connect them to the potential transformers. It is obviously extremely difficult for each contact to part at the same instant; thus, a transient voltage is set up which discharges through the other potential elements. Errors in the voltage reading up to 10 per cent have been noted from this, but can be reduced considerably by providing a shunt path to neutral. In most installations this path is provided by an external line to neutral load.

7. The magnetic link must be seated properly in the slot provided for it in the surge crest ammeter.

8. The surge crest ammeter is a sensitive device and will give different readings for the same magnetic link when at right angle or parallel to the earth's magnetic field. To eliminate this effect it is only necessary to check and reset, if necessary, the zero adjustment for each different position of the surge crest ammeter.

9. Error due to possible current transformer ratio breakdown on heavy through fault current.

When the fault locator is shipped it is calibrated in terms of secondary volts and amperes vs. surge crest ammeter deflection. Therefore, it is necessary to interpret these values in terms of primary volts and amperes by applying the proper instrument transformer ratio under fault condition.

10. Delta-connected current transformers make the interpretation of results more involved; however, it is usually possible to connect the current elements inside the delta connection.

The elimination or reduction of any or all of the above factors, the reduction of burden imposed on the instrument transformers, and improved methods in the calculation of distance to the point of fault from the results obtained, are the immediate objectives on the way to an improved fault locator.

Ralph C. Silver, M.E.I.C.[2]

Mr. Knapp is to be congratulated on the development of an apparatus which should be very useful in locating faults on transmission lines and in checking up, generally, on the magnitudes of currents and voltages on a transmission system under fault conditions.

Having witnessed tests on one of the experimental sets the writer was impressed by the relative simplicity of operation and the accuracy with which ground faults of comparatively high resistance were located.

As the author points out, there is a need for inexpensive equipment which will give even an approximate location of faults on long transmission lines through rough country. Hours, and, in some cases, days have been required to locate faults on such lines and restore service.

Interpretation of the current and voltage readings on single circuits with one or two points of grounding does not

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[2] Protection Engineer, Gatineau Power Company, Ottawa, Ont.

appear difficult, but on parallel circuits, close enough for the mutual inductance between circuits to be comparable with the self-inductance, and with a number of grounding transformers, it is felt that some difficulty may be experienced. It would be interesting to hear the results of the studies being carried out by Mr. Knapp's associates on this particular phase of the application of the fault locator.

What is the burden of the apparatus on current transformers and potential transformers, and has this had any adverse effect on the operation of the protective relays?

Would it be possible to show the direction of flow of fault current?

H. W. Haberl[3]

The writer cannot offer any constructive criticism or comments on the paper, as regards using the equipment described, in the manner for which it was originally intended; i.e., on long overhead transmission lines or medium-high to high voltage type.

On the power system with which the author is associated, there are many types of lines on which this equipment would be a real advantage. However, on a system operating in a metropolitan district where there are thirty or more low-voltage feeders which radiate from three or four bus sections usually fed by separate transformer banks, various conditions might decrease its accuracy to the point where it might become useless. One question might be—what changes could be made in the equipment so that it would, with reasonable accuracy, measure faults in cable systems on 4,000 and 12,000 volt services? These cable systems are usually in metropolitan districts and in underground duct systems. Our Company, operating such a system, is very interested in an apparatus of the type described in the paper, if it could be suited to our needs.

A. S. Runciman, m.e.i.c.[4]

A few years ago, a fault locator was developed by the Pennsylvania Water & Power Company engineers, which, when connected to a transmission line, would give information indicating the end of the line either "open" or "grounded." This device gave very accurate information in reference to breaks or grounds. Recent inquiry as to the usefulness of such apparatus indicates that any device which requires a considerable time to set up and use, does not give the information quickly enough, except in rare cases.

The fault locator, which has been developed by Mr. Knapp and his associates, is automatic in operation and shows considerable promise. The interpretation of the readings, as yet, requires specially trained men who give our Company operators the information required after a line has been faulted. It has been our experience that, when the instrument's results have been worked out, possibly several hours after the trouble has occurred, the location of the trouble as indicated by the instrument is usually within a mile or two of the actual fault. At times the agreement has been very much closer than this.

We look forward to the time when all of our station operators will be able to interpret the location of the fault within a few minutes. So far, this quick use of the instrument is not general. Our suggestion is that an interpreting machine be developed, into which the magnets can be placed in some definite order, so that by a proper procedure, a meter will be actuated which will indicate the tower number where the trouble occurred. This may seem a far step, but other schemes quite as complicated have been worked out.

P. W. Shill[5]

Mr. Runciman has laid considerable stress on the time that he felt must elapse between the occurrence of a fault and the computation of its position, so that the line crews could get busy on the necessary repairs.

Apparently over ninety per cent of transmission line faults are transient ones. In these cases time is not an important factor, for the line is soon replaced in service and remains so until arrangements can be made to take it out of service for inspection and to repair the damage, if any. But, in the cases of permanent faults—except where the position of the fault is such that the time necessary to compute its position may be longer than that required to notify the patrol and to patrol the line from one end to the position of the fault—there would be a saving in time. The number of cases of *permanent* faults that would take longer to locate with the detector than without it would probably not exceed ten per cent. Thus it seems that the fault detector as it now stands must be worthwhile in at least 99 per cent of all cases of trouble. Further, where no fault detector is in use, in order to locate the position of any fault with a minimum of delay, it is necessary to go to the expense of two patrols being sent out, one from each end of the line, and for them to work inwards along the section where the fault appears to be from the indications on the targets of the relays and from the circuit breakers affected.

It, therefore, seems that from an economic as well as an operating point of view the fault locator must offer very definite advantages in almost all cases of trouble.

No doubt as refinements are made the device will become a much more precise instrument than it appears at present.

There appear to be a few possible sources of error which it might not be too difficult to eliminate or minimize, if this has not already been done. These are:—

1. The rectifier units.
2. The magnetic links.
3. The surge crest ammeter.

It is very doubtful if any two rectifier units have exactly the same degree of perfection of rectification. That is to say, the best rectifiers allow some back-flow of current and they are surely not likely to be all exactly alike in this respect. Therefore, it seems that a circuit would be better if it had as many records as possible made through one rectifier.

The hysteresis loops and therefore the remanences of the several magnetic links in a set are bound to be somewhat different unless accurate tests are made in order to match them closely. If a link can be made to take a composite record of two or more phases or conditions by magnetizing it with a solenoid with more than one winding, and if a sufficient number of such combinations could be arranged, it might be possible to evaluate the errors due to this cause and eliminate them.

It is almost certain that the surge crest ammeter has some appreciable remanence. The effect of this could be reduced by the insertion of a soft iron core magnetized from an a-c source between its pole pieces between each reading of a magnetic link. Further, the surge crest ammeter and its standard comparison ammeter could both be equipped with knife edge pointers and have hand-drawn, accurately calibrated, scales which could be read if necessary with a magnifying glass. Experience has shown that any indicating instruments taken from a production bench and equipped with standard printed scales are seldom any more accurate than one requires for ordinary purposes and it is certain that not many of them are much better than the error allowed by their guaranteed accuracy. It might be more accurate to read the fluxes of the links with some sort of galvanometer with a movement suspended on a fine fibre rather than on the usual type of jewelled bearings.

The author has made it quite clear that the fault locator is not claimed to be a precision instrument. It is evident however that this instrument is a step in the right direction and that as time goes on and further work is done on it, accurately finding the location of a transmission line fault will become little more than a routine operation.

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[5] Electrical Designer, Montreal Light, Heat & Power, Consolidated, Montreal, Que.

Donald King, s.e.i.c.[6]

Experience with the fault locator in the field has shown that it is readily handled and that few difficulties are met within its operation.

After a fault has occurred, the operator must remove the links from the instrument and measure the extent of their magnetization with the surge crest ammeter. While doing this, he must take care not to drop the links, or hold them together, in order to avoid altering their magnetization. After recording the surge crest ammeter readings, he demagnetizes the links, making them ready for further service.

The operator transmits the locator readings to the system office, which is on duty twenty-four hours a day. For the fault locators turned over to "Operation," the system office is in a position to determine the location of the fault directly, and quite simply, from the surge crest ammeter readings.

At the present time, when a fault occurs, it takes the station operator about twenty minutes to reach the links, measure their magnetization and give the information to the system office; the personnel of the latter require, roughly, half an hour to calculate the fault location, so that the whereabouts of many faults can be known within an hour of their occurrence.

There are some inherent drawbacks in the operation of the instrument itself. Upon a fault occurring, the instrument locks itself out, preventing its further operation until reset by the push button. Before it is reset and returned to service, the links magnetized by the fault (which has just occurred) must be removed and replaced by "fresh" links. All this takes time, and if a series of faults on the line occur in quick succession, it is likely that only the initial fault will be recorded by the fault locator.

A difficulty along similar lines is met with during periods of extensive line trouble in stations with a large number of lines. A sleet storm, with its numerous line outages, is very likely to keep the station operators so busy with straight switching, that fault locator operation must be neglected temporarily. In this way, valuable information as to the location of faults may be lost.

R. B. Reed[7]

It may be of interest to consider some of the relationships between voltages and currents during transmission line faults on three-phase systems. These relationships are as follows, (see also Fig. 16):

For 3-phase faults:

$E_{12} = Z_\phi\ (I_1 - I_2) \times d$ Equation 1A
$E_{23} = Z_\phi\ (I_2 - I_3) \times d$ Equation 1B
$E_{31} = Z_\phi\ (I_3 - I_1) \times d$ Equation 1C

For phase-to-phase and phase-to-phase-to-ground faults on:

Phases 1 and 2 $E_{12} = Z_\phi\ (I_1 - I_2) \times d$ Equation 2A
Phases 2 and 3 $E_{23} = Z_\phi\ (I_2 - I_3) \times d$ Equation 2B
Phases 3 and 1 $E_{31} = Z_\phi\ (I_3 - I_1) \times d$ Equation 2C

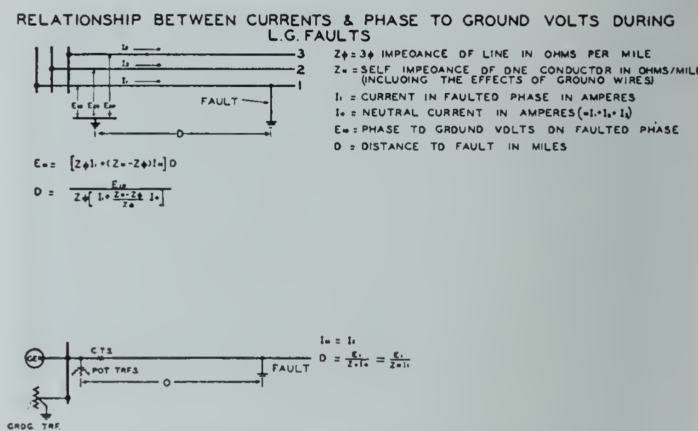
For single-phase-to-ground faults on:

Phase 1 $E_{10} = [Z_\phi I_1 + (Z_n - Z_\phi)\ I_n] \times d$ Equation 3A
Phase 2 $E_{20} = [Z_\phi I_2 + (Z_n - Z_\phi)\ I_n] \times d$ Equation 3B
Phase 3 $E_{30} = [Z_\phi I_3 + (Z_n - Z_\phi)\ I_n] \times d$ Equation 3C

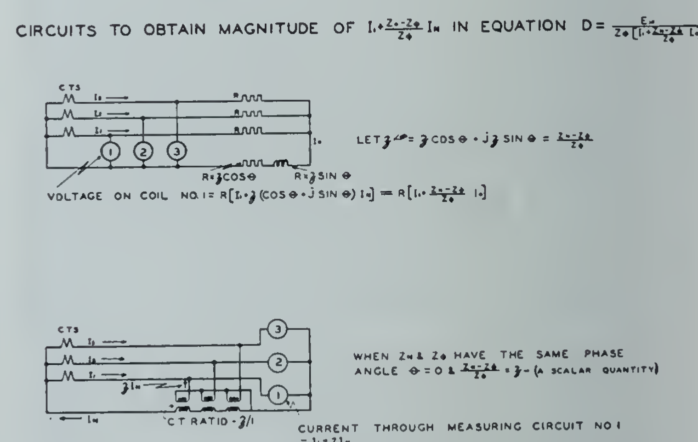
Where Z_ϕ = 3-phase impedance of line in ohms per mile.
Z_n = self impedance of one conductor in ohms per mile, (including effects of overhead ground wires and counterpoise).
I_1, I_2, I_3 = current in phase wires 1, 2, or 3.
$I_n = I_1 + I_2 + I_3$ = neutral current.
E_{12}, E_{23}, E_{31} = voltage between phases 1 and 2, 2 and 3, 3 and 1.
E_{10}, E_{20}, E_{30} = voltage to ground on phases 1, 2, 3.
d = distance to fault in miles.

Let us consider first equations 1 and 2; it will be noted that each of these equations contains a term consisting of the difference between two currents. This term is merely the delta current and is easily obtained on most installations. Thus, if we measure the phase-to-phase voltage and its corresponding delta current it is a simple matter to calculate the distance to any fault involving two or three phases. This calculation is accurate where the phases involved are at the same location on the line, and is substantially independent of any ground impedance or mutual impedance to any other line, under this condition.

Consideration of equations 3 shows, however, that the calculation for single-phase-to-ground faults offers considerable difficulty. This is due to the fact that one term of the equation consists of a vector sum of two currents each multiplied by a different line impedance constant. One method of overcoming this difficulty would be to measure the sum of the phase current and a part of the neutral current directly by the fault locator. This method requires three current coils per line as shown in Fig. 17. In practice, coils Nos. 1, 2 and 3 would be calibrated in amperes. Thus the distance to the fault may be calculated in the same manner as for phase-to-phase faults, except that the hybrid current would be used instead of delta current and phase-to-ground voltage used instead of phase-to-phase voltage. Since, on most lines Z_n and Z_ϕ have approximately the same phase angle, most installations would be satisfied with the arrangement shown in Fig. 19, in which the hybrid current is produced by current transformers in the neutral wire of the secondary circuit.



Figs. 16 and 17—Relation between currents and phase-to-ground volts during L.G. faults.



Figs. 18 and 19—Circuits for calculating phase-to-ground faults.

[6] Assistant Engineer, The Shawinigan Water & Power Company, Montreal, Que.

[7] Assistant Engineer, The Shawinigan Water & Power Company, Montreal, Que.

When using the hybrid circuit, results will be independent of system set-up and will give correct results for cross shorts. However, it is somewhat subject to errors due to ground impedance, and may need, in some cases, adjustment for mutual impedance between parallel lines.

The hybrid circuit is unnecessary for the system arrangement shown in Fig. 17, where all synchronous machines and grounding banks are behind the fault locator. Under this condition $E_{10}=Z_n I_n\ d$. Hence the calculation for distance is quite simple. It requires only one current recording element for all single phase-to-ground faults. It will not be accurate for certain cross shorts but simplifies calculations for mutual impedance between parallel lines and for ground resistance.

In those cases where it is not desirable to apply the hybrid circuit, there are two possible ratios to consider in determining the location of single-phase-to-ground faults. One is the ratio between phase-to-ground volts and neutral current. The other would be the ratio between phase-to-ground volts and phase current. If these ratios be treated as impedance to point of fault, the apparent impedance in ohms per mile of the transmission line will vary with the system set up and location of the fault. These effects may be estimated as follows:

Using the ratio between phase-to-ground volts and neutral current

$$\frac{E}{I}=[Z_n+2/3\,(C_1/C_0-1)\,Z\phi]\times d$$

where C_1 = distribution factor for pos. and neg. sequence currents.

C_0 = distribution factor for zero sequence currents.

Impedance ohms per mile $=Z_n+2/3\ (C_1/C_0-1)Z\phi$

$=Z_n-2/3\ Z\phi$ when $C_1/C_0=0$

$=Z_n$ when $C_1/C_0=1$

(condition of radial line discussed above).

= Infinity when C_1/C_0 = infinity

For the ratio between phase-to-ground volts and phase current,

$$\frac{E}{I}=\frac{[3\ Z_n+\ 2\ (C_1/C_0-1)\ Z\phi]\times d}{2\ C_1/C_0+1}$$

Impedance ohms per mile $=\dfrac{3\ Z_n+2\ (C_1/C_0-1)\ Z\phi}{2\ C_1/C_0+1}$

$=3\ Z_n-2\ Z\phi$ when $C_1/C_0=0$

$=Z_n$ when $C_1/C_0=1$

$=Z\phi$ when C_1/C_0 = infinity

The Author

The points brought out in these discussions deserve special consideration and an attempt will therefore be made to reply as fully as possible.

Tower Footing Resistance

High voltage steel tower lines are usually provided with overhead ground wires, supplemented with special grounding at the tower base and possibly buried counterpoise wires. Where any or all of these grounding facilities are provided, the effect of individual high tower footing resistance would be minimized. In those cases where no special grounding has been provided, tower footing resistance might prove a factor of some importance. This would apply particularly if the soil is of high resistance material, such as rock, or sand and gravel. It is quite possible, however, that this type of line would be more subject to flashovers involving two or more phases, in which case the phase-to-phase records should prove adequate for fault location. Although no difficulty has been experienced on steel tower lines as far as known, some difficulty has been experienced on wood pole lines. The redeeming feature on the wood pole lines, not provided with adequate grounding, is that in most cases, two or more phases are involved. In those cases of single-conductor-to-ground faults, the measured impedance is usually so high that no attempt is made to determine fault location from the records. This latter is especially true where two or more lines are operating in parallel with fault locating equipment on each line. Single-conductor-to-ground faults at the distribution stations are usually of low ground resistance and there have been several cases of quite accurate fault location for flashovers at distribution stations connected to wood pole lines.

Arc Resistance

There are a number of conditions where arc resistance might affect the accuracy of fault location. These include records on low voltage overhead lines, records during periods when the arc has become extended possibly due to high wind and a condition of obtaining a record as a broken or burned-off conductor is involved in an arc while falling to the ground. On relatively low voltage overhead lines, arc voltage may represent a large percentage of the system voltage. In practice, however, it is doubtful if this is a serious factor except on very short high voltage lines, or lines operating at less than possibly 4,000 volts. Fault locating equipment would probably not be applied to short overhead lines of any voltage and particularly lines operating at voltages below 4,000 volts. Moreover, on large capacity low voltage lines, the heavy fault currents would tend to keep the arc resistance per foot of arc to a low value, thereby tending to improve the general situation. In those cases where the arc might become extended, due to wind or other similar action, as might occur on line-end faults, the fault locator might be started from the sensitive protection so as to obtain the record before the arc has had time to become extended. To some extent this might apply to falling conductors but this is by no means certain. A single conductor lying on the ground might prove difficult of location if the soil is of high resistance material or possibly covered with either ice or snow. In general, fault location when applied to a broken conductor lying on the ground would appear to be more of a problem than high resistance tower footings. Fortunately, this type of fault does not occur frequently and a record obtained during the break might prove adequate, as the arc would probably involve two or more phases before reaching ground. In all of the records obtained to date, in only one case has a broken conductor affected the accuracy of fault location.

Resistance of Earth Return Circuit

This is a factor which may affect the accuracy of fault location on one and two conductors to ground. In practice this has not proved a serious factor, but where improved accuracy is required this may be obtained by conducting primary tests on the circuits under consideration. If this is not possible, the initial impedance-distance curves may be corrected as experience has been gained on the respective lines. In addition to the above, the formulae adapted to this application by Mr. R. B. Reed tend to minimize the effects of resistance of earth return circuit.

D-C Offset

A number of experiments have been completed on the possible effectiveness of a by-pass reactor for the current elements. These experiments have been rather gratifying and it is believed that the effect of d-c offset can be largely reduced in this manner. In the meantime a number of these reactors have been constructed and tested on existing instruments with a view to obtaining experience with regard to this problem and these experiments are being continued.

Recovery Voltage

No experience has been obtained on fault location where the clearing times are less than eight cycles and no difficulty has been experienced to date with recovery voltage. However, during 1941 an installation is being completed where the clearing times may be as low as six cycles. It is quite possible that future experience will dictate the necessity of special action regarding this feature and, as Mr. Brown has suggested, "electronic valves might prove to be the solution."

Simultaneous Operation of Auxiliary Relay Contracts

This is a condition which must be given careful consideration. Tests have revealed certain limitations but, in practice, voltage records have been moderately accurate without adopting special circuits. Should future experience indicate that trouble is being caused by this condition, then some action may become necessary.

Errors Due to Rectifier Units, Magnetic Links and the Surge Crest Ammeter

In practice, each element is calibrated as a unit and a given link is always used in the same current or potential element. The same surge crest ammeter is always used at any one station so that once this instrument has been properly adjusted, fairly consistent readings may be obtained. The back-flow of current through the rectifier is usually less than one per cent, so that this difficulty has not been important. The surge crest ammeter has an accuracy within the limits aimed at in the present arrangement. However, it may be necessary to use a different arrangement in the future. One important limitation at present is the range from minimum to maximum reading. This is only about ten to one, which is somewhat less than the preferred range, and may also require attention in the future.

Mr. Shill has suggested an arrangement of the current circuits to improve the accuracy of records. This arrangement might have certain advantages where it is impossible to use delta connected current transformers, or in case of single-conductor-to-ground faults. However, the added burden of the current elements together with the additional complication of fault analysis might tend to neutralize the advantages. No attempt has been made to use a circuit of this nature in the initial installations and it will be necessary to review the situation carefully before attempting to fully balance the advantages against the possible disadvantages.

Current Transformer Ratio Changes

In practice it has been customary to complete phantom load checks on all instruments in place in such a manner as to include all burdens encountered during operation. The calibration curves are then based on primary amperes and volts so that any current transformer ratio change is included in these curves. This represents considerable work, but the improved accuracy of readings appears to justify this method of calibration. In some cases these calibrations have been extended to primary tests, using an oscillograph to record currents and voltages, and from the results of these tests impedance-distance curves are plotted. In general, however, this procedure is not justified as calculated impedance-distance curves, based on phantom load checks, have proved satisfactory. In cases where it is difficult to calculate line constants, due to complications of system arrangement, primary tests would be desirable, although as mentioned previously actual experience should provide check points over a period of time. However, in those cases where either a d-c calculating board or an a-c network analyzer is available to the power company, these facilities could be used to good advantage.

Current and Potential Burdens

Current burdens are moderately low and compare favourably with relay burdens. These are somewhat as follows:—

0.5 to 5	ampere rating	= 65 VA/5 amperes
1.0 to 10	" "	= 13 VA/5 "
2.0 to 20	" "	= 7.5 VA/5 "
3.0 to 30	" "	= 5.0 VA/5 "

As the calibration curves are based on primary current under conditions of normal burden, accuracy of records is safeguarded. Protection relaying is not affected as the fault locator is not connected into the protection circuit until after the relays have operated. If the fault is within the instantaneous zone of protection, the circuit breaker receives a tripping impulse at about the same time as the fault locator. In any case, the instrument is only left in the protection circuits for a few half cycles. Potential burdens are low and should not prove a serious factor.

No attempt has been made to determine the direction of power flow during system faults with the present system. An arrangement of single wave rectifiers in the current and potential circuits might be used to furnish this record, but this might prove to be rather involved and possibly not suitable. However, the problem is worthy of consideration.

Use on 4,000 Volt to 12,000 Volt Underground Cable Systems

No experience has been obtained on underground cable systems to date. It would, however, be quite interesting to have one or more installations on a system of this nature. It is presumed that practically all faults on this type of system are of a permanent nature. A single portable instrument might, therefore, be used for a number of feeders in any one station, by providing a means of connecting into the relay circuits.

On radial feeders, no series difficulty should be experienced, particularly at the higher voltages. However, some difficulty might be experienced at the lower voltages, but even here experience might indicate that arc voltages might be low enough and consistent enough to establish fairly accurate impedance-distance curves for the various types of faults likely to occur in practice. It should not be necessary to make any changes in the fundamental design. although minor changes to the initiating and relay circuits might be necessary.

Time Required for Fault Location Analysis

Tests have been conducted to determine the times for various servicing operations. These are somewhat as follows:—

Time required to change links and reset the instrument—2 minutes.

Time required to take readings and demagnetize one set of links—5 minutes.

Time to transform original surge crest ammeter readings into primary current and voltage and analyze the results—about 15 minutes.

Total time—22 minutes.

This assumes an operation on an instrument which has been properly calibrated and for which there are available adequate calibration curves and impedance-distance formula. Any delay experienced in fault locator analysis is therefore due to conditions not directly associated with the instruments or records. This includes such problems as having a man available to take readings, a series of troubles in rapid succession, pressure of other duties during system troubles and possibly inadequate information on fault locator calibrations.

Some discussion has taken place with regard to additional faults occurring on a given line before magnetized links can be replaced and the instrument reset. This situation may develop, particularly during such conditions as wet snow, high wind, sleet or lightning. In case of transient faults, a number of faults might therefore occur with no corresponding fault location record. The work of taking readings, demagnetizing links, replacing links and resetting the instruments is comparatively simple, and can be done by the relay man, electrical repair man or anyone who has some knowledge of electrical equipment and who has received the necessary instructions. In times of severe storm, arrangements could probably be made to delegate someone, not directly connected with operation, to handle fault locator records. In this manner, more or less complete records could be obtained without interfering with normal operation. The readings could then be analyzed when convenient.

In case of a permanent outage on a transmission line, the record pertaining to the initial fault or faults on the respective line should be available. In case of necessity, it should be possible to close the line on test in order to obtain a specific reading. This record should then be compared with previous records in order to improve the accuracy of analysis.

The suggestion that an interpreting machine be developed has certain merit and an instrument of this nature could probably be devised. However, this type of instrument would be expensive and this might limit its application to important transmission lines operated by the larger power companies. This would appear to defeat the original purpose of the scheme which was to produce a low priced instrument of moderate accuracy which would have a wide application. The market price of the available instrument is such that it compares favourably with a graphic voltmeter or ammeter when equipped with high speed attachments and chronograph elements.

Any individual capable of handling the metering or relaying of a power system should be able to handle the fault locating equipment and fault analysis with the scheme presently developed. It should be kept in mind that this instrument is automatic in operation, can be returned to service after an operation by changing the links and operating a push button and need not interfere either with system operation or the operating staff during system troubles. It would, therefore, appear inadvisable to extend this development too far until more experience has been gained as to future requirements. It is quite possible, however, that if sufficient interest is taken in the present arrangement, additional improvements may be undertaken as the necessity arises.

The author would like to take this opportunity of expressing his appreciation to all those who have taken part in the discussion. Many good points have been given consideration and this has not only been helpful in foreseeing possible difficulties, but the interest shown has been gratifying.

DISCUSSION OF MOMENT DISTRIBUTION AND THE ANALYSIS OF A CONTINUOUS TRUSS OF VARYING DEPTH

Paper by E. R. Jacobsen, M.E.I.C.,[1] published in *The Engineering Journal*, January, 1941

H. J. A. Chambers, m.e.i.c.[2]

In discussing Mr. Jacobsen's paper one can hardly question the advisability of constructing a five-span continuous highway truss of varying depth, although this point might be raised.

Among the numerous means now employed in analyzing stresses in statically indeterminate structures, it is usually found that each designer uses the method of his preference. In this case the author submits that the method here presented involves less work and avoids some uncertainties inherent in other methods of analysis. While this may be apparently the case, in practice it may not actually be so. There are, undoubtedly, some among us who have already applied the Hardy Cross method to the continuous truss problem. Mr. Jacobsen, however, has taken the trouble to tell others about it. That he has found time to do so, under the pressure of war, makes his contribution all the more commendable.

There is perhaps a lack of clarity in the use of the same nomenclature in Formulae (5) and (6) under the heading "Fixed End Moment" as in Formulae (7), (8) and (9) under the heading "Carry Over Factor "*f*". Stresses X and Y in Formulae (5) and (6) are the result of the application of loads P, whereas X in Formulae (7), (8) and (9) is an assumed load, having no relation to load P and inducing stress Y at point b. This should perhaps have been made more clear, possibly by the use of subscripts. Also the statement that the minus sign in Equation (7) results from the fact that a moment applied at the free end of a member, fixed at the other end, produces a moment of opposite sign at the fixed end, while obvious in this instance, presupposes a knowledge of the sense of the moment in all cases. Unfortunately, this knowledge is frequently lacking. It would, perhaps, be better to state that, since the force Y has the opposite sense to the unit load at this point, the sign becomes negative.

There appears to be some doubt in the author's mind of Professor Haertlein's findings as to the general application. One wonders, therefore, at the advisability of using this short cut, since its use may not give approximations any nearer to the truth than the use of the moment distribution method using a uniform moment of inertia.

It would seem that the application of the basic formulae established in the paper should not present any serious difficulties. There is inherent in the design of a structure of this type a considerable amount of calculation. This should be lessened, however, by familiarity with this application of the Hardy Cross method.

The paper makes no reference to any investigations of stresses resulting from pier settlement. It should be kept in mind, of course, that this eventually can occur and, although the spans here are reaching lengths where reasonable settlement would not possibly have a serious effect upon the structure, the determination of the amount of these stresses should always be provided for.

Another factor entering into the stresses in a structure of this type might conceivably be the frictional resistance of the pier members. Normally this factor is neglected. In a five-span continuous truss, however, there are five restraints to movement from temperature effect. The movement is also considerable. It would be interesting to know if Mr. Jacobsen considered this in his analysis.

W. M. Laughlin, m.e.i.c.[3]

The writer wishes to offer his appreciation of Mr. Jacobsen's paper. The application of the Hardy Cross method of moment distribution to the analysis of continuous trusses of varying moments of inertia is unique. The determination of fixed-end moments, stiffnesses and carry-over factors for prismatic or solid-web members of varying moments of inertia has frequently been worked out but this is the first time the writer has seen such an application for trusses. The two laws of moment-area are usually applied to obtain these quantities for solid-web members of varying moment of inertia. In dealing with trusses, it is usual to consider only the chords in determining the moments of inertia, since the bending moments are resisted by the chords. The effect of web members does not add to the rigidity of the truss but rather makes it less rigid by reason of the distortion due to shear.

Referring to Table I of Mr. Jacobsen's paper for the 240 ft. span, neglecting all items for the web system, the writer

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[2] Chief Engineer, Hamilton Bridge Company, Limited, Hamilton, Ont.

[3] Designing Engineer, Dominion Bridge Company, Limited, Toronto, Ont.

calculates the left F.E.M. to be +15708 ft. kips and the right F.E.M. to be —18354 ft. kips which values are within three and five per cent, respectively, of the F.E.M's. used in the determination of the dead load moments for the 240 ft. span. Again, neglecting the web, the carry-over factor from left to right was 0.67, and from right to left 0.582, these values being both nine per cent higher than the values given for these quantities in the paper. Owing to curtailment of Table I for the 200 and 280 ft. spans, it was not possible to make a comparison of the stiffness factors. Also for comparison, the writer used the preliminary chord areas for the 240 ft. span, as determined by Mr. Jacobsen, on the assumption of constant moment of inertia. The moments of inertia were calculated at 20 ft. intervals and the web system was again neglected. This yielded a F.E.M. at the left of +15130 ft. kips and a F.E.M. at the right of −17570 ft. kips, these values being 6.6 and 9 per cent less than the values shown in Table I. The carry-over factors were 0.637 from left to right and 0.553, as against 0.614 and 0.535 shown in the table. The fixed-end moments were calculated by moment-area and checked by column analogy methods.

Mr. Jacobsen has shown us the tremendous saving in calculations resulting from moment distribution in analysis compared with conventional methods. Table III shows clearly the errors in moments over supports resulting from the usual assumption of constant moment of inertia. The application of Professor Haertlein's method, in which the $\frac{L}{A}$ terms for the members may be neglected, is very interesting and for the problem in question gives results in close agreement with the true moments.

It may be assumed that settlement of piers is of secondary importance for this structure. A continuous structure of this type would not be considered without fairly positive assurance that the settlement of piers would be negligible. The effect of any small settlement on any pier may be readily determined. The actual deflection of any point of the structure may be 10 per cent less than the theoretical deflection due to the effect of details in increasing the moment of inertia.

A. E. Macdonald, m.e.i.c.[4]

Mr. Jacobsen's paper is a definite contribution to the literature on the solution of trussed structures with redundant elements. Any method which can be applied to simplify and materially reduce the tedious calculations inherent in the conventional solution of statically indeterminate problems will be welcomed by structural designers. The author's adaptation of Professor Hardy Cross' method of moment distribution is not altogether surprising. More interesting, I think, is his application of the investigations of Professor Albert Haertlein, which tend to show that the lengths of members and more particularly their areas have less effect on the accuracy of analysis than has been supposed, and that the old dilemma of first having to know the area in order to find it may be taken care of, without practical error, by merely omitting the area term from summations.

Temperature must play some part in stressing members of such a long continuous truss, and it may be of some interest to know what effect it would have in this particular design. It is probably assumed that all but one of the reactions are "frictionless" and free to move longitudinally but, even so, a temperature variation of 100 deg. F. (from +70 deg. F. to − 30 deg. F.) would tend to shorten the truss a total of some 9 inches.

Again, it is always assumed that the supports are unyielding, yet this is not always the case and in a continuous truss such as this one any differential settlement of the piers would alter the distribution of the loading and consequently of member stresses.

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I. F. Morrison, m.e.i.c.[5]

In the process of the determination of the stresses in an indeterminate structure, a stage is reached which involves the solution of a set of simultaneous linear equations in terms of the redundants. In general these equations are of the form

$$\sum a_{ik} X_i = Z_i, \quad \begin{matrix} i & 1 \ldots\ldots\ldots n \\ k & 1 \ldots\ldots\ldots n \end{matrix} \qquad (1)$$

in which the a_{ik} are coefficients dependent only on the size, shape and elastic properties of the structure. The X_i are the redundants which may be chosen arbitrarily and the Z_i are constant terms which arise from various items such as the loading, temperature changes, etc. It is easy to show that the solution of the equations (1) can be obtained in the form of equations (2).

$$X_i = \sum b_{ik} Z_i \qquad (2)$$

in which the b_{ik} are explicit functions of the a_{ik} only. This method possesses the distinct advantage that once the b_{ik} are determined, they are constants for the structure and the changes of loading, and consequent changes in the Z_i enable the immediate and direct determination of the appropriate X_i.

The solution of the set of equations (1) by the usual process proves to be time-consuming, especially to those who are not skilled in the computation of determinants. It is natural, therefore, to expect engineers to seek to avoid the solution of these equations and it was for this purpose that the moment distribution method was developed by Professor Cross. That method, which has become further developed in the decade following 1930, effects the solution of the equations by a process of successive approximation and will always succeed wherever the process is convergent —as it usually is. In the present paper the author has quite successfully extended this process to apply to continuous

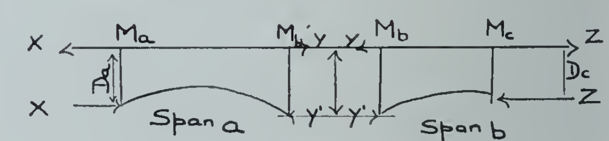

Fig. 5

trusses of variable depth and therefore has made a contribution of considerable value to the development of the method.

In every case, the number of redundants, external and internal, is equal to the degree of indeterminateness of the structure but the choice of the redundants, such as stresses in certain members, reactions, moments at supports, etc., is entirely arbitrary. For continuous structures, of the type under discussion in this paper, it is easy to show that, by choosing as redundants the moments over the supports, equations (1) become a set of three-term linear equations the coefficients of which form a symmetrical matrix. The solution of such equations is not difficult and may readily be reduced to a systematic process in which the calculations of the b_{ik} may be carried out on an ordinary slide-rule and the "difficulty and uncertainty of conventional methods" is not present. Unfortunately this method is not generally known to practising engineers.

The classical example of such a set of three-term equations is the well known three-moment equation of Clapeyron. A similar set of equations can be derived for framed structures such as illustrated in Figure 1 of the paper.

Figure 5 represents two contiguous spans of a continuous truss. Taking as the redundants the moments over the supports, i.e., the M_r the theory of least work gives the equation (3).

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$$\frac{M_a}{D_a}\sum_a \frac{U_aU_bL}{AE} + \frac{M_b}{D_b}\left(\sum_a \frac{U_b^2L}{AE} + \sum_b \frac{U_b^2L}{AE}\right) + \frac{M_c}{D_c}\sum_b \frac{U_cU_bL}{AE}$$
$$= -\sum_a \frac{S_oU_bL}{AE} - \sum_b \frac{S_oU_bL}{AE} \qquad (3)$$

The notation is essentially the same as in the paper. The S_o and S_o' are the stresses due to the real loads on the trusses taken as simply supported and the same terms may be made to include temperature effects, sinking of supports, etc.

This equation for trusses is the counterpart of the three-moment equation for girders. The coefficients $\frac{1}{D_a}\sum_a \frac{U_aU_bL,}{AE}$ etc are the a_{ik} of equations (1). The working out of their numerical values amounts to essentially the same process as that given in the paper and in fact they are, in a sense, stiffness factors; though not according to the definition laid down in the paper. The systematic solution of the numerical equations is not difficult and will lead to the same results as are obtained by the moment distribution method. No carry-over factors are required.

The equations (3) in the present case include only three unknowns and it is open to question whether the time spent in the direct solution of them would be any more than that involved in the moment distribution process. Moreover, once the b_{ik} have been determined, the

$$Z_i \equiv -\sum_a \frac{S_oU_bL}{AE} - \sum \frac{S_oU_bL}{AE}$$

can readily be computed to consider any number of loadings and this turns out to be especially convenient for influence lines.

In equations (5) and (6) of the paper the E_s have been omitted because if E be assumed constant throughout the structure it may be factored out and cancelled in the equations. It should be pointed out, however, that it is not the modulus of elasticity of the material of which the structure is built but the constant of proportionality of the total stress-stretch curve for each member of the truss that is represented by E in the equations (1) to (4) and it is pertinent to raise the question as to whether this is a constant for the members collectively. Compression tests on full sized built-up steel columns show that the variation is not large and give values which agree quite well with the modulus of elasticity of the material. However, the writer has been able—after only a brief search to be sure—to find nothing in the way of test values on the constant of proportionality for built-up tension members and there is reason to suspect that such information would yield results quite different from those determined by the compression tests. For this reason it is suggested that the E_s for the compression members may be different than those for the built-up tension members and therefore they could not be cancelled from the equations. This difficulty could be overcome, however, by multiplying the terms for tension members by the ratio $\frac{E_c}{E_t}$.

C. W. Deans, m.e.i.c.[6]

The use of the deflections in the energy method of the differential of $V = \sum \frac{S^2L}{2EA}$ where $S = P$ and $S = U_aX + U_bY$ is more accurate also than other schemes[7] where angle changes at joints are calculated and used as elastic weights. Mr. Jacobsen has shown very clearly the advantage of cancelling out the L over A terms for the purposes of preliminary design. The advantage of bringing complicated structural design into the realm of slide-rule operations is quite apparent in the clear way the paper is arranged.

[6] Acting Designing Engineer, Hamilton Bridge Western, Limited, Vancouver, B.C.

[7] "Beam Constants for Continuous Trusses and Beams," George L. Epps, Am. Soc. Civ. Engineers *Transactions*, Vol. 104, 1939, p. 1522.

The method has been applied, for brevity in presentation no doubt, only to a structure on unyielding supports but it is readily applicable to the investigation of the effect of the settling of supports. In this case the fixed-end moments will be found from the following simultaneous equations:

$$\triangle\left(\frac{D_b}{L}\right) = Y\sum \frac{U_b^2L}{EA} - X\sum \frac{U_aU_bL}{EA}$$
$$\triangle\left(\frac{D_a}{L}\right) = X\sum \frac{U_a^2L}{EA} - Y\sum \frac{U_aU_bL}{EA}$$

where $\triangle$ is the relative vertical displacement of the two ends of the span in question.

The calculation of fixed-end moments, carry-over factors and stiffness factors is very well explained. However it is perhaps well to point out that in Equations (10) and (11) the second term on the right is zero for the condition of the far end being free to rotate, as in the 200-ft. span, giving the added advantage of shortening the moment distribution procedure for the end joint and span.

A discussion of fixed-end moments calculation from the point of view of influence lines may be worth while. The use of simultaneous equations for each separate load condition as in Equations (5) and (6) is most useful for full span load conditions, but for the cases of partial span load conditions

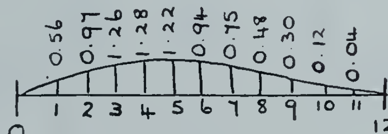

Fig. 6

it is advantageous to construct influence lines for fixed-end moments. The following is a suggested method: Let us consider the 240-ft. span. If $X = 1$ then the horizontal displacement is $\delta_b = \sum \frac{U_aU_bL}{EA}$; the equation for restoring the displacement to zero is $\delta_b' = Y\sum \frac{U_bU}{EA}$ so that for $\delta = \delta_b'$; $Y = \frac{\sum \frac{U_aU_bL}{EA}}{\sum \frac{U_b^2L}{EA}}$ which is similar to the carry-over equations (8) and (9). For this span $Y = \frac{61,403}{115,213} = 0.53$ from Columns 12 and 14 of Table I.

If we now multiply all the stresses of the line "Unit $MU_{12}L_{12}$" in Table V by (0.53) $\left(\frac{38}{33}\right) = 0.61$ with opposite sign and add them to stress values of line "Unit MU_0L_0" we have a set of stresses for the condition of moment at end U_0L_0 with end $U_{12}L_{12}$ fixed against rotation. Draw a Williot diagram with U_{12} and L_{12} fixed and determine the vertical displacements of load points δ_1', δ_2, ... δ_{11} and the horizontal displacement of $U_0 = \delta U_0$. The influence ordinates for X at U_0 are $\frac{\delta_1}{\delta U_0}$, $\frac{\delta_2}{\delta U_0}$ .... $\frac{\delta_{11}}{\delta U_0}$. Figure 6 shows the final form of the influence line for X at U_0, which gives fixed end moments directly.

End moments for partial loadings are determined by adding influence ordinates and multiplying by panel load as is usual in this type of work. The influence line for the far end being free can be taken directly from the Williot diagram for stresses recorded on the lines "MU_0L_0" and "$MU_{12}L_{12}$" in Table V.

In some cases of moment distribution work a great deal of time and space can be saved by balancing largest unbalances at each step in the procedure. Plus and minus additions and double calculations for distribution and carry-over factors can be avoided by using combined carry-over-distribution or COD factors shown in Table VI for the 240-ft. span.

Table VI

	a	b	c	d	e	e′	d′	c′	b′	a′
DF		0.41	0.59	0.50	0.50	0.50	0.50	0.59	0.41	
COF		0	0.61	0.53	0.52	0.52	0.53	0.61	0	
COD		0	0.36	0.26	0.26	0.26	0.26	0.26	0	

DF—Distribution Factor COD—Carry-over Distribution Factor
COF—Carry-over Factor

In this COD method it is best to distribute and carry over largest unbalances in order of size rather than in simultaneous steps across the whole sheet of calculations. After all the carry-over moments (COM) have been recorded, an addition is made and the sums are distributed in one final operation.

The advantage of using the percentage method of considering fixed-end moments is ably demonstrated by Mr. Jacobsen and should be noted. This arrangement with the other short cuts makes the moment distribution method of analyzing beams and trusses of varying depth very efficient and fast without any loss of accuracy.

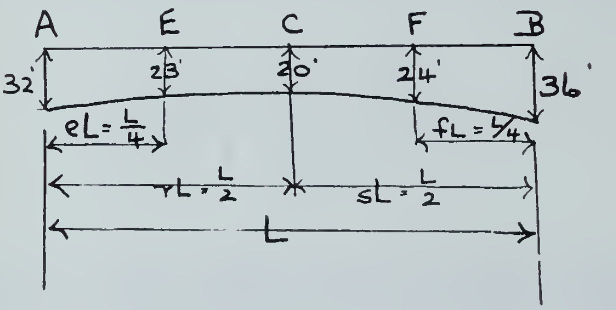

Fig. 7

The excellent arrangement of Table V should be studied. Perhaps it would be clearer if chord stresses and web stresses were kept separate, but that is a matter of choice. It should be pointed out that the method of using a stress diagram for unit reaction is most useful even in single span structures for moving load analysis.

Everything considered we should feel most grateful for the accurate and well explained paper prepared by Mr. Jacobsen, and students and practising engineers will be well advised to go over the paper in minute detail. Multiple span arches on trussed towers and multiple span trusses on trussed towers should be studied by using extensions of the ideas outlined in this paper.

C. M. Goodrich, m.e.i.c.[8]

Mr. Jacobsen's treatment of a continuous truss by moment distribution is a very clean-cut and workmanlike application of that method, using the elastic energy method to find carry-over and stiffness factors. It is a pleasure to see such a paper in the *Journal*, for it contributes to engineering knowledge.

It may be of interest to note the possible usefulness of the formulae developed by Weiskopf and Pickworth in the *Proceedings* of the American Society of Civil Engineers, October 1935. If one assumes the depths of the 240 ft. truss as shown in Fig. 7, and the moments of inertia to vary as the squares of the depths, the appropriate formulae and figures are as follows:—

$I_A = 2.56;\ I_E = 1.32;\ I_C = 1;\ I_F = 1.44;\ I_B = 3.24$ (relative I's)

$$A = \frac{I_A - I_C}{I_C} = 1.56 \qquad B = \frac{I_B - I_C}{I_C} = 2.24$$

$$n = \frac{lg\,\dfrac{I_A - I_E}{AI_E}}{lg\,\dfrac{e}{r}} = 1.11$$

$$m = \frac{lg\,\dfrac{I_B - I_E}{BI_E}}{lg\,\dfrac{f}{s}} = 1.07$$

$$F_1 = r^2\left[\frac{1}{2} - \frac{r}{3} + A\left(\frac{1}{n+2} - \frac{r}{n+3}\right)\right] = s^2\frac{I_A}{I_B}\left[\frac{1}{2} - \frac{s}{3} + B\left(\frac{1}{m+2} - \frac{s}{m+2}\right)\right] = 0.317$$

$$F_2 = r^3\left(\frac{1}{3} + \frac{A}{n+3}\right) + s\frac{I_A}{I_B}\left[1 - s + \frac{s^2}{3} + B\left(\frac{1}{m+1} - \frac{2s}{m+2} + \frac{s^2}{m+3}\right)\right] = 0.553$$

$$F_3 = r\left[1 - r + \frac{r^2}{3} + A\left(\frac{1}{n+1} - \frac{2r}{n+2} + \frac{r^2}{m+3}\right)\right] + s^3\frac{I_A}{I_B}\left(\frac{1}{3} + \frac{B}{m+3}\right) = 0.545$$

$$M_B = \frac{F_1}{F_2}M_A = 0.57\ M_A$$

$$M_A = \frac{F_1}{F_3}\ M_B = 0.58\ M_B$$

For stiffness:

$$K_A = \frac{F_2\,I_A}{4\,(F_2\,F_3 - F_1^2)\,L}$$

$$K_B = \frac{F_3\,I_A}{4\,(F_2\,F_3 - F_1^2)\,L}$$

The relative stiffnesses are as F_2 to F_3, 0.553 to 0.545, or 0.51 to 0.49. As to the actual stiffness, no figures can be made from the relative I's. Of course the design will change the relative I's from the ratio assumed. It will be noted that this treatment gives results roughly comparable in accuracy to the approximate method of Mr. Jacobsen's Table II.

There is another method which seems to possess sufficient accuracy, and an advantage over the Weiskopf and Pickworth method in the possibility of seeing more clearly what one is doing. In a beam of uniform moment of inertia, if we call $\angle B = 1$ the unit stiffness, then by Mohr's first theorem of elastic weights (announced in 1868), that the angle at B = the shear of the $\frac{M}{I}$ area divided by E, $\left(M_B\frac{L}{2}\frac{2}{3} - M_A\frac{L}{2}\frac{L}{3}\right)\frac{1}{EI} = \angle B = 1$. Now $\angle A = 0 = \left(M_B\frac{L}{2}\frac{1}{3} - M_A\frac{L}{2}\frac{2}{3}\right)\frac{1}{EI}$

From the latter $M_A = 1/2\ M_B$. From the former the stiffness $= \frac{M_B}{4EI}$. All this is for a uniform I. But to adapt it to a varying I we have only to plot the $\frac{M_X}{I}$ at various points, run a smooth curve through them, find the centroids of the two moment areas, and proceed as we did with the beam of uniform moment of inertia. This method seems rather attractive, as it cuts out all the $\frac{PUL}{E}$ work.

Whether the fabrication and erection can match the mathematical accuracy of the calculations is a doubtful matter, but fortunately that is of little practical importance, since at the limit of its capacity the structure can redistribute an overload in one part upon other elements with deformations still of the elastic order.

One wonders as to the treatment of the expansion problem as at least a 720-ft. length must be considered, with a

[8] Consulting Engineer, The Canadian Bridge Company, Limited, Walkerville, Ont.

range at the point farthest from the fixed point of say 8 inches. Slabs rounded at top and bottom, and of 30 inches and more in height have been very successfully used to provide a relatively free movement. This would, however, introduce a horizontal component in the case of so large a movement, while rollers would respond rather sluggishly, at least after a period of some years, when rust and dirt have accumulated. Rollers often offer considerable resistance to movement in old bridges, in such cases one hopes that the larger movements will take place when the span is unloaded.

There are alternatives to the design selected, doubtless all carefully considered. One is the so-called Garber system, where points off the piers are chosen to interrupt continuity, as is done in cantilever spans. This largely reduces the problem of expansion, and also renders the structure statically determinate.

A second possible alternative design is the Wichert truss, which is indeed the title of a book written by Dr. D. B. Steinman and published by Van Nostrand in 1932. The arrangement at the piers is as sketched in Fig. 8, where the heavy dots indicate pins. It will be noted that the structure is statically determinate, that any trifling errors

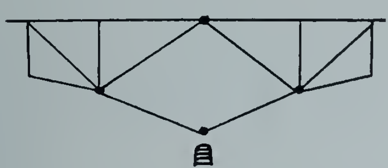

Fig. 8

in fabrication or erection (and settlements of piers as well) is automatically cared for. The problem of adequately caring for expansion remains the same as in Mr. Jacobsen's problem.

The Weiskopf and Pickworth formulae are applied to various uses, of which the above is but one instance, and at least two pamphlets on this subject were published by the American Institute of Steel Construction.

From the aesthetic standpoint, the outline of the 200-ft. span, where the central portion of the bottom cord L4-L6 is horizontal, is better than are the other two spans. The eye here travels more easily along the bottom chord.

Alfred Gordon[9]

The author's inspiration, to find the stiffness ratios, carry-over factors and F.E.M's of each span as ideally fixed, and then, with these constants, use moment distribution, starts an entirely new train of thought.

The great merit lies in having thought of these constants at all, for, by making moment distribution available, they save so much time that just how they are determined may seem a trifle, yet, in the writer's opinion even further saving may be effected by finding them in a somewhat different manner from the equations given.

The writer's suggestion is that the influence-line for the F.E.M's of each span as ideally fixed should be obtained immediately and directly, all the other constants required being found incidentally, as will be shown.

We know that if we take the beam shown in Fig. 9, and rotate the left-hand end, it will deflect as shown by the dotted line, and that this curve is also the influence-line for the moment at the left-hand end due to a unit load crossing the span when it is fixed at both ends, a uniform moment of inertia being assumed.[10]

We know also that this curve may be obtained qualitatively if we load the beam of Fig. 10 with the shaded area, representing the algebraic sum of the parallelogram and

Fig. 9

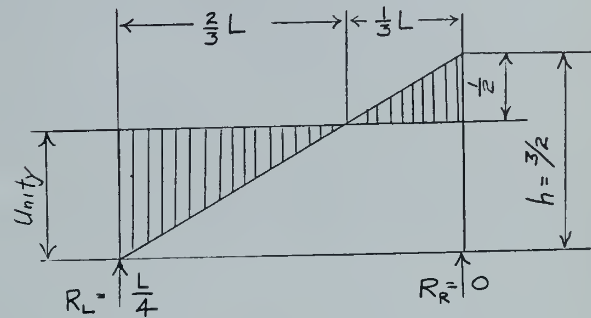

Fig. 10

triangle, and divide the resulting bending-moments by the reaction at the left-hand end.

We observe that the height ($h=3/2$) of the triangle was found by equating the moments of the parrallelogram and triangle about the left-hand end so that the right-hand reaction became zero, the left-hand reaction consequently becoming $L/4$; and we note that in the process of making this adjustment there appeared both the carry-over and stiffness factors for the left-hand end, the former being the ratio of the end moments, $(h-1)$ to 1, and the latter the reciprocal of the left-hand reaction, i.e. of $L/4$.

In short, the beam of Fig. 10 is "conjugate" to the "given" beam of Fig. 9, so that the shears and moments of the former are equal numerically to the slopes and deflections, respectively, of the latter. This conception[11] (a rather useful re-presentation of the method of "elastic weights") is doubtless so well-known that only allusion to it is necessary, and it may be superfluous to remark that for the end spans the "conjugate" beam will be a simple span upon which the load is a triangle of unit height at the restrained end of the actual span.

If the beam has a variable moment of inertia, the only change is a modification of the load applied to the "conjugate" beam, each ordinate or load of the diagram being divided by the appropriate I of the "given" beam. If the beam is unsymmetrical, and restrained at both ends, the same procedure must be followed for each end in turn. *If the "beam" is a framed truss, the loads applied to, and balanced on, the "conjugate" beam, are the same parallelograms and triangles, modified by the "elastic weights" of the various members of the truss.* The "elastic weight" of a truss member is $L/AE\rho^2$, ρ being the perpendicular distance to its moment centre. It is the exact counterpart of ds/I in beam analysis, and is applied as an "elastic load" at the moment centre of the member (except when this is inaccessible, two equivalent loads being then used, as described in various texts).

In a first approximation, at least, the effect of the web-members, as is well-known, may be neglected. This approximation, together with that of omitting all L and A terms, reduced the work of finding the "elastic loads" to calculating merely $1/\rho^2$ ($=G$) for each chord member.

If Y_p and Y_t be the ordinates of the parallelogram and triangle (of assumed unit height at the right-hand end) at any panel-point; G the "elastic weight" of the member having that panel-point for its moment-centre; and x the distance of the panel-point from the left-hand end: then the final elastic weight, W, to be placed at each panel-point is given by (with due regard to signs):

$$W=Y_pG+Y_tGh;\ \text{in which}\ h=\left(\sum Y_pGx\right)\div\left(\sum Y_tGx\right)$$

The bending-moments for these final weights, W, when divided by the sum of the weights, W, supplied as a reaction at the left-hand end, give the desired influence-line for the

[9] Canadian Pacific Railway Company, Montreal, Que.

[10] "Continuous Frames of Reinforced Concrete," Cross and Morgan, p. 79. "Applied Elasticity," Timoshenko, p. 126.

[11] "Deflection of Beams by the Conjugate Beam Method," H. M. Westergaard, *Journal* of the Western Society of Engineers, Vol. 26, No. 11, November, 1921.

moment at the left-hand end. The carry-over factor is $(h-1)$ and the stiffness factor is $1/W$. As a check, $\sum Wx=0$.

This procedure has several advantages:

1. The ideal F.E.M's are obtained for any loads whatsoever by the solving of two "conjugate" beams for each type of unsymmetrical intermediate span, and one for each end span, if they are different, the solutions at the same time giving all other constants required.
2. The calculations are extremely simple, because any units may be used so long as they are consistent, panel-lengths being most convenient, the multipliers becoming 1, 2, 3, etc., up to the number of panel-points, and moments are obtained by successive addition.
3. It is readily checked during development, quite a consideration, as there is usually no check until columns of summations have been made, and equations have been solved.
4. For continuous spans, when the number is so great as five or more and especially if "point loads" have to be taken into account, as they would have to be in a railway bridge, there is much to be said for graphical or semi-graphical methods,[12] which are greatly facilitated by this method of determining the constants; thus: The points of inflection of the influence-lines for the F-E.M's are "fixed points" of the spans, and may be accurately located as the points of zero shear for the "elastic loads" used in finding the influence-lines. The intersections of the line joining the ideal F.E.M's of any one span with the two vertical lines through these "fixed points" locate the "characteristic points." By means of the latter the complete moment diagram for a unit load at any point may be rapidly drawn, and the reactions thereby found. By the method of double influence-lines,[13] once the reaction influence-lines are drawn, all others, whether for moment or shear, may be obtained without any further work except drawing lines across them. This takes full advantage of the simultaneous determination of the F.E.M's, and is, in the writer's opinion, quicker than moment distribution for the particular problem. If, however, only full span loads are considered, this special advantage does not result, though it is still very convenient to have all the F.E.M's at "one fell swoop."

The figures obtained by this procedure, for the example given, were, in part, as follows:

	200 ft. Span	240 ft. Span	
Stiffness Factor	0.367	0.633	
Carry-over	0	0.63	0.57
F.E.M	18,800	15,450	17,320

The lever arms were merely scaled from a small diagram. The length of all chords was taken as one, except that of those next to the peak over the pier, which was taken as ½. All areas were taken as one. Web members were omitted. Despite all these crudities, the results are in substantial agreement with those of the author, so it appears doubly certain that a uniform moment of inertia is just about the one assumption that should not be made even for a first approximation.

A. R. Ketterson, m.e.i.c. [14]

The determination of the maximum stress in the members of a five-span continuous truss bridge by conventional methods, even when each truss is of uniform depth throughout, is a tedious job in itself, but the problem in this case is further complicated by the fact that each truss is of varying depth with the result that the computations to determine the unknown moments over the supports require an exceptional degree of patience and perseverance backed by good judgment to enable the various steps in the procedure to be carried through without error.

To determine the unknowns, practically all of the so-called conventional methods require the solution of successive sets of simultaneous equations, each containing terms which are themselves unknown and require to be estimated by judgment. It is a process of "trial and error" and then try again.

A most interesting section of the paper is that dealing with Professor Haertlein's discovery that, in general, the L over A terms in the virtual-work series could be omitted without appreciably affecting the final results. It is interesting to note that, for the dead load moment over the first support the omission of these terms made no difference and over the second support the difference was found to be only 3 per cent. Having in mind the fact that the calculations which include these terms involve the summation of a large number of small strains produced by the computed (or theoretical) stress in the various members, but that their actual stress under service conditions may vary therefrom as a result of external conditions, such as the effect of connections and of other members, it would seem that an even greater discrepancy could be ignored under such circumstances.

Referring to the fixed end moments, carry-over factors and stiffness ratios as determined from Table I, the writer infers that, starting with the member areas found by assuming a constant moment of inertia for each span it was necessary to set up Table I, or its equivalent, several times before a final solution which was considered sufficiently accurate was reached. It may be a question, therefore, whether the time expended in arriving at this preliminary table would not have seen the designer well on his journey towards the complete solution of the stresses by other methods.

However, by investigating Professor Haertlein's claim when applied to structures like that under discussion—and thus obtaining the material for Table II—the author has not only contributed information on a subject which should be valuable to every designer, but has also demonstrated that, at least for those structures in which the L over A term may be omitted (which would be the majority of ordinary cases), his suggested method is direct and saves much time and drudgery. The writer doubts, however, that the latter remarks would apply if it were always necessary to go through the procedure involved in arriving at the final Table I.

That a still greater saving might be possible by the adoption of some other method is, in any case, beside the point. Methods may often be left to individual preference—what may seem the longest way round may be the shortest way home if the direct route is full of pitfalls. It has been wisely stated that the best methods are those which enable the designer to vizualize the varying distortions of the structure which result from the varying mathematical steps. The suggested method conforms to that requirement. With some of the older conventional procedures the designer is liable to become so steeped in the solution of successive equations that his analytical work does not provide the assistance it otherwise should, when he begins the actual design, which, after all, is the important matter for which the computations are the preliminaries. No doubt there are many structures in which the actual service stress is quite different from the computed stress because of a lack of harmony between the various members which have a common meeting place under the influence of the stiff gussets which form the connections.

In the case of a railway bridge having span lengths the same as in this structure, or somewhat longer, it would be possible, after setting up Tables II and IV, to reduce the subsequent work since it would probably be found unnecessary to adhere strictly to those combinations of span loadings—either full or partial—which according to

[12] "Moments in Restrained and Continuous Beams by the Method of Conjugate Points," Nishkian and Steinman, Paper 1598, Am. Soc. C.E., the discussion as well as the paper. Note that for symmetrical spans Ruppel's Tables are available.

[13] "Movable and Long-Span Bridges," Hool and Kinne, Sec. 4-3 by D. B. Steinman.

[14] Bridge Engineer, Canadian Pacific Railway Company, Montreal, Que.

theory are necessary for the determination of maximums—are, nevertheless, when applied to service conditions, highly improbable combinations in some cases and impracticable in others.

S. D. Lash, M.E.I.C.[15]

More than forty years ago Professor Perry observed that not more than one good engineer in a hundred believes in what is usually called theory. Unless the percentage has greatly increased in the intervening years Mr. Jacobsen must belong to a very select group, for he has given proof not only of his belief in theory, but of his ability to use the tools provided by theory, with considerable adroitness.

It is interesting to read in the *Proceedings* of the Institution of Civil Engineers for 1850 that the Board of Railway Commissioners would not permit the use of a continuous tubular girder of two spans, which had been built for the Manchester, Sheffield and Lincolnshire railway at Torksey. The reason given was that if the spans were considered as simply supported, as had been done by Stephenson in the case of the Brittannia bridge, the allowable working stresses were exceeded. The ban continued for four months during which time the effects of continuity were hotly debated. It was finally established both by actual tests and by mathematical analysis that the stresses were greatly reduced by virtue of the continuity and the bridge was allowed to go into service. Rather surprisingly, there was no mention in the discussion of the possible consequences of settlement of the middle support.

It would seem, however, that bridge engineers have been reluctant to take advantage of the economies made possible by continuity largely owing to doubt about the effects of unequal settlement of supports and also owing to the more difficult calculations that are required. Mr. Jacobsen has indicated methods by which the latter difficulties may be overcome and it would be interesting to know if his studies indicated the probable effects of the former. In recent years there appears to have been a tendency to prefer the Wichert truss to the continuous truss since it is statically determinate and stresses are not induced by sinking of an intermediate support.

On previous occasions continuous trusses have been analysed using Professor Cross' "column analogy" method. Most engineers will prefer the moment distribution method described by Mr. Jacobsen if only for the reason that the significance of the method can be much more easily grasped. There would appear to be no doubt about the general validity of Mr. Jacobsen's approach and there are only a number of minor points to which attention may be directed.

The extension of the Maxwell-Mohr equations to include external couples, in order to determine fixed end moments, appears to be unnecessary. Actually this has not been done, since Equations (1) and (4) are not expressed in terms of angular rotations but in terms of linear displacements resulting from the application of horizontal forces at the ends of the top chord of the truss. It is true of course that in order to balance these forces suitable reactions must be introduced at the supports. However this is always the case whether the loads be horizontal or vertical and such reactions do no work and hence do not enter into the equations.

The use of the symbol U to represent stresses in members resulting from unit loads at deflection points is not in agreement with American Standards Association Standard Z 10a 1932, where u is preferred, and is somewhat confusing to those familiar with British literature in which U is the symbol for strain energy.

Engineers generally should be grateful to Mr. Jacobsen for drawing attention to Professor Haertlein's approximate method for determining stresses in redundant members. Approximate methods for solving redundant structures are of great utility and often prove to be surprisingly accurate. For example studies were made by Professor Baker of the University of Bristol of the distribution of moments in building frames on the assumption that columns were of uniform cross-section throughout their length. A check indicated that errors introduced by this apparently very drastic assumption were not likely to exceed two per cent. It appears probable however that the errors introduced by approximate method will be greatest in circumstances where it is difficult to make a check, viz: when the number of redundancies is large.

W. Chase Thompson, M.E.I.C.[16]

The method has been so clearly described in the text, and so well illustrated by diagrams and tables, that little can be said in criticism, except as follows: In the text, the equations for determining the fixed-end moments have been arranged for an intermediate span, whereas the lettering on the illustrating diagram would indicate an end span. This is slightly confusing, appearing to indicate that fixed-end moments are required at both ends of the end spans as well as for the intermediate spans. Now, although the necessary adaptations of these equations have been made in Tables I and II, it would seem advisable to explain in the text that, for the end spans, fixed-end moments are to be computed for the restrained end only, and to show the arrangement of the equations required for this case, in addition to that already provided for intermediate spans.

Referring to live-load stresses in the web members: To obtain mathematically-correct results for partially loaded spans, it would be necessary to calculate the fixed-end moments for every point of loading on the bridge, which would greatly increase the designer's work; even so, the total labour involved would not exceed that required to design, for point loadings, a continuous plate girder of variable I. But such treatment, although insisted upon by some engineers, seems to be an unnecessary refinement.

The writer has recently been engaged in designing a continuous-truss highway bridge of three spans: 120+240+120 ft. It may be explained that the central span of 240 ft. had been fixed by existing conditions, and that the side spans were made sufficiently long only to prevent uplift at the ends. For the final design of the trusses, the elastic-curve method was used, by which all stresses were obtained, and which may be considered to be substantially correct.

Then, in order to determine the degree of accuracy of the author's method for obtaining stresses in web members due to discontinuity of live load in a given span, the stresses produced by the omitted loads, as computed for a truss of uniform I, were deducted from the substantially-correct stresses, as previously obtained by the elastic-curve method for the controling combination of fully-loaded spans. The live-load stresses in web members, thus derived, were found to be from 0 to 5 per cent too great; but, when combined with the dead-load stress therein, the resulting total stress in the central web members was only 2.5 per cent too great, and in no way affected the section of these members which was determined by the stiffness requirements of the specification rather than by the stress. For all other web members, the total difference in stress did not exceed one per cent, and in no case was any difference in section required. Thus no reasonable objection can be made to the author's method for obtaining such stresses.

For a continuous truss having more than three spans, Mr. Jacobsen's method is particularly advantageous; but, where only two or three spans are involved, the elastic-curve method seems to be more convenient in some respects and to involve less labour. By this method substantially-correct reactions for unit loads at panel points may be readily derived; thus there is no need for fixed-end moments, carry-over factors, stiffness factors or moment distribution; and no additional work is required to obtain the stresses in web members due to broken loading in a span.

The elastic curve is constructed from ordinates obtained

[15] Acting Secretary, National Building Code Project, National Research Council, Ottawa, Ont.

[16] Engineer, Department of Public Works of the Province of Quebec, Quebec.

by a Williot diagram and representing the vertical deflection of every panel point when the truss is supported at both ends only and subjected to a unit load applied at one of the two intermediate supports, both of which are assumed to be removed temporarily. Having determined the elastic curve, a slide rule may be used with sufficient accuracy in calculating the reaction coefficients.

J. C. Trueman[17]

Knowing that the omission of the $\frac{A}{L}$ factor gives a close approximation will save the designer considerable time. Even though the error be much greater than the 3 per cent figure of this particular case, the original unit calculations apply to all subsequent trials so that further trials will not be laborious.

The author's original approach, assuming uniform moment of inertia and solving by the three moment theorem, is not in itself a difficult calculation. The writer has made the same calculations using the Cross method both on the basis of equal stiffness for all spans and on the basis of stiffness varying as to length of span. These different assumptions for stiffness affected the resulting moments very little, suggesting that the error is largely included in the fixed-end moments. The results were about 15 per cent in error, a little less than the author's 20 per cent. The method, to the writer, is simpler. The calculation is not needed for preliminary areas. It gives, however, a rough overall check since it is obvious from the shape of the trusses that the true moments will be greater than those so found. In view of this latter, the writer wondered why the author had not added some arbitrary percentage to the moments before making his first approximation of areas (Table I).

The author found an error of one or two per cent in his approximations for web members (part loading) but does not say whether this is a percentage of the total dead and live or of live load stresses only. The writer is interested in this phase as many highway bridges built in the West have wood decks. These have, of course, a higher proportion of live load stress than in the author's example. The economy of continuity will be less and the error of live load stress in webs more important. It would be interesting to know in this regard the estimated saving in tonnage of this continuous bridge over corresponding simple spans.

The author is to be complimented on the clear presentation and on his confining the paper to the principle and method involved without digressing into detail or variations not necessary for that purpose.

R. M. Hardy, m.e.i.c.[18]

The author has contributed an interesting and valuable piece of technique to the literature of the analysis of indeterminate structures. His approach to the solution of the particular problem discussed is from the engineering and not the mathematician's point of view. For this reason the paper will probably be the better appreciated by its readers.

It is of interest, however, to approach the general problem involved from the mathematicians point of view. From this aspect the technique of handling the computations to determine the redundant moments is essentially a process of solving a set of simultaneous equations by successive approximations. It seems reasonable to suppose, therefore, that the general equations of the conventional analysis for indeterminate structures based on the principle of Maxwell-Mohr could be arranged so that the technique of successive approximations could be applied to them.

Such an attempt has been made by O. T. Voodhigula in a paper scheduled to appear in the December, 1940, *Proceedings* of the A.S.C.E. In accordance with this procedure Mr. Jacobsen's fundamental equations can be generalized as follows:

$$-\sum\frac{PU_aL}{AE} = X\sum\frac{U_a^2L}{AE} + Y\sum\frac{U_aU_bL}{AE} + Z\sum\frac{U_aU_cL}{AE} + \ldots \text{(a)}$$

$$-\sum\frac{PU_bL}{AE} = X\sum\frac{U_aU_bL}{AE} + Y\sum\frac{U_b^2L}{AE} + Z\sum\frac{U_bU_cL}{AE} + \ldots \text{(b)}$$

$$-\sum\frac{PU_cL}{AE} = X\sum\frac{U_aU_cL}{AE} + Y\sum\frac{U_bU_cL}{AE} + Z\sum\frac{U_c^2L}{AE} + \ldots \text{(c)}$$

where in (a), (b) and (c) the terminology is the same as used by Mr. Jacobsen except that the redundants X, Y and Z may be any redundants, reactions, moments, or bar stresses; and U_a, U_b, U_c are the stresses due to the redundants X, Y, Z, respectively, having values of unity.

Equations (a), (b) and (c) may be written:

$$X = -\frac{\sum\frac{PU_aL}{AE}}{\sum\frac{U_a^2L}{AE}} - Y\frac{\sum\frac{U_aU_bL}{AE}}{\sum\frac{U_a^2L}{AE}} - Z\frac{\sum\frac{U_aU_cL}{AE}}{\sum\frac{U_a^2L}{AE}} - \ldots\ldots\ldots \text{(d)}$$

$$Y = -\frac{\sum\frac{PU_bL}{AE}}{\sum\frac{U_b^2L}{AE}} - X\frac{\sum\frac{U_aU_bL}{AE}}{\sum\frac{U_b^2L}{AE}} - Z\frac{\sum\frac{U_bU_cL}{AE}}{\sum\frac{U_b^2L}{AE}} - \ldots\ldots\ldots \text{(e)}$$

$$Z = -\frac{\sum\frac{PU_cL}{AE}}{\sum\frac{U_c^2L}{AE}} - X\frac{\sum\frac{U_aU_cL}{AE}}{\sum\frac{U_c^2L}{AE}} - Y\frac{\sum\frac{U_bU_cL}{AE}}{\sum\frac{U_c^2L}{AE}} - \ldots\ldots\ldots \text{(f)}$$

Consider the terms in (d). The first term is the value of the redundant X when no other redundants are acting. Further in the second term the coefficient Y is the value of the redundant X when the redundant Y is unity, or, it satisfies the definition of a "carry-over factor" for any value of the redundant Y to give the corresponding value of the redundant X. Similarly the coefficient of Z in the third term can be regarded as a "carry-over factor" from Z. The corresponding terms in equations (e) and (f) will, of course, have analogous meanings.

In applying this last group of equations, appropriate redundants would be selected and the first term of each equation computed. These values constitute the first approximation for the values of the redundants. The "carry-over factors" can then be readily figured, and the process of successive approximations applied in essentially the same manner as in the "moment distribution" procedure. It will be noted, however, that the process is simplified to the extent that no "stiffness factors" enter into the analysis. However, on the other hand the summations for the computations of the "carry-over factor" are for the whole frame, not simply for one span as in Mr. Jacobsen's procedure.

Equations (d), (e) and (f) are perfectly general and the redundancies may be either internal or external. In the case of external redundancies either moments or reactions may be selected as the redundants, but most designers would probably select them as reactions. It will also be noted that the simplification of assuming $\frac{L}{AE}$ constant can be introduced if desired.

The Author

The author wishes to express his appreciation for the thoroughness of the discussion and his thanks for the unanimous kindness of the discussers.

Mr. Chambers' commendation for finding time under pressure of war to prepare a paper applies equally well to Mr. Chambers and the others who have found time to digest and discuss the paper. Actually, the paper was conceived and roughly drafted before the pressure became

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[18] Assistant Professor of Civil Engineering, University of Alberta, Edmonton, Alta.

acute. But it did suffer in its final stages and the author has since been unable to give this discussion the consideration it deserves.

Before considering each discussion, it will save time to deal with those points which are common to several.

The first, while not strictly germane to the paper, appears to be pier settlement, mentioned by Messrs. Chambers, Deans, Lash, Laughlin and Macdonald. Obviously, foundation conditions must be taken into account before continuous structures are projected. However, on spans over a hundred feet, pier settlements large enough to cause serious overstress would have to be taken care of for quite other reasons. That is to say, the necessity for jacking and shimming would be apparent long before a structure of such dimensions would feel any structural distress. For instance, on the six-span continuous Ste-Anne-de-la-Pérade bridge (see *Engineering Journal*, April, 1938) a settlement of four inches, which would be objectionable from the point of view of grade, produced overstresses of 22 per cent—well within the elastic limit.

Unfortunately, the author has not found time to work out figures for the case under review. However, the method of the paper lends itself to such a study. Replace any pier by a unit load. Fix adjacent ends. Resulting PU/E tables will give deflections and fixed-end moments which are then distributed to give moments resulting from a pier deflection equal to the deflection found at the removed pier. Note that this deflection is, in terms of our example, the result of simple and fixed-end conditions. Mr. Deans' or Mr. Morrison's mathematical statement of this problem is to be noted.

The concern about expansion members dates from the days when rollers were made too small and were not properly guided to prevent misalignment and jamming. With modern pintle design, large rollers, proper skirting and dust and water protection, there can be little doubt that expansion members will act as they are supposed to with a minimum of resistance.

Criticism of the author's nomenclature and symbols by Messrs. Chambers, Lash and Thomson is justified. Nothing is more annoying in a technical paper than poor or faulty nomenclature and it is to be hoped that the remarks of these discussers will serve as a sufficient warning as regards this deficiency in the text.

The author is very grateful for the independent checks on his figures by Messrs. Goodrich, Gordon, Laughlin and Thomson. Speaking of independent checks such as those advanced by Mr. Goodrich and Mr. Laughlin, they either assume a solid web or neglect the web members. From the point of view of results, these assumptions may be accurate enough, but the author, as is usually the case, was under the necessity of producing a stress-sheet for each figure of which a watchful department was going to demand chapter and verse.

Mr. Chambers is to be commended for entering the discussion with his critical faculties at the alert. It is true that most designers have their own favourite methods. Now, on any particular job, it is always shorter to use the known method than to develop a new one. Unfortunately, there the matter usually rests until the next time.

Mr. Deans' favourable comments are doubly appreciated because of the discerning nature of his discussion. With rare economy and felicity of statement, Mr. Deans has made four distinct additions to the paper. His reference to and appraisal of Mr. George L. Epps' paper is to be noted. His statement of the pier settlement problem is terse and adequate. His calculation of influence lines from the data of the paper is useful. Lastly, he has added a refinement to the art of moment distribution which deserves a fuller treatment and which will repay study.

Mr. Goodrich's two alternate methods are to be welcomed. As a matter of reference, an example of his second method will be found fully worked out in the now famous discussion of Mr. Hardy Cross' pioneer paper in the *Transactions* of A.S.C.E., 1930. The Gerber system has been used by the author but, in this case, problems of details and erection outweighed its other advantages. The Wichert truss introduces complicated details, it makes difficult the simple cantilever erection necessary on high piers and it requires a steeper angle in the end chords over the supports than was deemed desirable. It was the author's good fortune a number of years ago to come under the stimulating influence of Mr. Goodrich who first interested and instructed him in the work of Hardy Cross.

Mr. Alfred Gordon's discussion extends the boundaries of the paper by adapting the useful and too little appreciated "conjugate" beam theory to a framed truss. It is to be regretted that he took so much for granted in suggesting the transition from the beam theory to the truss theory. Mr. Deans' remarks and his reference to Mr. Epps' paper should be taken in conjunction with Mr. Gordon's discussion. In passing, it is the author's feeling that the expression "method of elastic weights" has a misleading air of unreality which does a disservice to the simplicity and straightforwardness of the method itself.

Mr. Hardy has pointed out that the author's approach is from an engineering and not a mathematical point of view. This is a significant and discerning observation. The choice was a very conscious one on the part of the writer. It is therefore salutary that two such excellent appraisals should appear from a strictly mathematical point of view as those of Mr. Hardy and Mr. Morrison. In the author's opinion, Mr. Voodhigula's paper in the December *Proceedings* of the A.S.C.E. did not live up to the expectations engendered by Mr. Hardy's discussion. It seemed to have as its main preoccupation an unwarranted idea of the difficulties of solving a series of simultaneous equations. Like Mr. Morrison, the author has been unable to find any data relating to the difference between constants of proportionality of tension and compression built up members.

Mr. Ketterson's general remarks are both kind and penetrating. He questions the saving in time were it necessary to set up Table I involving lengths and areas rather than to proceed directly to Table II. By actual count, the number of calculations for the conventional solution using the four reactions as redundants was eight times as many as were required to arrive at the same result via Table I. In practice, however, Table II would be set up first and Table I would be used as a final check if deemed necessary.

Mr. Lash does not think it was necessary to extend the Maxwell-Mohr equations to include couples. The author cannot agree, although the point is mainly academic. Rotations are measured by the relative movements of the top and bottom of the end verticals. True, we can assume the base of one end vertical as fixed, but the bottom of the other end vertical must of necessity move from its original position.

The author is grateful for Mr. Chase Thomson's corroboration in the matter of the effect of broken loads on web members. He agrees, further, that the three-span continuous truss falls into a rather special category to which the elastic curve treatment is particularly applicable.

In answer to Mr. Trueman's question, the errors of one to two per cent in web stresses are for total dead plus live load. The ratio of dead to live load was about one to one. The author cannot give figures for a comparable simple span. The point is that the desired arched profile does not lend itself to simple span treatment.

In the main, the discussions speak for themselves and do not need further comment by the author.

CONSTRUCTION NORTH OF 54°

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Summary of an address delivered to the London Branch of the Engineering Institute of Canada, on December 12, 1940.

NOTE—This brief paper is based on observations made during a summer spent in the Mackenzie River basin, supplemented by information kindly supplied by the Consolidated Mining and Smelting Co. of Canada, Ltd., and Imperial Oil Ltd. The paper may be regarded as a supplement to that by Professor J. A. Allan, entitled "Mineral Development North of 54°" and published in *The Engineering Journal* for June, 1940. In order to make this description of construction activity in the Mackenzie basin complete in itself, a general description of the area has been included even though a similar note is to be found in Professor Allan's paper. Photographs kindly supplied by the two companies already mentioned supplement those of the author in serving as illustrations.

Further particulars of the Wellington Lake water power plant will be found in a paper by E. M. Stiles published in the Bulletin of the Canadian Institute of Mining and Metallurgy for August, 1940, on pages 468-480. In the February, 1941, issue of the same journal appears a description by Max W. Ball of the Abasand tar-sand refining project at Fort MacMurray, mentioned briefly at the end of this paper. Since the paper was written, the area with which it deals has attracted public attention because of the decision to build a series of airfields between Edmonton and Alaska. Some of the difficulties to be faced during the construction of these fields will be apparent from the description which follows.

Although recent developments in the vast area of northwestern Canada formed by the Mackenzie River Basin are known to mining engineers, if only because of the much publicised Eldorado radium mine on Great Bear Lake, to civil engineers the region still remains as a large space on maps of the continent and but little more. The distortions of map projections have probably led many to discount the size of the basin. Actually, the Mackenzie is one of the eight major river systems of the world, second only in size, in North America, to the Mississippi. Its catchment area is about 682,000 square miles, the St. Lawrence basin being only 498,000 square miles in comparison. From its source to its deltaic mouth in the Arctic Ocean the Mackenzie is about 2,525 miles long, the Columbia River ranking third in length at 2,200 miles. And Great Slave Lake, with an area of over 12,000 square miles, is the fourth great lake of the continent.

Extending from the 53rd parallel to the Arctic Ocean, the topography of the basin is featured by a central plain flanked by the western extremity of the Laurentian Shield on the east, and by the Rocky Mountains on the west. First explored by Alexander Mackenzie in 1791, in one of the greatest canoe journeys ever made, the region retained its virgin character until well on into the present century. The trapping of fur bearing animals was the only encroachment of man into this vast area of the wilds. Hudson's Bay Company posts along the main waterways were the only permanent settlements. Transport was limited to movements along navigable waterways and to short journeys inland from the river banks.

The coming of the aeroplane effected a radical change, making contact with the outer world regular and speedy, and permitting the study of large areas of otherwise inaccessible country with ease. The first flight into the North from Edmonton was made in March, 1921. In 1922 planes of the Royal Canadian Air Force started aerial survey work. To-day, two well established aerial transport companies operate regular services along the Mackenzie as far as the Arctic from Edmonton, Alberta, and Prince Albert, Saskatchewan. Aerial surveying of the basin is well advanced, especially for those parts adjacent to the main water routes. Strategically located government radio stations enable all planes to maintain constant touch with land throughout the entire area. Airport problems do not exist, for all planes are fitted with pontoons in summer and with skis in winter, using the rivers and innumerable lakes as regular and emergency landing places. Loose ice conditions in the fall and spring, and excessive smoke from forest fires are the only obstacles in the way of all-the-year schedules.

Prospecting, in the pre-cambrian rocks of the Shield, was greatly facilitated by aerial travel. As a result of the increased activity in prospecting, five gold mines are to-day

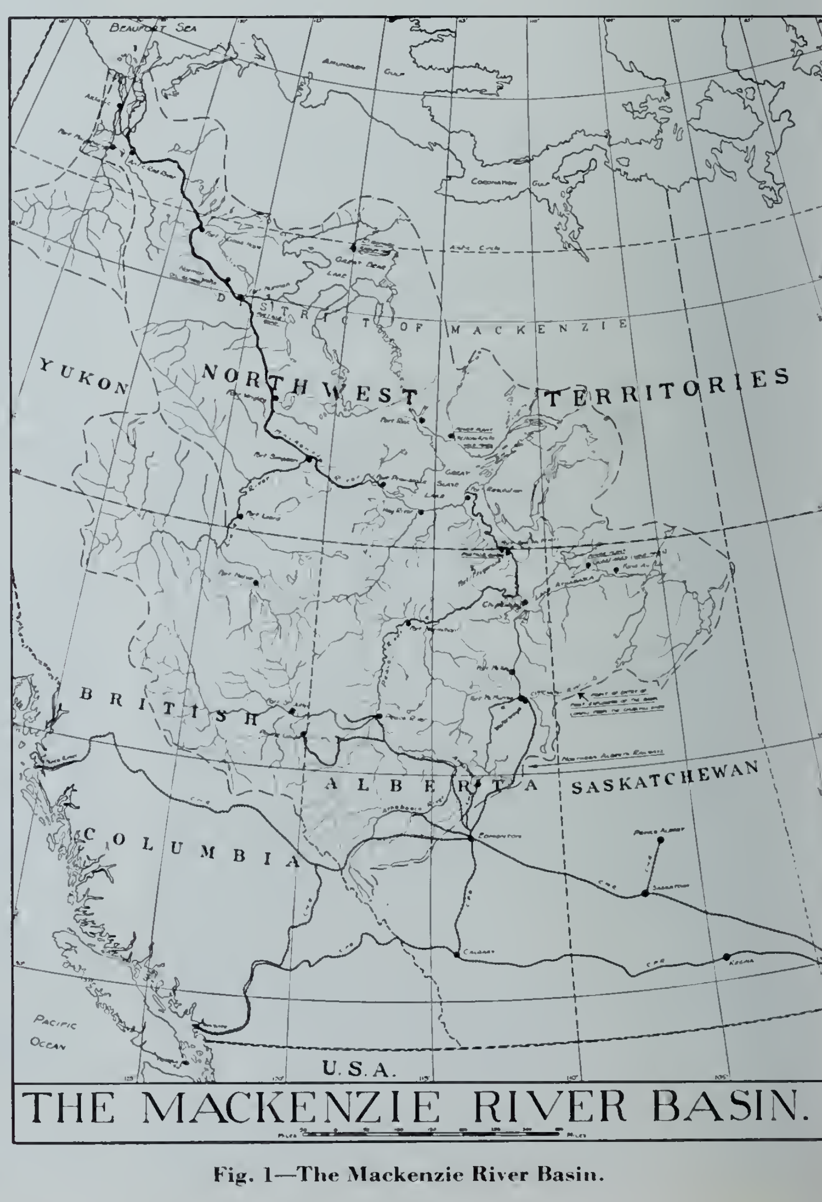


Fig. 1—The Mackenzie River Basin.

operating on the north shores of Lake Athabasca and Great Slave Lake, while on Great Bear Lake is the well known radium mine, now shut down. Other prospects are in course of development. Where previously Fort Smith, "capital" of the Northwest Territories, was the metropolis of the basin with a total population of about 400, to-day Goldfields on Lake Athabasca has a population of about 1,000 and Yellowknife on Great Slave Lake is about the same size, both thriving mining settlements.

The mills associated with the gold mines have a total capacity of 1,700 tons of ore per day; their construction involved the usual structural work encountered with mill buildings. Power supply was originally obtained from Diesel engines, but to-day the Box mine at Goldfields is served by a small water power plant on Wellington Lake, power being delivered to the mine over a 22 mile 60,000 volt transmission line. In view of the nature of the country traversed, rocky and rugged with much muskeg, steel towers were used for the line with the longest spans practicable. In consequence, there are only 107 spans in the whole line. Water for the plant is diverted from Tazin Lake through a 16 ft. by 12 ft. rock tunnel 1,100 ft. long, to Mud Lake. Three open cuts, totaling 77,000 cubic yards of excavation, provide a water channel from Mud Lake to White Lake, the level of which has been raised 15 ft. by a log crib dam 350 ft. long. Serving as the forebay, this lake is tapped by another tunnel, 15 ft. in diameter leading to two 10 ft. woodstave pipes, through a 14 ft. wye piece, and so to the power house. At present a flow of 500 cu. ft. per sec. is used to generate 3,300 h.p. under a 75 ft. head, but all the permanent works have been designed and constructed for an ultimate development of 6,600 h.p. using 1,000 cu. ft. per sec.

Fig. 2—Loading equipment for transport by air to Mud Lake, during the construction of the Wellington Lake Water power development.

Constructed in 1937-38 the plant called for no unusual construction methods but it did necessitate special transportation arrangements. Every conceivable means of transport in the north was employed at some time during the progress of the job, even to dog teams in the winter for hauling lumber over the ice. The greatest difficulties were encountered in connection with the Mud Lake tunnel and open cut excavation. A road was constructed from Lake Athabasca to the power house site, but diligent search failed to reveal any route from there to Mud Lake, either by land or by water, that would provide a road that could be economically constructed in the time available. All equipment and supplies for this section of the work were therefore flown in to the site. Handled in this way, in several large multi-passenger planes, were 300 tons of oil, 250 tons of gasoline, food for 40,000 man-shifts of work, three two-ton trucks, three 360-cu. ft. compressors, eighteen dump ore cars, a four-ton gasoline locomotive, and even a three-quarter yard Diesel shovel, this being the largest size that could be dismantled into parts sufficiently small for transport by air. The cost of this unusual transport job was $48,000, the total transportation cost for the whole project,

Fig. 3—Rock fill dam in process of construction on Bluefish Lake, as part of the Prosperous Lake water power development.

from the railhead at Waterways, being $229,000. Labour costs amounted to $457,000, the complete installation costing in all $1,511,600. This figure should be considered only in relation to the extremely isolated location of the job, and the fact that a good deal of the work had to be carried out in winter.

There has just been completed, to serve the mines in the Yellowknife area, a second water power plant of 4,700 h.p. capacity on Prosperous Lake, the power house of which is located on the Yellowknife River, below the lake. Water storage is obtained in nearby Bluefish Lake, the level of which has been raised 10 ft. by a rockfill crib dam about 500 ft. long, the penstock being supplied through a 900 ft. rock tunnel. Surge tank and penstock are of woodstave construction, the latter being 1,800 ft. long, giving a head of 105 ft. at the power house. Power will be delivered to the mines over a 22 mile transmission line, also constructed with steel towers and unusually long spans. Transportation problems have been relatively easy since all material could be delivered almost to the power house site by water with only one transfer from the regular freighting service on Great Slave Lake. Construction started with the summer opening of navigation in 1940 and was completed early in 1941. Both water power plants are projects of the Consolidated Mining and Smelting Company of Canada Limited, for whom W. G. Jewett is local superintendent.

The precious metal mines are all located in that part of the Mackenzie basin formed by the edge of the Laurentian Shield. To the west, but unconformable with the pre-cambrian rocks of the Shield, are exposures of cretaceous and palaeozoic rocks in which occur coal and oil deposits. One of the coal beds exposed on the banks of the Mackenzie River has been burning slowly ever since it was first seen by Mackenzie in 1791. Although the coal has been little used

Fig. 4—General view of oil refinery at Norman Wells, about 100 miles south of the Arctic Circle.

as yet, the Imperial Oil Company Limited have a small oil refinery located at Norman Wells, about 100 miles south of the Arctic Circle. Their Discovery Well No. 1 was completed in 1921 but lack of a market for the oil delayed further progress. Recent mining operations have provided a small market and led to the building of the refinery in 1939. The new unit has a capacity of 840 barrels of crude oil per day; an aviation gasoline and light Diesel fuel are produced. It operates for about three months of each year, all equipment near the river being hauled up high on the bank before the winter sets in so that it shall be clear of spring flood waters. Flood water level may be more than 50 ft. above normal water level, due to the fact that the river flows northwards and so thaws out first at its source; this unusual feature affects all river-bank development.

Construction of the refinery was interesting in that the ground at the site is frozen to a depth of over 50 feet, thawing out in the short summer season to no more than 18 inches below the surface. Grading operations for construction consisted of "skimming" off this thawed layer, and using it to form a foundation area raised above the general level of the surrounding ground. This raised section of thawed out earth was surrounded by a stone filled trench which prevents surface drainage from entering the soil and so freezing during the winter. As the untouched ground beneath the fill will never thaw, since the sun never reaches it, all frost heaving has been prevented. All equipment for the refinery had to be brought in to the site by water, the heaviest pieces being limited to 10 tons in weight and 10 ft. by 35 ft. in size. The fractionating tower was 35 ft. high and 4 ft. in diameter and so was shipped complete. All large piping was shop fabricated; storage tanks were of bolted construction.

Fig. 5—General view of the water front on the Clearwater River, at Waterways, Alberta. Freight cars on Northern Alberta Railway spur can be seen in centre, discharging into typical river craft below.

It will be appreciated that apart from the surmounting of climatic difficulties such construction as has been carried out in this great area has presented few unusual features. Contrary to usual experience, it is transport rather than building operations that presents the problems. Aerial transport has been mentioned; it provides all mail and light express service, but ordinary freight and heavy equipment have to be brought in by water, during the very short summer season of open navigation, always less than six months. The Northern Alberta Railway provides access to the basin from Edmonton by means of their Peace River lines and that to Waterways on the Clearwater River near its junction with the Athabasca River; the latter is the route used for all but local Peace River shipments. From Waterways to the Arctic Ocean at Aklavik the river route is about 1,600 miles long and in this distance the fall in water level is only 820 feet. Very fortunately 125 feet of this drop occur in a series of big rapids at Fort Smith, N.W.T., and these provide the only serious impediment to navigation in the whole course of this long journey to the sea. Two sixteen-mile portage roads have been built around the rapids on which operate competing fleets of heavy duty trucks and tractors capable of handling practically anything that can be loaded on to river boats from railway cars at Waterways.

The several water transport organizations have each to maintain two fleets of vessels, above and below the Fort Smith rapids respectively. The service thus provided has a special interest in that it is now one of the very few inland water transportation systems in this continent unaffected, as yet, by competition from road or rail. The economic problems are as unusual as the service provided. Practically all freight moves one way only, to the north; all freight for the Northwest Territories has to be portaged sixteen miles; and all freight for the year has to be moved in less than six months—these are some of the problems that complicate operations. In recent years there have always been competing transport services, but most of these have had short periods of existence. One service only has continued unimpaired throughout the years, that provided by the Mackenzie River Transport, a branch of the Hudson's Bay Company which has been operating in the north of Canada since it was incorporated on 2nd. May, 1670. The M. R. T. fleets consist of steam wood-fired stern-wheelers for passenger and special freight traffic, and Diesel tunnel tug boats and barges for its general freight services. On these boats over two thirds of the total freight on the river is handled.

Fig. 6—Steel drums of an electric mine hoist being unloaded at Fort Fitzgerald for portage, by truck to Fort Smith, seventeen miles downstream. Sternwheeler S.S. "Northland Echo" in background.

This note cannot close without brief reference to the tar sand deposits in the vicinity of Waterways and Fort MacMurray, Alberta, the latter settlement usually having its name associated with the deposits. Believed to cover an area of at least 750 square miles, and of great thickness, this vast area of bituminous sand has tempted many to investigate the commercial possibilities of separating the sand from the oil and bitumen. Several small plants have operated with some success and some of the untreated sand has been used for road pavement work in some locations in Alberta, but it has yet to be shown that the separation of the constituents can be put upon an economic basis. One small plant is operating to-day near MacMurray. When commercial success is achieved, the southern end of the Mackenzie River basin may be expected to develop rapidly. Until that time it would appear that human activity in this great area will continue to depend on the vagaries of precious metal mining as the only rival to fur trapping, which, after all these years, still remains the major incursion of man into this last frontier of the Continent.

UNDERPINNING THE HEADQUARTERS BUILDING

The Institute Council appreciates the willing response of the branches to the appeal for funds to meet the unforeseen expenditure on the foundations of the Headquarters' building. The House Committee—under whose direction this necessary repair work was handled—has approved the publication of the following detailed information about the undertaking, as it is felt that members generally should know why and how the money was spent. It is desirable also that the *Journal* should contain a record of a piece of work whose success was important to the Institute, even though it involved no unusual engineering features. The account which follows is based upon a report kindly furnished by Brian R. Perry, Chairman of the House Committee, who investigated the trouble and supervised the work of the contractors. E. V. Gage, representing the contractors, is also another member of the Institute.

Early in the summer of 1940, cracks opened up in the rear wall of the Headquarters building that indicated some foundation settlement. They were not serious enough to be considered dangerous, but the movement soon developed to the point where repairs were essential. In October, the House Committee reported to Council and were authorized to dig test pits to develop the fundamental reason for the cracking before arranging details and drawing definite conclusions for the extent of the repair.

The southwest corner of the wall had settled and the south wall was cracked horizontally near the top. Further, the rear wall opened in a wedge-shaped split with a maximum of 2 in.; this compares with a settlement which was probably about ½ in. at the extreme southwest corner. At the same time plaster partitions inside the auditorium section indicated a minor settlement of one interior column.

The rear portion of the Headquarters building contains a large auditorium section of fireproof design which was built in 1912. The front portion, facing on Mansfield Street, is an old residence built many years earlier and has shown evidence of minor settlement for many years. No details were available as to the type of foundation. Drawings of the auditorium section were available and indicated wood piles, but there were no details as to their arrangement or length.

Fig. 1—Cracked wall in the library on the ground floor.

To investigate the condition, three test pits were opened to expose the underside of the foundations. The first was dug at the southwest corner where trouble had developed; a second was located at the front portion of the south wall, and the third along the north wall. In general, the conditions found were quite uniform although there was some difference in degree. Excavation was carried through about 18 in. of fill and top soil and 3 to 4 ft. of firm yellow clay, at which point blue clay was encountered. These materials are all typical of Montreal conditions. In the test pits on the south side, the blue clay near the top was stiff and firm. On the north side this blue clay, even in the upper layer, was so soft that a man would sink in several inches. Pipes were driven in all test holes, pushed down by hand for about 20 ft. and then driven with a hammer. At a depth of about 25 ft. the sounding pipes brought up on hard pan and boulders. No water was encountered in the pits except a small amount of ground water seeping in from the top soil. Due to shrinkage of the clay from diminution of water content over a period of years, the clay had settled quite evenly away from the bottom of the foundation pads which were about 5 ft. wide. It was interesting to note the surprising uniformity of the settlement in each area. The soil had obviously shrunk so that a clear space existed as far as a flashlight could show details. The irregularities of the underside of the concrete footings were evident in the top surface of the clay. It was also noted that even around the wood piles the soil had settled quite cleanly and uniformly with very little disturbance due to adhering to the piles.

Fig. 2—Southwest corner of auditorium on the second floor, showing damage to plaster partition.

While the settlement was quite uniform in any one area, it varied in amount, being about 5 to 6 in. at the southwest corner; about 3 in. toward the front of this wall and 1½ in. under the north wall. As would be expected this shrinkage varied consistently with the firmness of the upper layers of clay.

Under the walls there were three rows of wood piles at about two foot centres; a surprisingly large number considering that the building is not heavy. The piles were small and badly decayed at the southwest corner. At the second test hole there was also evidence of considerable decay, but not as bad as at the rear. On the north side, where the clay was wet, the piles were quite sound. The conclusions of the committee were that the settlement was obviously due to decay which was associated with the fact that shrinkage had produced an air space and a semi-dry condition conducive to the development of decay under the footings. It seemed evident that the changed moisture condition in the clay was largely due to the very rapid and almost complete run-off of natural precipitation due to the large percentage of the ground covered by buildings and pavement during the past years. Along the south wall it is probable that one or two large trees contribute a great deal to the trouble by drawing moisture from the upper layers of the ground, but it is also possible that the location of the bricked-in ventilating duct laid on the basement floor along the south wall may have had some drying effect.

Fig. 3—Rear wall of building, showing the amount of movement previous to underpinning.

The committee investigated various means of doing the work and recommended to Council that competitive tenders should be received for various portions of the work. The principal decision to be made and obviously the most serious one was the extent to which underpinning should be carried. The very fact of doing work of this kind was certain to upset existing static conditions somewhat; and the provision of permanent support in only a portion of the building was also certain to hasten the relative movement of adjacent portions. It seemed obvious that the fundamental foundation condition was uniform and that eventually there would be trouble throughout the building although the decay had reached the final stage at only one corner. If a partial repair was undertaken the cost would be somewhat higher than the proportion of the building taken care of. Without doubt a second section would not be undertaken before the need became very obvious and the resulting repairs to masonry cracks, plastering and consequent complete re-decoration would cost well over a thousand dollars. Comparing this to the expenditure for a complete job, Council decided to proceed at once with the underpinning of the auditorium section complete, together with the old wall dividing this new building from the old residence. Similar proportional expense for this old building did not appear to be justified and its consideration was eliminated.

In considering repair, partial estimates were made of several arrangements for permanent support. Steel and pipe piles were investigated and also consideration was given to such ideas as lowering the footings and re-capping the existing wood piles after cutting off at a lower level where reasonably permanent moisture appeared to be available. Practically all of these alternative schemes were eliminated after checking comparative costs. It was found that sinking open piers would be the cheapest, quickest, most adaptable and permanent method of repair and would cause less disruption of normal headquarters activities. Sinking these open piers (often miscalled caissons in this district) requires only the simplest of equipment and unskilled labour, the availability of men and material being of primary importance due to war conditions. These piers are 4 ft. 6 in. diameter which is the minimum size in which a man can conveniently work. Their load carrying capacity is far greater than is necessary in this case but the ultimate cost was considerably less than for other methods. Due to the structural arrangement of the building with large windows and frequent points of concentrated load, it was necessary to support at twenty-one points. The aggregate capacity of this support is far in excess of the building load. However, it was found to be more expensive to attempt to introduce beams spanning from point to point than to sink the extra piers required. The only variation from this arrangement occurred at the interior columns which are located in pairs. They are quite close together and it was obviously very convenient to sink a pier mid-way between two columns and then install a steel beam to pick up the symmetrical column load after the lower part of the underpinning had been completed. This also avoided any necessity of shoring the upper floors; which would have been comparatively expensive due to suspended plaster ceilings. The use of piers also eliminated the necessity for needling through exterior walls to provide temporary support and it was also possible to do 80 per cent of the work from outside the building with obvious economy and a great saving of inconvenience to the staff.

The committee called for competitive prices on the basis of this scheme which seemed to them to be the cheapest and was without question definite and reliable. At the same time, they provided generous latitude for the submission of any alternate scheme which would provide safe support and which might be more economical. Prices, based on the plans and specifications and alternative bids, were received on various types of concrete piles jacked into place which varied in cost from $12,000.00 to $18,500.00. It is interesting to note that in the opinion of the committee the conditions developed during actual construction would have made it economically impractical to carry through any of the alternates submitted. In spite of the considerable difference in prices, it was the opinion of the committee that the lowest figure was reasonably safe, if not generous; it was therefore accepted and work started early in January.

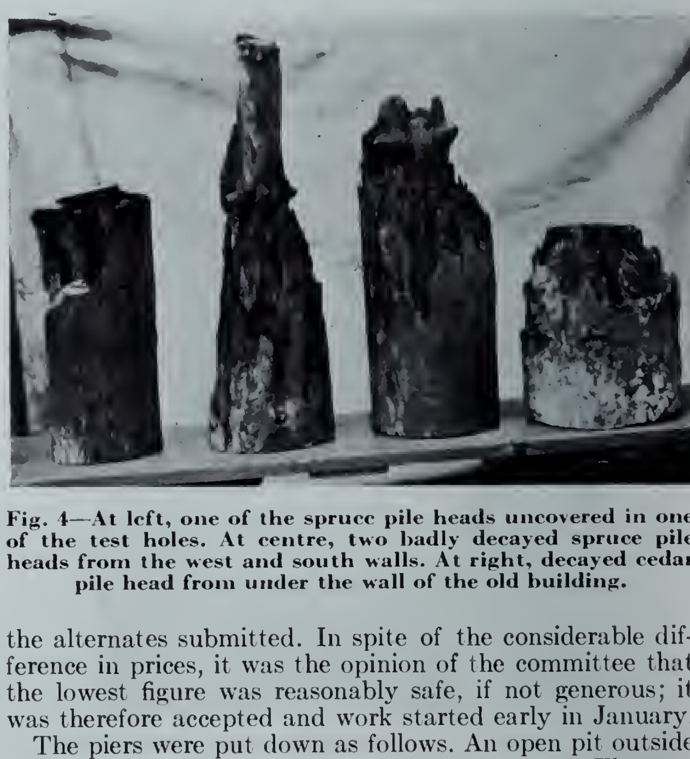


Fig. 4—At left, one of the spruce pile heads uncovered in one of the test holes. At centre, two badly decayed spruce pile heads from the west and south walls. At right, decayed cedar pile head from under the wall of the old building.

The piers were put down as follows. An open pit outside the building was carried 3 ft. below footing level. The projecting portion of the footing pad was broken off and any piles that interfered were cut away. Excavation was then carried on in the restricted size required for the pier. As soon as a depth of 3 to 4 ft. was reached, the excavated hole was trimmed carefully to diameter and 2-in. plank sheeting was placed in short vertical lengths, set in a ring; heavy steel hoops were used to support the sheeting in a true circle and to carry pressure when it developed. If necessary, the rings were held in place by occasional spikes driven into the sheeting. The excavation was carried out progressively to full depth in this manner using small derricks with buckets to remove the material. Even at the lower depths, the clay stood up quite satisfactorily to allow placing the sheeting loose. It was unnecessary at this pit to drive sheeting down into the clay ahead of the open excavation as is often the case where clay is extremely soft and pressure serious. Some pressure developed in all piers due to the plastic nature of the clay. It was possible to carry the pit down about 8 ft. in a shift with one man working at the bottom of the hole and another at the top, hoisting and taking the material away. As soon as satisfactory bearing material was reached and approved the hole was filled with concrete. It is necessary to have the full area of concrete at the bottom to provide bearing; but it is uneconomical and not practical to attempt to build forms and erect small sized shafts to carry the load above. For this reason, a comparatively lean concrete was used carried up on to within six inches of the under side of the footing and allowed to set. After preliminary set and consequent shrinkage was complete, this space was then packed with a dry mix of fine concrete rammed in place by hand using a small heavy tamp.

The depth to which footings were carried was determined by examination after taking the first two or three piers quite deep into the hardpan to make sure that satisfactory material had been reached and was not underlaid by soft layers. The material under the building proved to be soft clay to within about three feet of hardpan. At this point, it changed to a finely divided or pulverized limestone flour. Undoubtedly, there is a considerable clay content mixed with it and in this district it is ordinarily classed as clay, in the building trade. However, it acts in a very different manner from clay, particularly in that it bleeds water when exposed. This difference may involve a serious construction difficulty although in this particular case no trouble developed. It was noticeable that, at this level, water continually trickled into the excavation and it was essential to sheet the excavation although no pressure developed. If left exposed, large chunks of this soil would crack away and fall into the hole instead of squeezing in a plastic manner as in the clay above. The hardpan commenced at a uniform level and formed a very marked stratum. At the top of the hard-pan, the mixture is of ordinary sized gravel embedded in clay. At many points, it was soft due to the constant presence of water carried in the granular material overlying it. Within a few inches, clay in the hardpan became extremely stiff and the boulders increased in size rapidly with depth. These conditions are typical in the Montreal district. Such hardpan is quite satisfactory as bearing material and in many cases is so tough and well cemented that pneumatic spades are required for its removal.

Throughout the excavation, it was necessary to remove the wooden piles. These piles proved to be very small at the tip and most of them reached into the hardpan. The deepest ones driven did not enter the hardpan more than about three feet at which point they were locked between boulders and in many cases were badly broomed. It would appear that the springy nature of the piles and the small tip permitted the heavy driving that apparently was done and which caused some brooming at the pile heads. A few of the piles were found to slope as much as 15 deg., some of them passing out of the caisson excavation entirely and in many holes new piles were encountered as digging proceeded. A great many piles in the west and south walls were badly decayed and as expected those in the southwest corner proved to be the worst. One of these piles was rotted away completely for a height of two feet. Under the old residence wall, it was found that piles also had been used; these were of cedar, and comparatively large, being about 12 to 14 in. diameter. Only six or seven of these piles were removed as they were not closely spaced. In two instances, it was found that short piles had been driven with an additional butt about five feet long driven on top; apparently an old fashioned touch of economy. No splice had been used except that the piles had been cut square. It was interesting to note that the tops of the whole cedar piles were quite badly decayed for a height of about two feet but that these 5-ft. butts were so completely rotted away that they had no structural value.

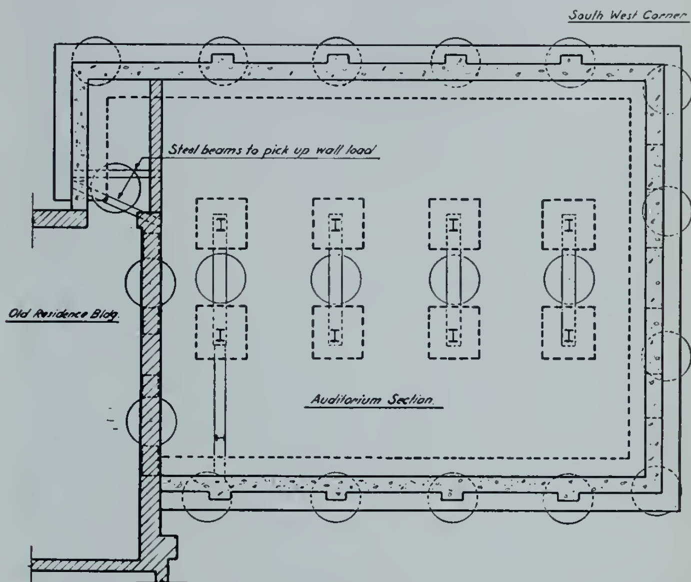


Fig. 5—Plan of the auditorium section showing location of new piers.

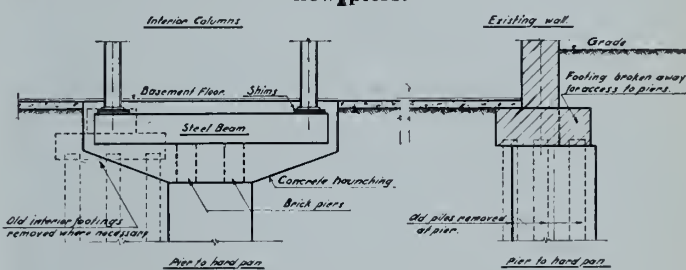


Fig. 6—Sectional view showing the arrangement of the piers between the interior columns.

No serious movement developed during the work. Some attention was paid to this detail and paper stickers were maintained over all cracks. A few of these tore through indicating a very slight movement which could be termed adjustment.

This spring, the brickwork at the southwest corner was cut out and bonded across the main crack and some plaster has been cut away. Complete plaster repairs and re-decoration remain to be done. Obviously it is essential to permit time for adjustment of all strains and movement before carrying out this portion of the repair.

Not the least important part of the work was the clearing out of all books and accumulation of magazines and other fyles from the basement. This room was fitted up as a library years ago and a great mass of papers and records had accumulated which Institute facilities could not utilise. It is interesting to note that at least six tons of scrap paper was sold.

In carrying out these repairs the House Committee was greatly assisted by the co-operation of the general contractors A. F. Byers & Company Limited. The Committee itself was augmented and profited by the advice of Messrs. R. E. Jamieson, J. A. Lalonde, and J. A. McCrory, all of whom were invited to assist because of their wide construction experience. The Committee is pleased to report that the work has been done satisfactorily and none the less happy to report also that the contractors made a satisfactory profit.

Abstracts of Current Literature

Abstracts of articles appearing in the current technical periodicals

BRITISH WORKMANSHIP

From *Trade & Engineering*, (London), April, 1941

"None of Our Aircraft is Missing"

On good days the official communiqués relating to the bombing activities of the R.A.F. frequently conclude with the words "None of our aircraft is missing." It all sounds so simple, as though the aircraft have had an uneventful, unmolested journey; but often the truthfulness of that ending is due to the sterling qualities of the big machines to which our pilots and crews have entrusted their lives, and in part also to the skill and devotion of the ground maintenance crews and the skill and endurance of the flying crews.

The shattered condition in which some of our aircraft have survived terrible batterings by the German anti-aircraft guns and yet succeeded in reaching home is a better tribute to the skill of British workmanship than anything else could be. It is doubtful whether the majority of German aeroplanes would have survived similar rough treatment. Very recently, for instance, a Whitley bomber, while seeking its target at Cologne, was hit by a splinter which penetrated the fuselage. By sheer bad luck the splinter also hit a particularly large flare and blew it up. The consequence can easily be imagined. The whole of the skin and ribs were blown off one side of the fuselage, and on the other side most of the rivets were forced out. There was very little left to hold on the tailplane, but it held; and after they had reached home safely pilot and crew were the first to acknowledge that they owed their safe home-coming to the first-class workmanship.

There are many similar stories. One is of the tail and rudder of a Hampden being shattered by cannon and machine-gun bullets by three Junkers bombers, which attacked at the same time; another, of the fuselage and of a Whitley which were holed by anti-aircraft fire while the British bomber was flying at a height of little more than 2,000 ft.; a third is of a Wellington hit in six places by a severe barrage over Berlin; a fourth, of very serious damage to the port airscrew of another Hampden; and a fifth, of a Hurricane which came back looking more like a colander than a fighter aircraft. And yet, in the words of the official communique, "all our aircraft returned safely."

There is almost no end to the stories demonstrating the toughness of British aircraft. The case is recorded of a Hampden, flying over Hamburg, which received a direct hit in the port wing which ripped open the oil tanks. Yet the port engine, much to the pilot's relief and astonishment, ran "sweetly" all the way home—a distance of more than 400 miles. A Blenheim operating over Rotterdam met exceptionally heavy anti-aircraft fire and the port oil tank was perforated in three places, the lead from the starboard petrol tank was fractured, the elevator main spar was holed, the main spar and fin shot through and a rudder cable cut half through. There were also holes in the tail and fuselage. Yet the buffeted machine not only got home but was back in service within three days.

Another Blenheim actually rose safely again after hitting the sea at almost full speed. After this dangerous encounter with the water the airscrew was badly bent back, the tail wheel was missing, the bomb-hatch cover stove in, and the cowlings and air intakes completely wrecked. Yet once again the machine remained airworthy and made what the pilot afterwards declared to have been a "good" journey home.

This is the sort of thing which is happening every week. Nothing could have been put to a more severe test than British workmanship and materials—and nothing could have emerged from that test with greater credit.

THE ROLE OF THE ENGINEER

From *Civil Engineering and Public Works Review*, May, 1941

Every day that passes brings fresh proof of the important part which the machine is playing in the war effort of the nation. The present struggle is only one of machine against machine and of the men that design and operate them. There is nothing new in this. Down the ages the engineer has ever played his part in warfare as in the more peaceful pursuits. When Alexander the Great attacked the Phoenician town of Tyre, he was only successful after his engineers had constructed a causeway across the strip of water that separated the town from the mainland. It was the engineer and his skill who made the final military assault possible.

The defeat of the Spanish Armada was directly attributable to the superior skill displayed in designing and building the ships used by Drake, Frobisher and the other sea captains of Queen Elizabeth. This skill was no chance thing, but was the outcome of experience gained by the sailors when fighting the enemy along the Spanish Main. The superiority of the English ships can be traced to the careful co-operation of the ship-builders of those days with the men who had to sail in those ships when they were built. It was this co-operation that made it possible to arm Elizabeth's ships more heavily than their Spanish equivalent. This skill played as great a part in the defeat of the Armada as did the courage and the determination of the men who sailed in them. It placed in the hands of the sailors the weapon with which to strike the enemy.

If the part played by the craftsmen in the days of Elizabeth was one of the decisive factors in that epoch making struggle, it is entirely overshadowed by the work of the engineer of to-day. In whatever direction we probe in our endeavours to gain a true picture of the nation's war effort we meet the work of the skilled craftsman and the product of the scientifically trained mind. In the days of Drake the ships stood as the great memorial to the skill of the shipwright. To-day there is no branch of the Army, the Navy or the Air Force that is not dependent on the skill of hands and the genius of science for the implements which it uses.

Since the rise of the Nazi regime to power, the German people have steadily and quietly devoted all their technical skill to the development of the machine for the purposes of war. The scientific mind of the German abandoned its peace-time pursuits and turned to the consideration of every aspect of the creation of an efficient and overwhelmingly powerful mechanised war machine. As physicists, chemists and metallurgists developed their researches, the military engineer translated that scientific knowledge into machines for the Army, the Navy and the Air Force.

The conception of the machine age was fully exploited and the rapid break through last summer bore eloquent testimony to the careful planning and detailed preparations which had been made.

The only counter move to the machine is the machine. The waters of the English Channel checked the advance and enabled this country somewhat belatedly to turn to her workshops and her laboratories. War is no longer a matter of masses of infantry advancing over open country or defending trenches as in the last war. The struggle has been transferred to the designing office and the workshop, for it is there that victory will be decided. It is the skill of our engineers and the craftsmanship of our work-people that has taken up the struggle.

No profession has contributed so much to the growing might of Britain as the engineer, and none is pressing forward with greater eagerness in the fulfilment of his destined part in this struggle. It is a profession that has every reason for pride in its contribution to the national effort, a contribution which will become greater and greater as the days and the months pass by.

THE APPLICATION OF AUTOMOBILE METHODS TO AIRCRAFT PRODUCTION

By Don R. Berlin & Peter F. Rossmann, *Curtiss Aeroplane Division, Curtiss-Wright Corp.*

From *S.A.E. Journal* (New York) June 1941

The international situation has demonstrated that the effectiveness of the airplane is a decisive factor in the outcome of the issues at stake. This potent weapon has directed attention to the urgency for quantity production of aircraft essential to national defense.

With the need for increased production quantities it is natural that there should be serious interest in the application of mass-production technique in the manufacture of aircraft. Consequently, the aircraft industry is urged to utilize the experience and facilities of the world's most outstanding mass-production enterprise, the American automobile industry.

What appears to be reluctance on the part of the aircraft industry to accept automobile production standards is due primarily to the numerical and other differences in what constitutes quantity or mass production and the influence of conditions peculiar to each field. Five hundred cars per day under normal circumstances would not represent unusually high production, whereas up to recently ten airplanes of one type per day would be outstanding. The situation is complicated further by the imperative compliance to rigid weight, performance, reliability, and strength specifications in aircraft manufacture. An empty gasoline tank or a broken gasoline line in an automobile is not a serious hazard; it is an inconvenience; while, in an airplane, a similar failure usually represents an emergency.

Special and single-purpose machine tooling and extensive conveyor systems are economically essential in the manufacture of 100,000 cars wherein certain details of the cost of 1/100 of a cent become important. In aircraft construction the application of such refinements obviously cannot be as extensive. Careful analysis, however, supports the conclusion that much can be gained through the utilization of automobile methods and practices when combined with a liberal application of common sense.

The term mass production is somewhat misleading. The general belief is that it involves only the manufacture of a large number of identical parts, usually by means of special machine tools. Quantity alone does not make mass production, however, mass demand is a reciprocal factor. Therefore, it is necessary to differentiate between large quantity and mass production. A change in the production demand from 100 to 1,000 parts, with certain time limitations, requires more than merely moving the decimal point on a shop order. It may necessitate redesign or re-tooling of the part as dictated by conditions.

Mass production results in uniformity. Although a single craftsman can produce an object of superior quality, it is unlikely—except under the most propitious circumstances—that the same craftsman can duplicate the original results exactly. Nor is it reasonable to expect that artisans of equal skill using average tools can produce identical results unless the operations influenced by individual judgment, tending to cause variations in the final product, can be controlled.

Therefore, mass production may be defined as being the most efficient utilization of the human element. It can be accomplished by observing four requisites. Additional elements could be added; however, the following are listed in sequence rather than in the order of their importance:

(a) Product Engineering;
(b) Tool Engineering;
(c) Cost Analysis and Regulation;
(d) Production Control.

Interchangeability is a desirable product of reduced manufacturing tolerances that automatically eliminates the need for selective fits which represent a definite limitation on output and control. These advantages can be obtained by special machine tooling and processing, but in the automobile industry mass production begins on the drafting board when the design is in an embryonic stage.

This suggests the first consideration in that it has been found advantageous to have design personnel familiar with machining and other factory processes.

It then becomes the problem of determining the extent to which the engineer in the development of a product is constrained to permit tooling methods and manufacturing processes to influence design.

Engineering is basically concerned with the creation or development of a new device or product, or an improvement on one in current use, the design of which is dictated by certain conditions—trend of the art, sales appeal, improved durability, weight and strength requirements—some of which permit no deviation from prescribed specifications.

The project of tooling, on the other hand, is that of utilizing, wherever possible, available standard machine tools, selecting, designing and providing suitable jigs and fixtures, assuring the maintenance of the specified degree of accuracy, and planning the manufacturing operations to obtain the lowest possible production cost.

Unless the product designer is familiar with manufacturing processes and production methods, the impression might be gained that the production tool engineers in their analysis of the design are unnecessarily critical and do not fully appreciate its functional requirements.

Often a slight change in a casting or forging—a modification to simplify basic design or increased tolerances—makes appreciable savings in tool and manufacturing costs. Also, attempts to reduce cost through redesign frequently result in seriously penalizing weight and performance. They are also closely related to serviceability since liberal tolerances, and, in some cases, incomplete interchangeability, might be economical from a production standpoint but the cost of subsequent service because of such conditions might be excessive, and very often the difference between profit and loss. Engine cowling is in this category.

However, the product engineer should not normally be fettered by precedent to the extent that the expression of ingenuity and invention in the design is restrained. Frequently the development and perfection of new and original processes necessitated by engineering design are distinctly advantageous in that competitors are handicapped in duplicating or approximating the new designs if a special process is vital to its fabrication.

In general, the trend in manufacturing processes should tend to permit the engineer more latitude in designs.

Tool engineering is influenced greatly by quantity and the basic design of the part. Properly planned and executed tooling contributes much toward the fulfilment of the mass-production principle, particularly:

(a) Properly planned operation sequences;
(b) Simple foolproof jig-and-fixture design;
(c) Gauging and locating points common to mating parts;
(d) Non-fatiguing work heights and positions;
(e) Reasonable application of time-and-motion studies;
(f) Providing adequate inspection tools.

The advantages and necessity of proper tooling cannot be over-emphasized since the manufacture of interchangeable parts is the indispensable requisite precedent to mass production.

The inspection item, although limited in its application (by quantity requirements), is of more importance than is generally conceded; it is one of the most essential factors in controlling variations in the product. Inspection expedites production, witness for example, the extensive and ingenious automobile inspection tools. Therefore, it is imperative that provisions should be made in the airplane tooling budget for inspection equipment. Good inspection tools inspire greater confidence in inspection results.

The third requisite, accurate "Cost Analysis and Regulation," is more than keeping books to record expenditures. Accurate estimates are necessary for reliable cost predictions, and there is sufficient precedent and cataloging of aircraft manufacturing operation data to be of material assistance in compiling useful cost estimates. Cost regulation is the applied art of intercepting costs before the money is expended. All costs should be challenged and justified; otherwise there can be no confidence in the operation of the expense budget. Time studies may be considered part of the analysis.

The fourth requisite, "Production Control," involves principally scheduling and material handling. The former requires accurate data on equipment and man-power capacities so that an orderly flow of production can be maintained with the minimum of congestion due to holdups, changes, shortages, and so on. This control in automobile manufacture is the nerve centre of production and the clock-like precision with which cars are produced is significant evidence of its effectiveness. Another element of such control that has had practically no recognition in the aircraft industry is the application of economical lot size (the economical cycle) or as it is more generally known the most economical number of parts to make in a set-up. Heretofore, there has been limited opportunity to apply this science in aircraft, but now circumstances are much more favourable to its adaptation.

Material handling can be regarded as part of production control. Its function is more than regulating and moving material through the plant. In fact, an efficient plant layout is planned on the basis of proper routing of material.

Finally, there is the problem of designing the experimental airplane. In the automobile industry there are different influences with regard to sales, customer's desires and requirements, trend of the art, and so on. Furthermore, there is this important difference: the automobile industry flourishes under more advantageous conditions because that type of product can be slanted toward a sales field with every assurance that the experimental model will finally go into active production. In addition, the experimental costs can be amortized over a larger number of units. With aircraft, all experimental projects are likewise considered as production possibilities but this cannot be regarded with the same degree of certainty. Of necessity, progress in this regard has been cautious.

In conclusion, it must be said that the aircraft industry is unique in its development and resourcefulness under the handicap of small quantity production which circumstance has stimulated ingenious methods and techniques adapted to its special requirements. The similarities between the automobile and the aircraft industry are greater than the differences, and the exchange of ideas is a logical development and conducive to progress if the art is not merely utilized but advanced.

HIGH STEAM PRESSURES IN MARINE SERVICE

From *Trade & Engineering*, (London), April, 1941

The employment of higher boiler pressures and temperatures with regenerative feed heating and other expedients has progressively improved the performance of marine steam propelling machinery. The pioneer modern water-tube boiler installations fitted in this country were arranged to work at about 375 lb. pressure, but later installations in the Strathmore, Orion, and similar vessels work at 450 lb. Notable examples fitted abroad include a number of United States tankers with boilers working at 600 lb., and the Yarrow boilers of the Nieuw Amsterdam are arranged for 625 lb., while the German liners Gneisenau and Scharnhorst were fitted with Wagner boilers working at 710 lb.

All these boilers rely upon natural flow for the water circulation, which results from the mixture in the rows of tubes receiving the greater proportion of transmitted heat being less dense than that in the other tubes. This tends to set a limit upon the pressure at which natural circulation can be relied upon to maintain sufficient velocity for the avoidance of over-heating at the high rating of modern installations, and for this reason an alternative line of development with forced circulation boilers working at pressures from 1,900 lb. up to the critical condition of water has been pursued in a number of German liners, including the Uckermark, Potsdam, Pretoria, and Windhuk.

The gain theoretically obtainable from really high pressures is very considerable, and recent research gives promise of even better performances than have hitherto been claimed. High-pressure steam plants under test conditions have frequently shown better results than were expected from calculation, and the difference has been generally attributed to inadequacy of the steam tables on which the predictions were based or to errors of observation on the test. It has, however, been found that the Reynolds number corresponding to the steam conditions has a marked influence on turbine efficiency, so that, with all the other factors equal, a better relative performance is to be expected with high-pressure than with low-pressure steam. At the same time it has to be considered that gains due to improvements in the theoretical cycle with high initial pressures are more readily dissipated through parasitic losses in the nozzles, blading, and spindle glands.

That the thermal performances reported from the German super-pressure liners have been disappointing may be partly due to the latter cause, and it is doubtful whether the complications inherently involved in fitting forced circulation boilers on shipboard can be thermally justified unless the utmost degree of economy offered by their adoption is forthcoming. Consideration of all these factors suggests that steam conditions for marine service may be stabilized at a pressure which, while permitting the employment of natural circulation boilers, is higher than the value so far employed with steam generators of this type but appreciably below those adopted with the German forced circulation boilers.

For this reason special interest attaches to the experimental high-pressure installation which is being fitted in one of the United States Maritime Commission's C 3 class cargo vessels. The main propulsion turbines are of the three-cylinder double-reduction geared type developing a total of 8,000 s.h.p. at a propeller speed of 96 r.p.m., and taking steam at about 1,200 lb. pressure and 740 deg. F. temperature. The two boilers are of a special design of natural circulation three-drum type with air preheater, economizer, and convection superheater. A reheating section fitted in each of them takes the exhaust steam from the high-pressure turbine at about 260 lb. and restores its temperature to about 740 deg. F. before it completed its work in the intermediate and low-pressure cylinders.

Separate oil burners are provided for steam generation and the reheating sections of the boilers. To prevent excessive superheat temperatures during manoeuvring when the reheater is out of action, primary and secondary superheater elements are provided, so located that there is a balance of heat transmission under all conditions of working to maintain a constant outlet steam temperature. Automatic combustion control is provided to maintain a steady steam pressure, and the reheating is regulated by the outlet steam temperature. Manual control is also provided together with safeguards for the reheating section should the flow of steam fall below a predetermined rate. An efficiency of 87 per cent is guaranteed, but it is expected that this figure will be exceeded. All the auxiliaries will be motor-driven with electrical power provided by turbo-generators using steam at 230 lb. which has been reheated to 740 deg. F. and extracted from the intermediate turbine inlet. It is estimated that an oil fuel rate of 0.5 lb. per s.h.p. hour for all purposes will be obtained. An important feature in the design is that as the steam temperature is limited to under 750 deg. F., special alloys are unnecessary and the ordinary materials of construction can be used.

FOG LIGHTS AND FOG FALLACIES

From *Aeronautics* (London), April, 1941

The following is an extract from a paper read before the Institute of the Aeronautical Sciences at Columbia University, New York, by Dr. Sverre Petterssen.

It was commonly believed for some time that light of long wave length (red and infra-red) would penetrate fog more readily than the shorter wave lengths. This supposition was based on the formula developed by Lord Rayleigh for the transmission of light through a suspension of particles of a diameter small compared with the wave length of the light. This formula showed that the scattering coefficient was inversely proportional to the fourth power of the wave length. However, since fog drops are large compared with the wave length of visible and near infra-red light, this formula does not apply. In a typical fog with an average drop radius of 20 microns, the transmission is the same for all wave lengths less than about four microns. The transmission would not become appreciably higher until the wave length was greater than 40 microns. In this far infra-red region water vapour and some of the other atmospheric gases absorb strongly, so that even though the scattering were reduced, the total transmitted energy would probably be smaller. It may, therefore, be concluded that there is no region of the radiant energy spectrum which will penetrate fog better than visible light. This result has been confirmed by direct measurements.

Koschmieder has shown that the visibility or more properly the visual range, is a function only of the scattering coefficient if the observed object is essentially black, is seen against the horizon sky and the sky is uniformly overcast. These conditions are generally satisfied in the case of a fog of considerable depth.

SIX NEW R.A.F. MACHINES

From *Trade & Engineering,* (London), April, 1941

Gradually information is being released about the new types of British aircraft with which the Royal Air Force will conduct its offensive and its defence of Britain in the months ahead. Many of the details of these aircraft, and most of their performance figures, are still secret, but what is no secret is that the authorities are well pleased with the new bombers, while great things are expected from two new fighters.

The existence of the four-engined heavy bomber, the Short Stirling, had already been made public, and two or three weeks ago the existence of the Avro Manchester was made known. It is a twin-engined bomber and according to an American technical journal—these facts cannot be confirmed or denied—the engines are Rolls-Royce Vultures. The Vulture is described as being "two Merlins put together." The same journal says that the Manchester has a speed of 325 miles an hour, a wing span of 90 to 95 feet, and a gross weight of 30,000 lb. This is heavier than the U.S. Army Air Corps' B18 and B23 and much faster than the B18. The Manchester is made by the firm of A. V. Roe, which gave the R.A.F. the excellent training and reconnaissance machine, the Anson. The Anson has achieved such phenomenal success as a fighter—though not intended for that purpose—that the men of the Coastal Command have an expression, "Anson is as Anson does."

The somewhat scanty details about the new range of bombers were added to materially by Sir Archibald Sinclair, Secretary of State for Air, when he introduced the Air Estimates in Parliament on March 11. He revealed that there was in existence a third new bomber, the Halifax. All of these, i.e., the Stirling, the Manchester, and the Halifax, the Minister said, had already proved their worth, and the Stirling had been used against enemy targets. These bombers, he added, were more than twice the size of any earlier type. They were faster and could carry not only a heavier defensive armament, but also three times the weight of bombs for the same distance as their predecessors. The Hampdens, Whitleys, the Wellingtons which, in the past, had constituted the main offensive power of the R.A.F., had undergone many improvements. The latest models were fitted with more powerful engines which gave them increased performance and striking power. Some of them, although the original name remained, were really quite different aircraft from those which flew under the same name last year. Sir Archibald also renewed the assurance given just previously by the Prime Minister that developments would also be continued in the types supplied for coastal reconnaissance and for Army co-operation work.

Then he turned to the fighters. It was known some time ago that the original Spitfires and Hurricanes had been "hotted up" and that the Mark 2 Hurricane and the Mark 3 Spitfire which had come into service were fitted with more powerful engines which had considerably increased their speeds and provided the ability to fight at much greater height, although equipped with heavier armament which increased their fire-power. The Secretary of State was able to reveal that the new Hawker Tornado, with an engine "nearly twice the horse-power of the machines which bore the brunt of the Battle of Britain" and carrying still heavier armament can yet attain speeds in excess of 400 m.p.h. It had previously been stated that the Tornado is a single-seat fighter equipped with a 2,000 h.p. Rolls-Royce Vulture engine.

Then came the first public reference to the existence of the Beaufort Fighter (known as the Beaufighter), which the Secretary of State said is being used for long-range operations and night fighting. He completed the announcement on this formidable range of new aircraft by referring to the twin-engined Whirlwind.

This made a total of six new machines—three bombers (the Stirling, Manchester, and Halifax) and three fighters (the Tornado, Whirlwind, and the Beaufighter)—to be announced this year. They show the speed at which new types have been able to go into production, thanks very largely to the sustained success of the faithful Spitfires and Hurricanes, backed up by the Defiants. The Air Minister summed up by saying:—

"Unless Hitler has up his sleeve a more effective secret weapon than he has yet managed to produce, our technical superiority, with the moral superiority which accompanies it, will certainly be maintained during the year."

Sir Archibald Sinclair also paid a well-deserved tribute to those concerned in the British aircraft industry. The Air Ministry and the R.A.F., he said, recognized their debt to those who, in the crisis of the Battles of France and Britain last year, served the country so well behind the lines. Sometimes it happened that we lost dozens of aircraft in a single battle, but the pilots who baled out nearly always "found fresh mounts waiting for them in the stable." For this strong and timely flow of aircraft into the R.A.F. they must thank, first and foremost, the workman in the factory—the man who gave ungrudgingly of his skill, who worked long hours and seven days a week cheerfully, whose careful and unerring industry never flagged, and who went on working after the sirens had sounded. The victories of the R.A.F. were his victories, too. He included in his tribute the executives, scientists, and designers, who had all "deserved as much as a victorious general." The Ministry of Aircraft Production was devoting its efforts not only to increasing the flow of production but to bringing on as rapidly as possible those new types of bombers and fighters with which we shall engage the enemy this year.

The Minister also referred to a subject which has inevitably given rise to some difficulty—the question of the sterilization of land because of the necessity for constructing many new airfields since the collapse of France deprived us of the use of any airfields on the Continent. He pointed out that more than half of the British Isles is mountain, rock, marsh, or land in other ways unsuitable for aerodromes, which must be level and easily drained. In the flatter parts of the country there are more than 3,700 miles of electric grid to be avoided—and avoided with a wide safety margin—not to mention canals and railways, smoke from industrial areas, balloon barrages, and other obstacles. An aerodrome must also be less than 600 ft. above sea level, otherwise it may be in the clouds for considerable periods; while he pointed out that the development of aircraft tends towards a longer take-off run, so that aerodromes now have to be bigger than before.

Many of the agricultural Members of the House were relieved to have his assurance that the Air Minister was taking no rigid attitude, that he had gone closely into the problem with the Minister of Agriculture, and that, as a result, there would in the future be improved liaison between the Air Ministry and the County War Agricultural Committees.

WARTIME BUILDING

By R. Fitzmaurice, B.Sc.

From *Civil Engineering and Public Works Review*, April, 1941

Wartime building presents peculiarly difficult problems for the designer, since a number of factors unknown in peacetime become of the utmost importance.

The Building Research Board was requested by the Works and Buildings Priority Sub-Committee to take as a first task during the war the solution of problems of building created by the changed position of supplies of building materials. The work carried out as a result is summarized in a series of publications, known as the Wartime Building Bulletins, published by H.M. Stationery Office. The first task undertaken was a study of methods of factory construction suitable for wartime conditions.

Factory Design

At this stage it is appropriate to consider what are the factors to be taken into account in the design of a factory. They are as follows:

1. Suitability for the particular process to be carried out in the factory.
2. Speed and ease of erection, taking into account the conditions of supply of material and labour prevailing at the time.
3. Economy in the use of materials and labour for which demands are heavy in wartime.
4. Ease of concealment from the air.
5. Resistance to damage by air attack.

It will be realized that the wartime factory must be shorn of embellishment, for every single brick and ton of steel must be used to maximum advantage.

Large, clear spaces have their disadvantages in that big spans need more steel than smaller ones and the damage due to the explosion of a bomb may be more widespread.

The whole problem of ease and speed of erection turns on using to the maximum advantage such materials and labour as are available at the time. Thus in a building consisting mainly of structural steel-work it is desirable to find out what range of sections is most readily available at the time required. If reinforced concrete structures are proposed, it may be well worth while to give the contractor some latitude in such matters as the use of precast elements or work poured "in situ." The essential condition for speed in building in wartime is collaboration between all parties concerned and avoidance of too rigid adherence to the original details and specifications. However carefully these details may have been prepared, it is better to adjust a project to the changed conditions than to delay it by insistence on carrying it out exactly in accordance with the original intention.

Building Material

There are various ways of setting out to find the most economic method of covering a given building space. The co-operation of a group of leading structural steelwork designers was enlisted through the kind offices of the British Steelwork Association and the Director of Structures of the Iron and Steel Control.

This group assembled a series of designs of structural steelwork for single storey factories; these were tabulated and reviewed and the less economical rejected. The final selection, for roof spans of 22, 33, 40, 55, 77 and 110 feet, was then again reviewed and the results were made available in Wartime Building Bulletins Nos. 1, 4 and 10. The designs have recently been revised to incorporate the results of experience of actual air attack.

The investigation has shown the importance of the economy which can be got by making use of continuity to keep bending moments to a minimum. Structural continuity also contributes materially to resistance to effects of bomb explosions.

Concrete Construction

To use reinforced concrete construction is an obvious method of economizing in the use of steel. Some typical structures have been designed, suitable for dormitory hutting and temporary hospital accommodation, as well as single storey factories.

Arch structures in reinforced concrete represent a still further move towards economy. The potentialities of reinforced concrete arched construction have been little exploited in Britain, though in France very interesting pro jects have been carried out.

The use of reinforced concrete in wartime is made somewhat more difficult by the need to economize in timber for shuttering. It has been found, however, that by keeping structures simple and repetitive, and by designing in terms of specific, recoverable systems of shuttering, that the waste of timber can be kept very small indeed. This and other aspects of reinforced concrete construction are discussed in Wartime Building Bulletins Nos. 3 and 5.

Generally speaking, great quantities of cement are used in roads, paved areas, runways and solid concrete floors in factories.

Tar macadam can be substituted when necessary for concrete for roadways and paved areas out of doors, and recommended specifications are given in Wartime Building Bulletin No. 9.

Timber in Shuttering

Mention has already been made of the investigations into economy in the use of timber in shuttering and formwork for concrete construction.

The Forest Products Research Laboratory of the Department of Scientific and Industrial Research is preparing data on working stresses to be used in the design of timber structures and these should be available in the near future.

Concealment and Camouflage

Concealment from the air is a very important aspect of wartime construction. As with all other A.R.P. questions, it is an elementary precaution to assume that the worst form of attack may come at some time or other. It is dangerous to assume that there is no possibility of daylight air attack.

One method of approach to the problem of concealment is to disregard it entirely, allowing the building project to take whatever shape it will, then at completion to call in the camouflage expert to disguise the resulting structure. This is the worst possible approach and the camoufleur is presented with a task which may be impossible.

It is strongly recommended that the Civil Defence Camouflage Establishment, Ministry of Home Security, should be consulted at the earliest stage in a wartime building project. Advice is given free of charge.

The following are some of the more important factors to be observed:

(a) Choice of site. Avoid conspicuous landmarks such as the confluence of rivers, important junctions of roads and railways, lakes, etc.

(b) The orientation and arrangement of the buildings on the site should be contrived so as to avoid conspicuous regular patterns. Consideration should be given to the type of building development in the locality which so far as is possible should be simulated.

(c) Saw-tooth and northlight roof lighting should as a general rule be avoided. The deep shadows cast by vertical and steeply pitched glazing are very difficult to conceal.

(d) Where ground has to be excavated the soil may with advantage be banked against the north, east and west sides of the buildings to conceal the shadows cast by the walls. Generally speaking, the buildings should be kept as low as possible in order to minimize the shadows they cast.

(e) Natural features on the site such as clumps of trees, hedges, ditches and streams should be preserved as far as possible and advantage should be taken of them in working out the camouflage scheme.

(f) Building work should be restricted to the minimum possible area of ground. Heavily scarred ground is difficult to conceal and even if ploughed and planted at completion, a considerable time must elapse before the scars recede into the general tone of the landscape.

(g) Great size of individual buildings makes concealment difficult, and factory units should be kept to the smallest size consistent with a satisfactory production layout. A maximum dimension for a unit of 200 ft. in any direction is a desirable limit to aim at.

War Damage

There are three main lines of approach to the problem of minimizing damage by air attack, firstly, by disposing the buildings on the site so that the likelihood of damage by direct hit in any one attack is reduced; secondly, by constructing the buildings so that in the event of a direct hit or near miss by high explosive bombs the resulting damage is reduced to a minimum and production can easily be started again; and, thirdly, by constructing the buildings so that damage by fire resulting from incendiary attack is minimized.

Bombs are dropped in rows or "sticks", so that other things being equal, it is well in laying out a new site to keep in mind the possibility of reducing the chance of a single stick of bombs hitting a number of buildings in line. For instance, arrangements of buildings in curves or crescents on plan is advantageous.

It is a gratifying fact that factory buildings can be made highly resistant to demolition by direct hits or near misses by high explosive bombs. A study of this aspect has been made by Prof. J. F. Baker of the Research and Experiments Department of the Ministry of Home Security, and the advice of this organization is freely available.

The studies of Prof. Baker are particularly complete for single-storey buildings in structural steelwork. The aim should be for such structures to be so designed that any one main member can be cut without causing adjacent members to collapse.

With very little or no additional steel a great many normal roof types are capable of satisfying this condition, but there are other types which are inherently so unstable that injury to one member may lead to progressive collapse extending to the whole of the shop concerned.

The ability of a soundly designed structure to withstand the demolition of a main member without significant deflection of the remainder has been amply proved in recent raids. These principles have been observed in the buildings which are dealt with in Wartime Building Bulletins Nos. 1, 4 and 10, and the revisions which are now just complete.

Briefly the following are the main principles:

1. Trusses and lattices of an unbalanced type should not be arranged so that the removal of a supporting member at one end causes adjacent members to collapse.

2. Beams and built-up girders should be designed to develop full continuity in their lower flanges or chords over staunchion supports, so that in the event of staunchions being removed or damaged the beam or girder can span between adjacent staunchions without collapsing.

3. Roof systems generally should be braced more liberally than would normally be provided for wind action, realizing that damage to a truss or its supports may induce considerable forces which will be transmitted along the line of the purlins.

Fires due to incendiary attack have caused very serious damage. It is suggested that some discrimination needs to be exercised between buildings where the occupancy is such that the fire hazard is important and those where it is negligible.

Where the fire hazard exists, the roof structure may with advantage be made resistant to the small incendiary bomb but, in addition, the building should also be divided up into compartments of moderate extent by adequate fire walls carried right up to the roof with openings closed by fireproof doors (not self-acting). It is suggested when considerable quantities of combustible goods are stored or handled, that a limit of 10,000 sq. ft. of floor area should be the maximum size for any one compartment. In addition all steel work in the building should be encased in concrete or otherwise protected against fire.

From Month to Month

News of the Institute and other Societies, Comments and Correspondence, Elections and Transfers

THE ENGINEERING INSTITUTE OF CANADA IN KINGSTON

On Saturday, June 14th, there was a combination of events in Kingston that will long mark the day in local Institute history. Taking as a central "motif" the presentation of an honorary membership certificate to Dr. R. C. Wallace, Council and the branch arranged a full and interesting programme.

Under the guidance of the president a regional meeting of Council was held during the afternoon in the board room of the gymnasium of Queen's. There was an excellent attendance of officers, councillors and guests. This latter group included past presidents, past councillors, chairmen of three other Ontario branches, and members of the local executive. Another very welcome guest was the president of the Association of Professional Engineers of Ontario.

For the ladies the afternoon programme consisted of a sight-seeing tour and tea. In the evening, dinner was held at the golf club. Details of these features are given in the branch news.

R. C. Wallace, Hon.M.E.I.C.

The Kingston members and their wives may well be proud of the success of their efforts. Every detail was well thought out, and much time and effort was expended in making arrangements so that visitors would fully enjoy their day. The value of such gatherings cannot be over estimated. They assist materially in developing interest and friendship not only in the branch itself but throughout the Institute. The Kingston branch has done an excellent piece of work.

GREETINGS FROM ENGLAND

As mentioned in the June *Journal*, the Institution of Electrical Engineers has done the Engineering Institute of Canada a great favour in presenting in such a handsome manner the Sir John Kennedy Medal to Lieut.-General A. G. L. McNaughton. The illuminated address and the photographs referred to in the correspondence arrived a short time ago, and were presented to Council at the regional meeting held in Kingston in June.

The address is reproduced on an adjacent page, and herewith is a copy of the acknowledgement from Council sent to the Institution at the conclusion of the Kingston meeting:

"James R. Beard, Esq., President,
The Institution of Electrical Engineers,
London, England.

"Dear Mr. Beard:

"The Council of The Engineering Institute of Canada, at a regional meeting held in Kingston, Ontario, on June 14th, received the message from the President, Council and Members of The Institution of Electrical Engineers, and the illuminated address commemorating the presentation of the Sir John Kennedy Medal to Lieut.-General A. G. L. McNaughton, which presentation was so graciously carried out by the Institution of Electrical Engineers on behalf of The Engineering Institute of Canada.

"The Council of the Institute is greatly pleased by the action of the Institution and hastens to express its agreement with the policy of 'close co-operation between engineering institutions in Great Britain and their sister institutions in the overseas countries of our Commonwealth of Nations.' The further development of such co-operation is a part of the programme for the future of this society, and opportunities for such co-operation will be planned for and welcomed at all times.

"May I, Sir, on instructions of Council, convey this message to you and at the same time thank you personally for all that you have done in assisting us to honour this distinguished engineer whose name graces the membership lists of both our organizations.

"Yours sincerely,

(*Signed*) L. Austin Wright,
General Secretary.

Lieutenant-General A. G. L. McNaughton, M.E.I.C., acknowledges the Sir John Kennedy Medal of the Engineering Institute of Canada which has been presented to him by J. R. Beard, President of the Institution of Electrical Engineers, at their meeting held in London, England, on May 8th.

1942 ANNUAL MEETING

Montreal's invitation to hold the next annual and professional meeting in that city was accepted at the 1941 meeting in Hamilton. There was some discussion as to whether or not the programme should be curtailed because of war conditions, but the decision on this point was left with the branch executive. The success of the Hamilton meeting seemed to indicate that there was a place for such functions even during war years.

The Montreal executive has held its first meeting to complete preliminary arrangements. The dates selected are Thursday and Friday, February fifth and sixth, and the location will be the Windsor Hotel. Chairmen of committees have been named, and the work of securing papers is already under way. It is planned to restrict papers and discussions to phases of the engineers' participation in Canada's war effort.

The President, Council and members of

The Institution of Electrical Engineers,

on the occasion of the Ordinary Meeting of The Institution held on Thursday, 8th May, 1941, wish to place on record their appreciation of the invitation received from

The Engineering Institute of Canada

that The Institution should, on their behalf, present to

Lieut.-General A. G. L. McNaughton, C.B., C.M.G., D.S.O.,

the

Sir John Kennedy Medal

awarded to him for "his noteworthy contribution to the science of engineering".

Since some years before the outbreak of the present war this Institution has advocated and fostered closer co-operation between Engineering Institutions in Great Britain and their sister Institutions in the overseas countries of our Commonwealth of Nations; the opportunity to carry out this ceremony on behalf of The Engineering Institute of Canada has therefore been especially welcome at a time when activities towards that co-operation have necessarily had to be curtailed. It adds to the Council's pleasure in arranging this ceremony that General McNaughton has long been an Associate Member of The Institution of Electrical Engineers.

The members present at this meeting extend a hearty welcome to General McNaughton and offer him their warm congratulations, not only on the signal honour in the engineering field conferred on him by the award of the Medal, but on the great distinction which he has achieved in a wider sphere by his appointment as head of the Canadian Forces in Great Britain during the present momentous conflict.

The contribution which is being made by Canadian Engineers to the war effort is recognised to be one of inestimable value in the vital place that is being taken by Canada in the cause of freedom at the side of the Mother Country.

A facsimile copy of this Address is being handed to-day to General McNaughton in commemoration of the occasion of the presentation to him of the Medal.

Witness our hand and Seal at Westminster this Eighth day of May, 1941.

James R. Beard. President.

Johnstone Wright. Past President.

W. K. Brasher. Secretary.

A reproduction of the address prepared by the Institution of Electrical Engineers to commemorate the presentation of the Sir John Kennedy Medal to Lieutenant-General McNaughton.

UNIVERSITY OF TORONTO APPOINTS NEW DEAN

Clarence Richard Young, M.E.I.C., has been appointed Dean of the Faculty of Applied Science in the University of Toronto, in succession to Brigadier-General C. H. Mitchell, M.E.I.C., who has retired. This appointment is a fitting climax to Professor Young's distinguished career as educationalist, author and practising consultant.

The new dean is an honour graduate of the University of Toronto of the class of 1905. He has been on the teaching staff of its engineering school since 1907, when he became lecturer in civil engineering; his professorship dates from 1929, when he succeeded the late Peter Gillespie in the chair of civil engineering.

Dean C. R. Young, M.E.I.C.

His published works include text books and articles in structural engineering subjects and on engineering law. He has been much in request as a consultant on matters concerning the design of structures, and on technical, economic and legal problems of a civil engineering character. In 1937-38 he sat on Mr. Justice Chevrier's three-man Royal Commission on Transportation, dealing with the economics of motor transport in Ontario. The Engineering Alumni Association of the University awarded him their medal in 1939, for outstanding achievement in engineering.

The extent of Professor Young's activities is further shown by his services to The Engineering Institute of Canada of which he is a past councillor and past chairman of the Toronto Branch. He is now chairman of the Institute's Committee on International Relations, and also represents the Institute on the Committee on Professional Training of the Engineers' Council for Professional Development. He has been prominent in the work of the Canadian Engineering Standards Association and in the preparation of the National Building Code.

In view of his wide range of interests it is not surprising to note that during the last war Major Young was Second-in-Command of the Polish Army Camp at Niagara, where over twenty thousand Polish soldiers were trained and sent to France—later to Poland. His services were fittingly recognized by the French and Polish governments.

The Institute membership, which includes so many of Professor Young's friends and former students, will join in wishing the new dean a long and prosperous term of office.

ERRATUM

Attention is called to a serious error made in the June *Journal* in the article "The Justification and Control of the Limit Design Method" by F. P. Shearwood, M.E.I.C. Inadvertently, in laying out the pages, two galleys were interchanged, with the result that the continuity of the paper was badly broken. As there has been a heavy demand for copies (one order from the United States being for 2,000), reprints have been made. Any member who desires a corrected copy may have it upon request without cost. Both to the author and to readers we apologize for this mistake.

WARTIME BUREAU OF TECHNICAL PERSONNEL

A new phase of the Bureau's activity has developed lately. The Department of Labour has placed with the Bureau instructions to proceed with an extension of the plant training scheme for producing skilled and semi-skilled workmen, and with the proposal to put machine shops on a twenty-four hour basis for the manufacture of materials for war contracts. The schools included in the federal government training schemes are well ahead of schedule, but lack of shop facilities has made it difficult to give the candidates sufficient practical experience. The proposal to put partly idle machine shops on a twenty-four hour basis will permit of training a greater number of men, and of producing an increased quantity of war supplies at the same time. Already the pulp and paper industry has produced fine results, and it is expected that the extension of the scheme to other industrial groups will aid materially in producing the much needed and related products of trained mechanics and mechanical merchandise.

The Bureau has already consulted with the mining industry at a largely attended meeting in Ottawa. Out of this conference has come an extension of the activity, setting up an organization to handle the work on behalf of the whole group, and generally developing a plan to utilize the spare machine hours of all mine machine shops.

Steps are now being taken to discuss the proposals with other groups. It is expected that each group will take in other shops that are close to it geographically or industrially so that eventually the scheme will be expanded to cover the country and to permit owners of large and small shops alike to participate in the war effort.

This programme is similar to the "bits and pieces" policy of the old country which has produced such excellent results there. There is no doubt of its practicality—the example of the pulp and paper group proves that. The need for machine tools and for trained mechanics can be met by an intensive development of this proposal.

CORRESPONDENCE

W. L. Waters, C.E.,
150 Nassau Street,
New York, June 4th, 1941.

The Editor of the Engineering Journal,
Montreal, P.Q.

Aircraft Cost Estimating

Dear Sir:

In Mr. Wanek's most interesting paper and Miss MacGill's enlightening discussion thereon, published in the May issue of the *Journal*, it is noted that Mr. Wanek places the emphasis on estimated costs, while Miss MacGill places it on actual shop costs. As the writer has worked in engineering shops in both England and America, though not on aircraft, perhaps he can comment on this difference in viewpoint.

In America all important shops have an elaborate shop costing system, while in England few concerns, even now, have such systems; and until recently the only cost figure usually available was the total expense charged to a completed order. As a result the management of an English firm placed the emphasis on the estimated cost; and if the actual shop costs differed from this it was the shop that was criticized; while in America it is, of course, the opposite. An American manager would consider that an English estimated cost obtained as indicated in Mr. Wanek's paper was merely an approximate figure. But that is not the case. English estimators are highly expert engineers with long practical experience, and their work is really very accurate. The English and the American methods are each based on their respective national industrial aptitudes. The American is based on detailed specialization in the job of costing, and the English on a high degree of craftsmanship in estimating. Both give reasonably accurate results with the type of personnel available.

Respectfully,

(Signed) W. L. Waters, M.E.I.C.

Rainier, Alberta,
June 8th, 1941.

L. Austin Wright, Esq., M.E.I.C., General Secretary,
The Engineering Institute of Canada,
2050 Mansfield Street, Montreal, P.Q.

Dear Mr. Wright:

I would like to take this opportunity to thank you for your letter of congratulation on my winning "The Engineering Institute of Canada Prize" at the University of Alberta for the year 1941.

This high honour encourages me greatly in the belief I have chosen the correct profession.

During the last term I became a Student Member of The Engineering Institute of Canada and found their meetings interesting and educational.

I believe this close association between student and professional engineers helps the student considerably in realizing his future duties as a professional engineer.

I am sure that I am also speaking for my classmates when I say that I am indeed looking forward to becoming a Member of The Engineering Institute of Canada.

Yours sincerely,

(Signed) Ralph N. McManus.

The following letters refer to Council's recent action in granting remission of fees to all members in the combatant zones. Many additional letters have been received but these are typical of them all—*Editor.*

Ruston & Hornsby Ltd.,
London, W.C.2., 6th June, 1941.

L. Austin Wright, Esq., General Secretary,
The Engineering Institute of Canada,
Montreal, Canada.

Dear Sir:

I have your letter of May 3rd re Institute fees of members in the United Kingdom.

I request that you will place before the President and Council this, my sincere appreciation of the very handsome gesture thus made by the governing body of the Institute.

Although you are all exceptionally sympathetic and generously minded in respect of the inconveniences and danger we are putting up with in the old country just now, I would have you know that the spirit of all our people is such that these dangers and hardships seem less than they sound. As a matter of fact you would be amazed how nearly normal we all seem to manage to be in the doing of our job in wartime, which, needless to say, is plenty.

Nobody has any doubt as to the ultimate result, and already we feel we are getting steadfastly towards that superiority of power which will ultimately put the supermaniac out of business.

Speaking for all concerned, we thank you for your excellent sentiment on behalf of your fellow Britishers. Although the monetary aspect of the gesture is not perhaps called for by any privation on this side, it is true that we have difficulty in getting permission to remit money overseas.

One wishes that more Institutions and persons could see their way to be as understanding and brotherly as the Engineering Institute of Canada.

With compliments and kindest regards to you all.

Yours sincerely,

(Signed) T. W. Fairhurst.

Exeter, Devon, England.
June 7th, 1941.

Dear Mr. Wright:

I have only just recently received your very nice letter of May 3rd, remitting annual fees payable to the Engineering Institute of Canada for the duration of the war and until happier days come. Please convey my very best thanks to the Members of the Council and also to yourself for the generous resolution.

The forces of Righteousness must eventually triumph and it is a grand thing to see the way in which all this world wide misery and trouble has knitted together more firmly than ever before the peoples of our great God given Empire in the cause of Justice and Truth.

I remain,

Yours sincerely,

(Signed) F. J. Bellamy.

Dorset, England,
June 1st, 1941.

Dear Mr. Wright:

I wish to acknowledge your letter of May 3rd in which you inform me of the Council's resolution, regarding the remittance of fees to members residing in the United Kingdom; may I express my deep appreciation of their kindness, which act is so typically Canadian. Truly we have many hardships and trials to contend with, but the receipt of your letter brought great encouragement and I am sure the effect of the resolution on all members over here will far exceed anything the Council could have anticipated.

Yours sincerely,

(Signed) P. Reynolds, M.E.I.C.

9 Copplestone Road,
Budleigh Salterton, Devon.,
4th June, 1941.

Dear Sir:

Your letter dated 3rd May with reference to the remission of fees granted to members of the Institute in the United Kingdom, only reached me this morning.

I shall be obliged if you will convey to the Council my thanks and appreciation of the thoughtful kindness they have shown by their action, which forges another link in the ties between the Mother Country and Canada, and I trust that our final victory may not be long delayed.

Yours sincerely,

(*Signed*) H. A. Elgee, M.E.I.C.

56 Beaconsfield Road, London, S.E.3, England,
4th June, 1941.

Dear Mr. Wright:

The friendly gesture of the Council of the Institute in arranging to remit my fees during this trying period, as indicated in your letter of 3rd May, is greatly appreciated. It is not so much the amount of money involved that concerns us on this side, as the difficulties of obtaining Canadian exchange and the desire on our part to avoid using any foreign exchange except for the purpose of prosecuting the war.

You will no doubt be glad to know that I am engaged as a director of a very large works employed exclusively on the manufacture of vital explosives plant and armaments, and in spite of the great numbers of H. E. bombs, oil bombs and incendiaries that the Germans have dropped on our works, we have been able to put out all the fires quickly and clean up and repair all damage with great speed, and our output has not dropped even one per cent, although we can consider ourselves very lucky. Of course, we have all had very narrow shaves at times, and working continuously round the clock, Saturdays and Sundays included, with such heavy air attacks going on from time to time has been a bit trying, but as a member of the Institute having opportunities better than most people of knowing what our vital works on this side are doing, I think we will yet turn out the necessary equipment to enable our fighting forces to win through. Most of us now hardly call ourselves civilians, as those, like myself, who must stick to their jobs nevertheless belong to the Home Guard, in which I hold H.M. Commission.

My lifelong friend, C. G. Du Cane, who was a member of the Institute and was for some years in partnership with me in Vancouver, has, as you will know, passed away. I think it was due to his being out all night in his car on rescue work in the City of London when he was suffering from a very severe cold aggravated by asthma, which brought on pneumonia.

Yours sincerely,

(*Signed*) H. B. Fergusson, M.E.I.C.

Apparently at the time of writing, the author of the following letter had not received notice of Council's decision to remit fees for members in combatant areas. The letter is reproduced as it seems to indicate in a subtle way something of the splendid spirit of the people who are so gallantly and so calmly resisting the worst efforts of the enemy.

—*Editor.*

"The Secretary, Engineering Institute of Canada,
2050 Mansfield Street, Montreal, Canada.

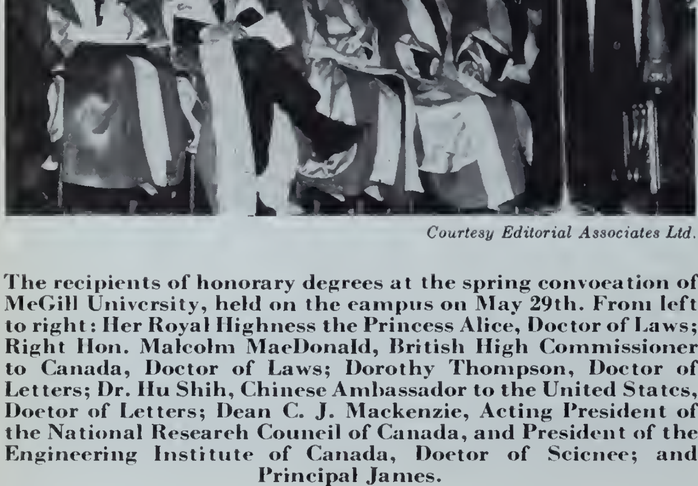
"Dear Sir:

"I wish to advise you that I have taken up a post as Assistant Works Manager with International Alloys Ltd.

"I lost my home some time ago due to enemy action, and have therefore lost the statement of dues—could you let me have a copy of same in order that I may make application to our Government for permission to export the necessary Canadian currency to meet these dues. In the meantime, will you continue please to mail the Journal to me.

"Yours faithfully,

(*Signed*) C. H. Oakes."



Courtesy Editorial Associates Ltd.

The recipients of honorary degrees at the spring convocation of McGill University, held on the campus on May 29th. From left to right: Her Royal Highness the Princess Alice, Doctor of Laws; Right Hon. Malcolm MacDonald, British High Commissioner to Canada, Doctor of Laws; Dorothy Thompson, Doctor of Letters; Dr. Hu Shih, Chinese Ambassador to the United States, Doctor of Letters; Dean C. J. Mackenzie, Acting President of the National Research Council of Canada, and President of the Engineering Institute of Canada, Doctor of Science; and Principal James.

MEETING OF COUNCIL

A regional meeting of the Council of the Institute was held at Queen's University, Kingston, Ontario, on Saturday, June 14th, 1941, at two-thirty o'clock p.m.

Present: President C. J. Mackenzie in the chair; Past-Presidents J. B. Challies (Montreal), T. H. Hogg (Toronto); Vice-Presidents deGaspé Beaubien (Montreal), K. M. Cameron (Ottawa), and McNeely DuBose (Montreal); Councillors W. H. Munro (Ottawa), D. S. Ellis (Kingston), J. H. Fregeau (Three Rivers), C. K. McLeod (Montreal), H. Massue (Montreal); Secretary Emeritus R. J. Durley, and General Secretary L. Austin Wright.

There were also present by invitation: Past-Presidents F. P. Shearwood, G. J. Desbarats, A. Surveyer; Past Vice-Presidents A. H. Harkness, R. L. Dobbin, E. V. Buchanan; Past Councillor L. M. Arkley; Branch Chairmen H. E. Brandon (Toronto), T. A. McElhanney (Ottawa); T. A. McGinnis (Kingston); D. J. Emery (Peterborough), and H. H. Lawson (Kingston); S. Frost, President of the Association of Professional Engineers of Ontario.

Past-President Challies, as Chairman of the Institute's Committee on Professional Interests, reported on the recent negotiations with the Association of Professional Engineers of New Brunswick. He commented on the discussions which had taken place between members of his committee and members of the council of the Association in Saint John in May. Out of these negotiations a revised agreement had been developed and a new draft prepared. He recommended that the agreement be submitted to the Institute's legal authorities before it went out for final approval. Subject to this condition, Mr. Challies recommended that the council approve of the draft, so that the agreement could be submitted to all councillors, to corporate members in the province of New Brunswick, and printed in *The Engineering Journal* in accordance with the terms of By-law No. 78 (old No. 76). Accordingly it was agreed that the draft be approved.

It was noted that the financial statement up to the end of May showed the Institute finances to be in good condition. It was recommended by the committee that the cost of repairs to headquarters, beyond the amounts which were collected by the branches, should be paid this year out of current funds. Mr. Beaubien thought that with the excellent assistance which had been given by the branches, the Institute would have little difficulty in meeting its obligations for the year. Past-President Challies, in moving the approval of the financial report, complimented Mr. Beaubien on his excellent management of this important part of Institute affairs.

The secretary made a general report on the amounts collected by various branches. Discussion followed as to the advisability of council making a further appeal to the branches, but it was decided that all branches were fully informed and would do their best without any further requests.

The finance committee recommended that a sum of $2,500.00 be used to purchase Victory Loan Bonds, this to be taken from cash lying in "special accounts." It was also recommended that a further $2,500.00 be taken from current funds. It was felt that the latter sum might be a large amount to withdraw from the cash available, but that it was a patriotic action and the Institute should make every effort to assist in the endeavour. Mr. Beaubien stated that if at the end of the year it was found that cash was needed, the bonds could be very readily converted. After discussion Council agreed that the purchase should be made.

The general secretary read communications from the Institution of Electrical Engineers describing the ceremony which had been put on by that body to present the Sir John Kennedy Medal to Lieutenant-General A. G. L. McNaughton in London.

A beautiful illuminated address had been prepared to commemorate the ceremony, one copy being given to

General McNaughton and one being sent to the Institute. The secretary read this address and he was instructed to communicate to the Institution Council's appreciation of the manner in which the presentation had been made, and also of the sentiments expressed in the address.

The general secretary reported that some of the branches of the Institute had set up special groups to co-operate with others in their localities in the development of Air Raid Precautions in Canada. He also reported that permission had been received from the Ministry of Home Security to distribute in Canada the various bulletins printed in London by the Ministry. Duplicate sets of all bulletins issued to date had been forwarded to the Institute and the secretary asked council if they would discuss the matter in order to determine to what extent the Institute would participate in this activity. The secretary also reported that some preliminary figures had been obtained on the cost of mimeographing the bulletins, and that he had also been in touch with Dr. Glidden, Federal Director of A.R.P. at Ottawa to discuss with him the possibility of the Institute assisting. Mr. Munro reported on some of the activities in Ottawa, and pointed out that these bulletins might be of assistance to groups such as that established in Ottawa as well as those in other cities.

Mr. McElhanney reported that the Ottawa Branch had recently discussed the question, and that it was thought that the branch might join with other groups in Ottawa to set up a joint committee to deal with at least one phase of Air Raid Precautions, that is, air raid shelters. It had been suggested that the question of community shelters and the improvement of personal property for the same purpose might also be considered. A joint committee had already been formed with the A.R.P. group.

The president stated that he thought the Institute should investigate this matter to see if it could not be of assistance. He thought it might be advisable to suggest to the federal A.R.P. group that the Institute should have a representative on their committee.

Past-President Challies supported the president in his suggestion. He recommended that the Institute take the matter up aggressively, and constructively, and give all the support possible.

The president stated that an attempt was being made in the National Research Council to have some one person familiarize himself with the many bulletins which had been published in Britain so that information appropriate to Canadian conditions could be brought to the attention of interested parties. Some one person should read everything so as to obviate the necessity of many people going through the same material. Finally, it was decided that Mr. Munro be appointed chairman of a committee, with power to add. He was to communicate with the proper authorities at Ottawa to see what could be done by the Institute to assist the federal and local authorities. It was also agreed that Mr. Munro and his committee could make the decisions with regard to the printing of the bulletins.

The general secretary presented a report on the Institute prizes and medals prepared at Council's request by Mr. Durley and himself, making recommendations that would eliminate some of the over-lapping and confusion in the present arrangement.

The report read by Mr. Durley made many suggestions of a constructive nature. The re-distribution which it proposed made it possible for the Institute to offer a reward in each of the principal fields in which the members of the Institute are interested. The report also clarified regulations applying to several of the existing awards. It also recommended certain additional prizes.

The president congratulated Mr. Durley on the recommendations, and suggested that copies be made and sent to all councillors so that a full discussion could take place at a later meeting. It was agreed that this should be done and that all past-presidents should be included in the list of those receiving copies.

A communication was read from Dean Wilson, of the University of Alberta, in which he inquired whether students in engineering physics would be eligible for the Institute undergraduate prizes. It was agreed that such students should be eligible.

Attention was called to the summer meeting of the American Institute of Electrical Engineers to take place in Toronto. The president reported that he had received an invitation to attend, but that he would be absent from Canada at that time on important business. Past-president Hogg was asked to represent the president and to present the meeting with the good wishes of the Institute.

As it is not customary to have meetings of Council in July and August it was left with the president and the general secretary to set a date for the next meeting.

Before adjourning the meeting, the president expressed Council's appreciation of the attendance of Mr. Stanley Frost, president of the Association of Professional Engineers of the Province of Ontario.

The meeting adjourned at 5.15 p.m.

THE QUEBEC SCHOOL OF MINES

The recent inauguration of the Quebec School of Mines marks another milestone in the advance of engineering education in Canada. The establishment of this new school by Laval University, as part of its Faculty of Science, has been made possible by an undertaking on the part of the provincial government to provide a substantial yearly grant.

The Quebec School of Mines

Laval University has been granting degrees since 1852 in Medicine, Law, Theology and Arts, but has only recently extended its activities into the field of engineering. It is the first university in Canada to offer courses in mining and metallurgical engineering and geology to French speaking students. The courses leading to the Bachelor's degree in mining and metallurgical engineering extend over a period of four years. Bachelor's degrees in geology are not granted, but graduates in mining engineering can obtain their Master's degree in geology by taking one year of post-graduate work. Students wishing to take courses in other branches of engineering may, on completion of the first two years at Laval, apply for admission to the third year in other universities. The courses offered at the School are very similar to those offered by other Canadian universities in these branches of learning. The first two years are devoted largely to the fundamental sciences: chemistry, physics and mathematics. Courses are also given in engineering drawing and descriptive geometry. The third and fourth years are devoted to specialization in engineering subjects.

The School of Mines occupies a new five-story building of steel and masonry construction on the outskirts of the city of Quebec. The fifth floor is now largely used by the Canadian Officers Training Corps. The fourth floor is occupied by the department of geology and includes lecture rooms, offices, the geological museum, research laboratories and laboratories for general geology, economic geology, mineralogy and petrography. On the third floor are the library, the amphitheatre, draughting rooms and offices and some of the ore dressing laboratories. The second or ground floor is occupied by the administration offices of the Faculty of Science, the museum of mining and metallurgy, various laboratories and the recreation room. On the first floor are located the strength of materials laboratories, the main ore dressing and metallurgy laboratories and the showers and locker rooms. The heating plant, the transformer and panel rooms, and most of the mechanical engineering laboratories are in the basement.

A corner of the ore dressing laboratory

The equipment in the various laboratories is all of the latest design. The metallurgy laboratories are equipped with an Ajax-Northrup high frequency induction furnace, a Hayes controlled-atmosphere Globar furnace, two electric furnaces for fusion and cupellation and several gas furnaces. There are also assay balances, a Burrell gas analyzer, a Junkers gas calorimeter, an oxygen bomb calorimeter, a gas density balance, potentiometers, various types of pyrometers, a set of rolls, Amsler and Brinell hardness machines, an Amsler impact testing machine and a torsion machine. Equipment for hydrometallurgical tests has been ordered from England and will be installed as soon as received. The metallography laboratories include all the equipment necessary for grinding and polishing, several Leitz microscopes and a Panphot microscope. This equipment is also used for mineralography.

The ore dressing laboratories contain in laboratory and small commercial sizes all the types of equipment used in crushing, grinding, classification, flotation, amalgamation, cyanidation and precipitation. The various pieces of equipment in the advanced section can be operated as a complete mill unit or separately for research purposes.

In the strength of materials laboratory are a 72,000 lb. Amsler universal tensile testing machine, a 200,000 lb. Amsler compression machine with a special beam carriage for flexure tests, a Chatillon crane scale for deflection of beams, extensometers and all the equipment required for concrete, oil and asphalt testing. The mechanical engineering laboratory contains a 50 hp. boiler for boiler trials, a 15 hp. steam engine, a Diesel engine, a fan with wind tunnel for experiments in ventilation, a compressor, a vacuum pump and other equipment. The most important equipment in the hydraulics laboratory includes two centrifugal pumps, a Pelton wheel and two flumes. In the electrical engineering laboratory the main pieces of equipment are a 40 kw. motor generator set which supplies direct current to the various laboratories of the building, a dynamometer set, various types of motors and generators and a mercury-arc rectifier.

The geological laboratories have several microscopes, a Merman specific gravity balance, a Fuess one-circle goniometer, a Baird x-ray unit, a Zeiss Abbe refractometer, a diamond saw and polishing equipment.

The teaching staff has been selected with great care, each member of the faculty being a specialist in his particular field. With its long experience as an institution of higher learning and its well established traditions, Laval University will no doubt do much to maintain the high standards of the engineering profession in Canada.

The following members of The Engineering Institute of Canada are on the teaching staff:

A. O. Dufresne, M.E.I.C., Deputy Minister of Mines of the Province of Quebec; Professor of Mineral Economics.

G. W. Waddington, M.E.I.C., Professor of Mining Engineering.

René Dupuis, M.E.I.C., Assistant General Superintendent, Quebec Power Company; Lecturer on Industrial Relations.

R. F. LeBlanc, S.E.I.C., General Assistant in the Mining Department and Lecturer on Mine Surveying.

Other members of the staff are:

Adrien Pouliot, Dean of the Faculty of Science of Laval.

Gérard Letendre, Director of the Department and Lecturer on Metallurgy.

Maurice Archambault, Chief of the Division of Chemistry and Mineralogy, Bureau of Mines, Quebec; Lecturer on Assaying.

Eugène F. Poncelet, in charge of the Ore Dressing course.

Joseph W. Laverdière, Secretary of the Faculty of Science; Professor of Geology and Paleontology.

Carl Faessler, Geologist for the Provincial Department of Mines; Professor of Mineralogy and Petrography.

J. D. H. Donnay, Lecturer in Crystallography and Mineralogy.

G. M. Schwartz, Professor in Economic Geology and Mineralography.

THE ENGINEERING INSTITUTE OF CANADA PRIZE AWARDS 1941

Eleven prizes known as "The Engineering Institute of Canada Prizes" are offered annually for competition among the registered students in the year prior to the graduating year in the engineering schools and applied science faculties of universities giving a degree course throughout Canada.

Each prize consists of twenty-five dollars in cash, and having in view that one of the objects of the Institute is to facilitate the acquirement and interchange of professional knowledge among its members, it has been the desire of the Institute that the method of award should be determined by the appropriate authority in each school or university so that the prize may be given to the student who, in the year prior to his graduating year, in any department of engineering has proved himself most deserving as disclosed by the examination results of the year in combination with his activities in the students' engineering organization, or in the local branch of a recognized engineering society.

The following are the prize awards for 1941:

Nova Scotia Technical College	Harold Thomas Rose
University of New Brunswick	Alastair D. Cameron
McGill University	John F. Davis, S.E.I.C.
Ecole Polytechnique	Gérard Lefebvre, S.E.I.C.
Queen's University	N. Grandfield
University of Toronto	A. B. Extence
University of Manitoba	John Frederick Pink
University of Saskatchewan	James Charles Buchanan
University of Alberta	Ralph Norman McManus, S.E.I.C.
University of British Columbia	Eric L. Smith
Royal Military College of Canada	No award—regular course discontinued during the war

RECENT GRADUATES IN ENGINEERING

Congratulations are in order to the following Juniors and Students of The Institute who have completed their courses at the various Universities:—

NOVA SCOTIA TECHNICAL COLLEGE

HONOURS

Archibald, Lester Joseph, Halifax, N.S., B.E. (Mi.); Honours in Mining Engineering.

DEGREE OF BACHELOR OF ENGINEERING

MacCallum, Wallace Allison, Amherst, N.S., B.E. (Mech.)
McInnis, John Francis, Inverness, N.S., B.E. (Mech.).
MacKinnon, Archibald Hugh, New Glasgow, N.S., B.E. (Mech.).
Tibbo, Gordon Tucker, Grand Bank, Nfld., B.E. (Mech.).

THE UNIVERSITY OF NEW BRUNSWICK

HONOURS AND MEDALS

Ronalds, Ivan Frederick, Toronto, Ont., B.Sc. (Ci.); Honours in Civil Engineering; Ketchum Silver Medal for the highest standing in civil engineering.

DEGREE OF BACHELOR OF SCIENCE

Brenan, William Murdoch, Saint John, N.B., B.Sc. (Ci.).
Bruce, Gordon Wyndham, Fredericton, N.B., B.Sc. (Ci).
Kennedy, John Frederick, Fredericton, N.B., B.Sc. (Ci.).
Kinghorn, William Wallace, Fredericton, N.B., B.Sc (Ci.).
Lutes, Eric MacPherson, Fredericton, N.B., B.Sc (Ci.).
McKnight, Samuel William, Fredericton, N.B., B.Sc. (Elec.).
McLaughlin, George Frederick Armstrong, Perth, N.B., B.Sc. (Ci.).
Saunders, William Allison Baxter, Calgary, Alta., B.Sc. (Ci.).
Shearer, John Alexander, Fredericton Junction, N.B., B.Sc. (Ci.).
Snodgrass, John Roscoe, Fredericton, N.B., B.Sc. (Ci.).

ÉCOLE POLYTECHNIQUE

DISTINCTIONS ET PRIX

Lessard, Roger, Montréal, Qué., B.Sc.A., I.C., avec grande distinction. Médaille de S. H. Le Lieutenant-Gouverneur de la province, décernée au premier de sa promotion pour toute la durée des études.
Manseau, Marcel, Montréal, Qué., B.Sc.A., I.C.; avec grande distinction. Médaille de L'Association des Anciens Elèves de l'Ecole Polytechnique, attribuée au premier dans les matières de cinquième année d'études.
Monti, Thomas Attilio, Montréal, Qué., B.Sc.A., I.C., avec grande distinction. Médaille de bronze l'Association des Anciens Elèves de l'Ecole Polytechnique, le prix Augustin Frigon ($25.00) offert au premier des cours de Physique et d'Electrotechnique, cours theoriques et travaux de laboratoires.
Lavigueur, Bernard, Montréal, Qué., B.Sc.A., I.C., avec distinction. Médaille d'or de l'Association des Anciens Elèves de l'Ecole Polytechnique, offerte à l'étudiant ayant presenté la meilleure thèse.
Aubry, Gérard, Montréal, Qué., B.Sc.A., I.C., avec distinction. Prix de la Cinquantième Promotion de l'Ecole Polytechnique ($50.00), offert à l'élève qui a présenté la meilleure thèse industrielle.
Melillo, Vincent, Montréal, Qué., B.Sc.A., I.C., avec distinction.
Proulx, Gilbert, Montréal, Qué., B.Sc.A., I.C., avec distinction.
Larose, Gerard, Montréal, Qué., B.Sc., I.C., avec distinction.
Beaupré, Bernard, Montréal, Qué., B.Sc., I.C., avec distinction.

DEGRÉS

Marceau, Séraphin, Montréal, Qué., B.Sc.A., I.C.
Lanouette, Marcel, Montréal, Qué., B.Sc.A., I.C.
Ravary, Robert, Montréal, Qué., B.Sc.A., I.C.
Martel, Pierre, Montréal, Qué., B.Sc.A., I.C.
Joncas, Louis, Montréal, Qué., B.Sc.A., I.C.
Archambault, Jean, Montréal, Qué., B.Sc.A., I.C.
Michaud, Maurice, Montréal, Qué., B.Sc.A., I.C.
Samson, Jean, Montréal, Qué., B.Sc.A., I.C.
Bousquet, Paul, La Providence, Qué., B.Sc.A., I.C.
Lacroix, Jean, Montréal, Qué., B.Sc.A., I.C.
Grothé, André, Montréal, Qué., B.Sc.A., I.C.
Dauphinais, Ernest, Montréal, Qué., B.Sc.A., I.C.

McGILL UNIVERSITY

HONOURS, MEDALS AND PRIZE AWARDS

Brown, William Crocker, St. John's, Nfld., B.Eng. (Elec.); Honours in Electrical Engineering; British Association Medal; Montreal Light, Heat and Power Consolidated First Prize; The Institute of Radio Engineers' Prize.
Godbout, Adolphe Gérard, Montreal, Que., B.Eng. (Ci.); The Robert Forsyth Prize in Theory of Structures and Strength of Materials.
Gordon, John Abraham, Canso, N.S., B.Eng. (Elec.); Montreal Light, Heat and Power Consolidated Second Prize.
Harvie, Thomas Allan, Montreal, Que., B.Eng. (Mech.); Honours in Mechanical Engineering; British Association Medal.

DEGREE OF BACHELOR OF ENGINEERING

Baburek, Christian Stephen, Montreal, Que., B.Eng. (Mech.).
Blanchard, John Rust, Montreal West, Que., B.Eng. (Chem.).
Copping, Edward, Joliette, Que., B.Eng. (Elec.).
Cumming, John William, New Glasgow, N.S., B.Eng. (Ci.).
Dubé, Jean Thomas, Montreal, Que., B.Eng. (Mech.).
Harley, Gordon Glen, Montreal, Que., B.Eng. (Mi.).
Hayman, William Morris, Montreal, Que., B.Eng. (Mech.).
Hibbard, Ashley Gardner, Sherbrooke, Que., B.Eng. (Ci.).
Hodgson, Ronald High, Montreal, Que., B.Eng. (Mech.).
Jones, Edward Lewis, Calgary, Alta., B.Eng. (Chem.).
Kane, Redmond John, Westmount, Que., B.Eng. (Ci.).
Kelly, James Oswald, Montreal, Que., B.Eng. (Chem.).
Keyfitz, Irving Mortimer, Montreal, Que., B.Eng. (Mech.).
Mackay, William Ronald, Montreal, Que., B.Eng. (Elec.).
Morse, Clifford Eric, Montreal, Que., B.Eng. (Elec.).
Pue-Gilchrist, Alfred Condé, Sydney, N.S., B.Eng. (Mech.).
Russell, Gordon Douglas, Montreal, Que., B.Eng. (Chem.).
Simpkins, Arthur Chalkley, Sunny Brae, N.B., B.Eng. (Mech.).
Stopps, Frank Sidney, Cochrane, Ont., B.Eng. (Mech.).
Webster, Geddes Murray, Yarmouth, N.S., B.Eng. (Mi.).
Williams, Donald Drysdale, Montreal, Que., B.Eng. (Mech.).
Wright, Austin Meade, Westmount, Que., B.Eng. (Elec.).

QUEEN'S UNIVERSITY

HONOURS, MEDALS, SCHOLARSHIP AND PRIZES

Courtright, James Milton, Ottawa, Ont., B.Sc. (Ci.); Honours in Civil Engineering.
Curtis, John Knowlton, Kingston, Ont., B.Sc. (Ci.); Honours in Civil Engineering.
Eddy, Robert Cheyne, Bathurst, N.B., B.Sc. (Chem.); Honours in Chemical Engineering; Post-Graduate Scholarship in Chemical Engineering.
Kennedy, Russell Jordan, Dunrobin, Ont., B.Sc. (Ci.); Honours in Civil Engineering; Departmental Medal.
Van Damme, Joseph, Arvida, Que., B.Sc. (Mech.); Honours in Mechanical Engineering; Departmental Medal.

DEGREE OF BACHELOR OF SCIENCE

Brown, Graham Edward, Ottawa, Ont., B.Sc. (Chem.).
Carlson, Arthur John, Fort Frances, Ont., B.Sc. (Ci.).
Chandler, Ralph Wright, Kingston, Ont., B.Sc. (Ci.).
Collins, Kenneth Fawcett, Niagara Falls, Ont., B.Sc. (Chem.).
Cunningham, Robert Auld, Ottawa, Ont., B.Sc. (Ci.).
Cuthbertson, Robert Shedden, Cardinal, Ont., B.Sc. (Mech.).
Demers, Charles Eugène, Québec, Que., B.Sc. (Ci.).
Dickie, Harold Guthrie, Fort William, Ont., B.Sc. (Mech.).
Dowd, Elbert Watson, Ottawa, Ont., B.Sc. (Ci.).
Guy, Ross Thomas, Oshawa, Ont., B.Sc. (Mech.).
Hamilton, Harry Irwin, Sault Ste. Marie, Ont., B.Sc. (Mech.).
Kempton, Douglas Robert, Brockville, Ont., B.Sc. (Ci.).
Mitchell, John Douglas, Moose Jaw, Sask., B.Sc. (Mi.).
McCorkindale, Donald Harvey, Indian Head, Sask., B.Sc. (Ci.).
McDowell, Creighton Joseph Mackintosh, Windsor, Ont., B.Sc. (Mech.).
Pearce, Eldridge Burton, Fort Erie, West, Ont., B.Sc. (Mech.).
Phemister, William Ian, Niagara Falls, Ont., B.Sc. (Mech.).
Pierce, John Gourley, Peterborough, Ont., B.Sc. (Ci.).
Remus, Frank Richard, Oshawa, Ont., B.Sc. (Mech.).
Rigsby, David L., Chatham, Ont., B.Sc. (Mech.).
Sanders, Robert Lewis, Cornwall, Ont., B.Sc. (Mech.).
Savory, John Alfred, Hamilton, Ont., B.Sc. (Mech.).
Stone, John Gordon, Ottawa, Ont., B.Sc. (Ci.).
Thompson, George Wilbert, Niagara Falls, Ont., B.Sc. (Chem.).
Tkacz, William, Fort William, Ont., B.Sc. (Mech.).
Trout, Ross Gregory, Estevan, Sask., B.Sc. (Mech.).

UNIVERSITY OF MANITOBA

DEGREE OF BACHELOR OF SCIENCE

Boone, William Edward Roy, Indian Head, Sask., B.Sc. (Elec.).
Borrowman, Ralph Willson, Winnipeg, Man., B.Sc. (Ci.).
Browne, Jack Wilkinson, Winnipeg, Man., B.Sc. (Elec.).
Gauthier, Raymond Claude, St. Boniface, Man., B.Sc. (Ci.).
Gavlas, Edward Henry, Winnipeg, Man., B.Sc. (Elec.).
Heppner, Selwyn Alexander, Winnipeg, Man., B.Sc. (Elec.).
Hopps, John Alexander, Tuxedo, Man., B.Sc. (Elec.).
Horsburgh, John Graham, Winnipeg, Man., B.Sc. (Ci.).
Kippen, James Alexander, Winnipeg, Man., B.Sc. (Ci.).
Knights, Kenneth Ronald, Winnipeg, Man., B.Sc. (Elec.).
Koropatnick, Peter, Winnipeg, Man., B.Sc. (Ci.).
Kummen, Harold Thorvald, Winnipeg, Man., B.Sc. (Elec.).
Lamb, Thomas, Winnipeg, B.Sc. (Ci.).
Mackinnon, William Donald, Winnipeg, Man., B.Sc. (Ci.).
Olafson, Harold Sigmur, Winnipeg, Man., B.Sc. (Elec.).
Paget, Kenneth Kane, Winnipeg, Man., B.Sc. (Ci.).
Pauch, John Emil, Winnipeg, Man., B.Sc. (Elec.).
Sokoloski, Steve, Winnipeg, Man., B.Sc. (Elec.).
Steinman, Morris Irvin, Winnipeg, Man., B.Sc. (Ci.).
Vance, Fenton Russell, Winnipeg, Man., B.Sc. (Elec.).
Yee, Thomas Marion, Winnipeg, Man., B.Sc. (Elec.).
Young, Hume Blake, Winnipeg, Man., B.Sc. (Ci.).

UNIVERSITY OF TORONTO

HONOURS

Dinsmore, Clarence Sherman, Clarksburg, Ont., B.A.Sc. (Eng. Physics); Honours in Engineering Physics.
Etkin, Bernard, Toronto, Ont., B.A.Sc. (Eng. Physics); Honours in Engineering Physics.
Phripp, Clarence Frank, Toronto, Ont., B.A.Sc. (Ci.); Honours in Civil Engineering.
Smith, Harold Pennell, Newtonbrook, Ont., B.A.Sc. (Elec.); Honours in Electrical Engineering.

DEGREE OF BACHELOR OF APPLIED SCIENCE

Ames, John Wilkes, Toronto, Ont., B.A.Sc. (Ci.).
Merritt, Robert James, Toronto, Ont., B.A.Sc. (Met.).
Near, James Dailey, St. Catharines, Ont., B.A.Sc. (Ci.) Degree of Master of Applied Science.
Ramore, William David, Port Arthur, Ont., B.A.Sc. (Ci.).
Waller, Milford John, Montreal, Que., B.A.Sc. (Elec.).
White, Walter Edmund, Toronto, Ont., M.A.C.

UNIVERSITY OF SASKATCHEWAN

HONOURS

Mantle, John Bertram, Saskatoon, Sask., B.Sc. (Mech.); Great Distinction in Mechanical Engineering.

DEGREE OF BACHELOR OF SCIENCE

Armbruster, Erhart, Saskatoon, Sask., B.Sc. (Ci.).
Ball, Walter Harvey, Maidstone, Sask., B.Sc. (Ci.).
Crook, Donald Gordon, Regina, Sask., B.Sc. (Ci.).
Dawson, George Ernest, Medicine Hat, Alta., B.Sc. (Mech.).
Dougall, Allan Thomas, Saskatoon, Sask., B.Sc. (Mech.).
Dwyer, Francis Richard, Macoun, Sask., B.Sc. (Mech.).
Edwards, John Bevan, Saskatoon, Sask., B.Sc. (Mech.).
English, William John, Saskatoon, Sask., B.Sc. (Mech.).
Fraser, Frederick Walter, Calgary, Alta., B.Sc. (Ci.).
Genge, John Pope, Gliddon, Sask., B.Sc. (Mech.).
Malloff, William, Yorkton, Sask., B.Sc. (Mech.).
Mann, Gordon Charles, Tessier, Sask., B.Sc. (Mech.).
Mercer, George, Saskatoon, Sask., B.Sc. (Ci.).
Milavsky, David Saul, Saskatoon, Sask., B.Sc. (Ci.).
Miller, John Leonard, Saskatoon, Sask., B.Sc. (Ci.).
Minty, Gordon Robert, Eldersley, Sask., B.Sc. (Mech.).
Mitchell, John Hugh, Regina, Sask., B.Sc. (Mech.).
Noble, William Lawrence, Saskatoon, Sask. B.Sc. (Ci.)
Powers, John Louis, Artland, Sask., B.Sc. (Mech.).
Sturdy, Ferris Durnin, Saskatoon, Sask., B.Sc. (Mech.)
Sweeney, John Bartholomew, Saskatoon, Sask., B.Sc. (Chem.)
Symons, Lloyd George, Jansen, Sask., B.Sc. (Mech.).
Todd, Henry, Biggar, Sask., B.Sc. (Ceramic).
Walker, Roger Hugh, Grandview, Man., B.Sc. (Ci.).

UNIVERSITY OF ALBERTA

HONOURS AND PRIZE AWARDS

Stollery, Charles Alexander, Edmonton, Alta., B.Sc. (Ci.); High Distinction with First Class General Standing in Civil Engineering; First Class General Standing in Applied Science; Association of Professional Engineers of Alberta Prize in Civil Engineering.

DEGREE OF BACHELOR OF SCIENCE

Dewis, Marshall Woodworth, Canmore, Alta., B.Sc. (Elec.).
Ehly, Lucas Joseph, Edmonton, Alta., B.Sc.
Hargrave, John Huxley, Walsh, Alta., B.Sc. (Ci.).
McKernan, Earl Wesley, Edmonton, Alta., B.Sc. (Elec.).

ELECTIONS AND TRANSFERS

At the meeting of Council held on June 14th, 1941, the following elections and transfers were effected:

Members

Carroll, Cyril James Gibson, B.Arch. (Univ. of Toronto), Flight-Lieutenant, R.C.A.F., Ottawa.

Dixon, Noel (Mansfield Tech. College, England), office engr., H. F. McLean Limited, Valleyfield, Que.

Gray, Nesbit (Dalziel Technical School), dsgr. and supervisor of constrn., Shawinigan Water & Power Co., Three Rivers, Que.

Lajoie, Gerard, B.Sc.A. (Ecole Polytechnique), i/c constrn. of Intercepting Sewer, Quebec City, for Arthur Surveyer & Co.

Leipoldt, Ewald Van Niekerk (Charlottenburg Tech., Berlin), elctl. engr., Shawinigan Engineering Co., Montreal.

Mitchell, William Geddes, B.A. (Trinity College, Univ. of Dublin), chief dftsman., Canadian Bridge Co., Walkerville, Ont.

Morissette, Joseph Simeon Antonio, B.Sc.A. (Ecole Polytechnique), dist. engr., Department of Roads, Quebec.

McLeish, William Andrew Edward, elecl. supt., Belgo Divn., Consolidated Paper Corp., Shawinigan Falls, Que.

Nixon, William Herbert, B.A.Sc. (Univ. of Toronto), night supt., Foundation Co. of Canada, Arvida, Que.

Pinto, Enrico Arthur (London Univ.), engr., United Kingdom Technical Mission in Canada, Montreal.

***Reynolds,** John Alfred, Aircraft Inspector, Trenton Air Station, R.C.A.F.

Ryley, Alfred St. Clair, B.Sc. (McGill Univ.), vice-pres. and dist. mgr., Truscon Steel Co. Ltd., Montreal.

Affiliate

Holland, Alwin, res. engr. Watson Lake Aerodrome, Civil Aviation Divn., Dept. of Transport, Watson Lake, Yukon Territory.
Schenck, William Edwin, partner, The Pfeffer Co., Stratford, Ont.

Junior

Arpin, Jean Victor, B.Sc.A. (Ecole Polytechnique), prod. engr., Canadian Car Munitions Ltd., Montreal.

***Linke,** Richard Herman (Univ. of Alta.), instrumentman, City of Edmonton.

Lucyk, John Wasyl, B.Sc. (Univ. of Manitoba), demonstrator, University of Manitoba, Winnipeg.

Swift, Lionel D., B.Eng. (McGill Univ.), operation dept., Shawinigan Water & Power Co., St. Roch, P.O. Quebec, Que.

Transferred from the class of Student to that of Member

Arnason, Einar, B.Sc. (Univ. of Man.), Capt., 2nd in command, 1st Canadian Corps, Field Park Coy, R.C.E. (Overseas).

Berenstein, Leslie, B.Sc. (McGill Univ.), vice-pres., and structl. engr., Louis Pickard & Co. Inc., Montreal.

Dow, Gordon Young, B.Sc. (Univ. of N.B.), Capt., O.C. 1st Brighton Fortress, R.C.E., Saint John, N.B., M.D. No. 7.

Dunlop, Duthie MacIntosh, E.E. (1933), C.E. (1934), (Univ. of Man.), Roadmaster, C.P.R., Reston, Man.

Hare, Charles Mackay, B.Sc. (McGill Univ.), surveyor & dftsmn., Noranda Mines Ltd.

Heavysege, Bruce Reid, B.Eng. (McGill Univ.), inspr., Canadian Underwriters Assoc., Montreal.

Muir, Clarke Bower (B.Sc.), (N.S. Tech. Coll.), genl. foreman and asst. engr., i/c Wire Dept., Canadian General Electric Co., Peterborough, Ont.

Transferred from the class of Affiliate to that of Junior

***Pollock,** Allan, McIntyre Porcupine Mines, Schumacher, Ontario.

Transferred from the class of Student to that of Junior

Corbett, Bruce Sherwood, M.A.Sc. (Univ. of Toronto), Pilot Officer, R.C.A.F., Montreal.

Diggle, William Marvin, B.Sc. (Univ. of Sask.), dftsmn., Canadian Bridge Co., Walkerville, Ont.

Piette, Guillaume, B.Sc.A. (Ecole Polytechnique), soil engr., Quebec Highway Dept., Quebec, P.Q.

Thibault, Joseph George, B.Sc. (Univ. of Sask.), engrg. apprtee., Southern Canada Power Co., Montreal.

Admitted as Students

Cumming, John William (McGill Univ.), jr. dsgr. & dftsmn., Aluminum Co. of Canada, Montreal.

Dawson, George E. (Univ. of Sask.), attending A.I.D. School, Toronto.

Macdonald, Ian Malcolm (N.S. Tech. Sch.), 267 South St., Halifax.

Thompson, George Wilbert, B.Sc. (Queen's Univ.), chemist, Welland Chemical Works, Niagara Falls, Ont.

Tetrault, Robert (McGill Univ.), 1587 MacGregor St., Montreal.

*Has passed the Institute's examinations.

COMING MEETINGS

Fourth Pan-American Highway Congress—Mexico City, September 15-24.

National Industrial Advertisers Association—Annual Conference, September 17-19, Royal York Hotel, Toronto, Ont.

Canadian Good Roads Association—Twenty-sixth Annual Convention—early in October, Niagara Falls, Ont.

Personals

News of the Personal Activities of members of the Institute, and visitors to Headquarters

John McLeish, M.E.I.C., director of the Mines and Geology Branch of the Department of Mines and Resources, has retired, after completing forty-five years in the service of the Dominion Government. The good wishes of his chiefs and colleagues were conveyed to him by the Minister, the Hon. T. A. Crerar, at a recent gathering of the departmental staff. In doing so, the Minister referred particularly to the effective part taken by Mr. McLeish in the work of developing the mining industry—now so important a factor in Canada's war effort. During Mr. McLeish's twenty-year period of responsible office as director, the Mines Branch has become widely known for the work of its ore dressing, metallurgical and fuel testing laboratories and for the technological assistance rendered to industry and engineering.

A graduate of the University of Toronto Mr. McLeish entered the Civil Service in 1896, rising until in 1936 on the amalgamation of the Mines, Interior, Immigration and Indian Affairs departments to form the new Department of Mines and Resources, he was selected as the first director of its Mines and Geology Branch.

John McLeish, M.E.I.C.

During his government service, Mr. McLeish held many special appointments among which may be mentioned his membership of a commission on the Iron Industry of Canada (1914), the vice-chairmanship of the Dominion Fuel Board (1922), and membership of the Turner Valley Gas Conservation Board (1932). He has served on various Associate Committees of the National Research Council, including that recently formed to deal with the metallic magnesium question.

His services to the professional and scientific bodies to which he belonged included the chairmanship of the Ottawa Branch of the Institute for four years; for two years he was president of the Ottawa Branch of the Royal Astronomical Society of Canada. He has always given freely of his time and energy in promoting the welfare and advancing the legitimate interests of his fellow members of the technical and scientific services of Canada. His many friends hope that in his leisure he may long be able to continue such public spirited activities.

Lt. Colonel H. G. Thompson, M.E.I.C., has been promoted to colonel and appointed chief ordnance mechanical engineer at the Department of National Defence, Ottawa. He returned recently from England where he commanded No. 2 Army Field Workshop, R.C.O.C. In his new work, Colonel Thompson is to have available to him, through consultation, the expert advice and experience of Colonel N. C. Sherman, M.E.I.C., Commandant of the R.C.O.C. Training Centre at Kingston, Ont.

H. G. Angell, M.E.I.C., has resigned from the engineering staff of the Aluminum Company of Canada Limited to take up official duties with the British Admiralty at Bermuda. He had returned last year from Portsmouth, England, where he had been employed with the Admiralty for the past few years.

C. H. McL. Burns, M.E.I.C., formerly manager of the Welland plants of Canada Foundries and Forgings Limited recently joined the Ordnance Division of the Otis-Fensom Elevator Company at Hamilton and is at the present time on temporary loan to the Wartime Merchant Shipping Limited, Montreal.

(Courtesy Canadian Newspaper Service)
James Ruddick, M.E.I.C.

James Ruddick, M.E.I.C., has recently been appointed consulting engineer to the Royal Canadian Air Force. Born in England, he was educated at Durham College of Science and served his apprenticeship with the firm of Selby, Bigge and Company, Newcastle-on-Tyne, and with Messrs. Clarke, Chapman & Company, at Gateshead. After several years of electrical construction experience in England he came to Canada in 1907 and joined the Shawinigan Water & Power Company where he was responsible for construction work. From 1909 to 1912 he was employed by E. A. Wallberg of Cobalt, Ont., as construction engineer, and later as general superintendent of operation. In 1912 he became chief construction engineer with the Dominion Coal Company at Glace Bay. From 1915 to 1924 he was manager and engineer with the Laurentian Power Company. In 1924 he engaged in private practice, and has since specialized as a consultant in general engineering.

R. H. Findlater, M.E.I.C., is now located at Joplin, Mo., where he is employed with the Inspection Board of the United Kingdom and Canada as British Inspection representative at the plant of the Atlas Powder Company.

R. C. McMordie, M.E.I.C., has obtained his degree of Civil Engineer from the University of Toronto this spring. He is on the staff of the Hydro-Electric Power Commission of Ontario at Toronto.

Joachim Fortin, M.E.I.C., is now employed as an engineer in the Agricultural Engineering Department of the Province of Quebec, at Quebec.

Augustin Frigon, M.E.I.C.

F. H. Kester, M.E.I.C.

McNeely DuBose, M.E.I.C.

Augustin Frigon, M.E.I.C., assistant general manager of the Canadian Broadcasting Corporation, has recently been entrusted with new responsibilities by the Board of Governors of the Canadian Broadcasting Corporation. Hereafter, he will be in charge of the financial administration of the Commercial and of the Engineering Divisions and will supervise generally the programmes of the French network. He will also be responsible for the entire staff of the Corporation, numbering 620, except for the programme producing staff remaining under the general manager who is still looking after the national network, public relations, policy matters and official relations generally. According to the revised by-laws of the Corporation, Dr. Frigon is now reporting directly to the Board of Governors of the Canadian Broadcasting Corporation and to its Executive Committee. His headquarters will be in Ottawa.

F. H. Kester, M.E.I.C., has resigned from the position of general manager of the Canadian Bridge Company Limited, Walkerville, Ont., and has been asked to remain with the organization as consultant. He has been with the firm since 1907 when he joined as a draughtsman, becoming successively assistant engineer from 1912 to 1919, contracting engineer from 1919 to 1927, vice-president and director from 1927 to 1937 when he was elected president of the company. Until his recent resignation he combined with his office of president that of general manager.

McNeely DuBose, M.E.I.C., has been elected president of the Canadian Electrical Association at the annual meeting held at the Seigniory Club, Lucerne, Que., last month. Mr. DuBose who is a vice-president of the Institute, is the general manager of Saguenay Power Company Limited.

J. R. Hango, M.E.I.C., has been appointed general superintendent of Saguenay Transmission Company Limited at Arvida, Que. He was previously superintendent of distribution of Saguenay Power Company Limited.

S. W. Hall, M.E.I.C., is now employed as senior assistant engineer, Works and Buildings Branch, Naval Service, Ottawa. Since his graduation from the University of Toronto in 1938 he had been with the Building Department of the City of Toronto.

W. M. Reynolds, M.E.I.C., has accepted a position with the Hydro-Electric Power Commission of Ontario at Ferland, Ont. He previously carried a consulting practice at Sault Ste. Marie, Ont.

J. H. Ingham, M.E.I.C., has joined the staff of Walter Kidde Company of Canada at Montreal. A graduate of McGill University in 1935 he had been with the Dominion Bridge Company ever since as a mechanical designer and estimator.

G. H. Kimpton, M.E.I.C., has left the Oxygen Company of Canada, Montreal, to join the Royal Canadian Air Force in the aeronautical engineering division. He is at present stationed in Montreal. He was graduated in chemical engineering from McGill University in 1935.

C. K. McDonald, M.E.I.C., is at present on the staff of Wartime Merchant Shipping Limited, Montreal, on loan from the Shawinigan Water & Power Company.

J. P. Leroux, Jr.E.I.C., is now employed as resident engineer at Mont-Joli Airport, Mont-Joli, Que. He was graduated from the Ecole Polytechnique in 1939, and was employed with the Department of Public Works of Canada at Montreal until last year when he transferred to the Civil Aviation Branch of the Department of Transport.

Flight-Lieutenant R. C. C. Brown, Jr.E.I.C., is now officer commanding No. 3 Repair Depot, R.C.A.F., at Vancouver, B.C.

G. K. Narsted, Jr.E.I.C., has joined the engineering staff of Sorel Steel Industries Limited. He was graduated in mechanical engineering from McGill University in 1940, and worked for several months with the Canadian Bridge Company Limited at Walkerville, Ont. Lately he had been employed with the Eaton, Wilcox Company Limited at Windsor, Ont.

Paul E. Rose, Jr.E.I.C., who is on the staff of the Canadian General Electric Company, has recently been transferred from Toronto to Montreal. He was graduated from the Ecole Polytechnique in 1937, and upon his graduation joined the company as an apprentice in the test course.

A. E. Chard, Jr.E.I.C., has received a commission as pilot officer in the armaments branch of the R.C.A.F., and is stationed at Belleville, Ont. He was graduated in mechanical engineering from the University of British Columbia in 1935. In 1937 and 1938 he was employed with the British Columbia Pulp and Paper Company at Port Alice, B.C. Lately he had been on the staff of Spruce Falls Pulp and Paper Company at Kapuskasing, Ont.

Lorne B. Whiteway, Jr.E.I.C., who has been resident engineer with the Prince Edward Island Department of Public Works and Highways for the past three years, has accepted an appointment with the R.C.A.F. Works and Buildings, as assistant engineer at No. 4 Repair Depot, Scoudouc, N.B.

L. J. Ehly, S.E.I.C., who was graduated from the University of Alberta in chemical engineering this spring is now employed with the Royalite Oil Company at Turner Valley, Alta.

J. Angelo Roncarelli, S.E.I.C., is now overseas where he is attached to the Royal Montreal Regiment in charge of transport. Captain Roncarelli was graduated in mechanical engineering from McGill University in 1938. He joined the Royal Canadian Ordnance Corps at the outbreak of war as a sub-lieutenant, and was soon promoted and sent to England where he took a special course in ordnance at the Royal Academy of Military Science.

J. C. Loiselle, S.E.I.C., has returned to the staff of Canadian International Paper Company at Gatineau, Que. He was graduated in civil engineering from McGill University in 1937. Upon his graduation he joined the Canadian International Paper Company at Gatineau. From 1938 to 1940 he worked with Baulne & Leonard, consulting engineers, Montreal. For the past year he had been with Truscon Steel Company of Canada at Montreal.

Gérard Brosseau, S.E.I.C., has been appointed by the Aeronautical Inspection Directorate as inspector at the plant of Federal Aircraft Limited, Montreal, upon his return from Toronto where he followed a four months' course. Previous to his joining the Department of National Defence he was with Canadian Car & Foundry Company Limited in Montreal.

Murray D. Stewart, S.E.I.C., has resigned from the staff of Messrs. Babcock, Wilcox and Goldie-McCulloch Limited, to accept a commission as lieutenant in the Royal Canadian Ordnance Corps, and is now located at Toronto.

Marcel Papineau, S.E.I.C., has joined the R.C.A.F. as a pilot officer in the aeronautical engineering branch, and is located at Montreal. He was graduated from the Ecole Polytechnique in 1940, and was on the staff of Noranda Mines Limited at Noranda, Que., for the past year.

J. E. Pauch, S.E.I.C., has joined the engineering staff of R.C.A. Victor Company at Montreal.

VISITORS TO HEADQUARTERS

H. N. Goodspeed, S.E.I.C., International Nickel Company, Sudbury, Ont., on May 30th.

Lieut. J. R. Carson, S.E.I.C., H.Q. 3rd Canadian Division Engineers, Debert, N.S., on June 2nd.

S. Hogg, M.E.I.C., St. John Drydock and Shipbuilding Co. Limited, Saint John, N.B., on June 4th.

C. J. Oliver, M.E.I.C., Assistant Superintendent, Electrical Distribution, Rio de Janeiro Tramway Co. Limited, Rio de Janeiro, Brazil, on June 4th.

A. E. Hopper, M.E.I.C., Ottawa, Ont., on June 6th.

G. N. Houston, M.E.I.C., Olds, Alta., on June 7th.

B. E. Surveyer, AFFIL. E.I.C., Aluminum Company of Canada Limited, Arvida, Que., on June 9th.

P. M. Schear, S.E.I.C., Buchans Mining Company Limited, Buchans, Nfld., on June 10th.

E. L. Ball, Jr.E.I.C., Field Engineer, Foundation Company of Canada Limited, Arvida, Que., on June 11th.

D. A. Evans, M.E.I.C., Resident Manager, Powell River Paper Co. Limited, Powell River, B.C., on June 17th.

W. G. Reekie, M.E.I.C., Resident Engineer, Quebec North Shore Paper Co. Limited, Baie Comeau, Que., on June 19th.

N. Klodniski, S.E.I.C., International Nickel Co. of Canada Limited, Sudbury, Ont., on June 20th.

R. D. McKay, M.E.I.C., Sanitary Engineer, Dept. of Public Health, Halifax, N.S., on June 21st.

Obituary

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Theodore Kipp, M.E.I.C., died at Winnipeg, on May 30th after a lengthy illness. He was born in Germany in 1880 and came to the United States with his parents at the age of one year. He was educated at Bradley Polytechnic Institute, Peoria, Ill. From 1897 to 1903 he served an apprenticeship in flour and cereal mills at the same time taking home courses and private instruction in mechanical engineering. In 1904 to 1905 he was mill superintendent with Woolner Distilling Company, Peoria, and in 1906 he became assistant manager and engineer with Independent Cereal and Milling Company. During the years 1907 and 1908 he was engaged in contracting and consulting engineering in the firm of Kipp-Lackey Company at Peoria. He came to Canada in 1909 as mill superintendent with Tillson Company Limited, at Tillsonburg, Ont. From 1910 to 1914 he was manager of the cereal department at Robin Hood Mills Limited, at Moose Jaw, Sask. From 1914 to 1918, he was engaged in consulting and sales engineering under his own name in Winnipeg, Man. In 1918 he was appointed general superintendent and engineer of Ogilvie Flour Mills Company Limited, at Winnipeg. He later returned to consulting engineering and contracting and organized the firm of Kipp-Kelly Limited, at Winnipeg. He was also a partner in the firm of Sullivan, Kipp and Chace Limited, of Winnipeg. During the last war he was consultant to the British Food Board for whom he designed and built a number of cereal mills in England and Ireland. At the time of his death he was director of several firms.

Mr. Kipp joined the Institute as a Member in 1918.

CANADIAN PETROLEUM PRODUCTION

Canada's crude petroleum production in 1940 amounted to 8,717,345 barrels compared with 7,826,301 barrels in 1939, reports the Department of Mines and Resources.

About 97 per cent of the total Canadian output came from the Turner Valley field, southwest of Calgary, Alberta, where at the close of the year 131 wells were producing crude oil and 24 others were being drilled. Thirty-five crude oil wells were completed in 1940 in Turner Valley. Small amounts of crude oil were also produced in other localities in Alberta, namely, in Red Coulee, Wainwright, Vermilion, Del Bonita, Dina, Lloydminster, and Moose Dome. Alberta's total production of petroleum in 1940 aggregated 8,493,000 barrels as compared with 7,576,932 barrels in the preceding year.

Ontario, New Brunswick, and the Northwest Territories also produced crude petroleum in 1940. The Ontario output, totalling 186,000 barrels, came from Petrolia, Oil Springs, Bothwell, and the townships of Dawn, Warwick, West Dover, and Mosa. The Stoney Creek field, southwest of Moncton, New Brunswick, produced 21,161 barrels, and the wells near Norman, about fifty miles west of Great Bear Lake in the Northwest Territories, yielded 17,184 barrels.

Tests were completed at a number of prospective producing localities in Alberta during the year, namely, at the Blood Indian Reserve, Brazeau, Lloydminster, Steveville, and Vermilion, and drilling or preliminary operations were in progress in several other areas including Black Diamond, Clearwater, Grease Creek, Mill Creek, Moose Dome, Pincher Creek, Pouce Coupé, Sheppard Creek, Spring Coulee, Taber, Twin River, and Willow Creek. Tests were also conducted in Saskatchewan at Bishopric, Kamsack, Lloydminster, and Little Pines; in British Columbia at Commotion Creek; in Ontario near Collingwood and on Manitoulin Island, and in Quebec near York River in the Gaspé Peninsula.

News of the Branches

Activities of the Twenty-five Branches of the Institute and abstracts of papers presented

HAMILTON BRANCH

A. R. Hannaford, M.E.I.C. - *Secretary-Treasurer*
W. E. Brown, Jr.E.I.C. - - *Branch News Editor*

On the evening of May 9th, Dr. H. B. Speakman addressed the regular branch meeting on **Alcohol from Wheat.** The speaker was introduced by Vice-Chairman S. Shupe. Dr. Speakman outlined briefly the historical background and the serious character of the present situation in regard to stocks of wheat in western Canada. Reference was made to the use of alcohol in motor fuels in European countries, and the attempts recently made to show its possibilities, both technically and economically in the United States. Working under the auspices of the Associated Boards of Trade, a committee of chemists and engineers has recently looked into the possibilities of "Power Alcohol" from a Canadian viewpoint.

Dr. Speakman outlined the findings of this committee and discussed the merits of the proposal both as a relief from an emergency and also as a part of a long-term policy for Canada. The necessity for continued research and economic study along other lines was emphasized.

The lecture brought forward many questions from a very deeply interested audience of 36. After the lecture, members and visitors retired for coffee and cake and a friendly chat with the speaker of the evening. Before the address the audience enjoyed the showing of the Engineering Institute film of the events leading up to and the failure of the Tacoma Bridge.

KINGSTON BRANCH

J. B. Baty, M.E.I.C. - *Secretary-Treasurer*

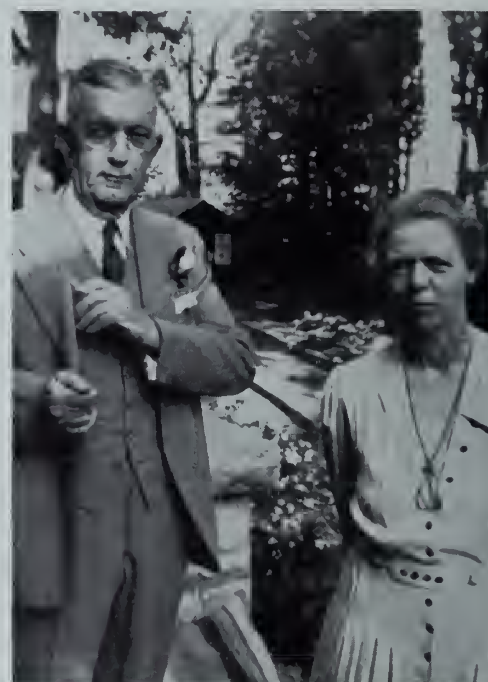
The Kingston Branch of the Engineering Institute felt that such an event as the election of Principal Wallace of Queen's University to honorary membership in the Institute should be acknowledged in some special way. A dinner, given to the principal by the branch was decided upon, with the hope that the Council would mark the occasion by meeting in Kingston. These invitations were willingly accepted, and the date was set for Saturday, June 14.

A report of the Council meeting held in the Board room of the Gymnasium at Queen's University will be found elsewhere in this issue.

During the afternoon the visiting ladies were taken for a drive, to see the sights of Kingston and the surrounding country. They then gathered at the home of the branch chairman, where Mrs. McGinnis entertained them at tea, and where they were later joined by the members of council, just released from their official duties. The hospitable reception and the beautiful gardens and lawns were enjoyed in a perfect summer afternoon.

The dinner took place in the evening at the Cataraqui Golf Club, where over one hundred members and guests sat down about eight o'clock. The chairman of the branch presided.

At the close of the dinner Mr. McGinnis welcomed the guests, and then asked Past President Dr. A. Surveyer of Montreal to speak about the new honorary member. Dr. Surveyer's presentation of Dr. Wallace was delightful. He told of the principal's early education in Scotland and Germany, his coming to Canada as a young man some thirty years ago, the way in which he entered into the life



Tea host and hostess—Mr. and Mrs. T. A. McGinnis

Past President Surveyer introduces Principal Wallace, Left to right: Dr. Wallace, Chairman T. A. McGinnis, Mrs. Wallace, and President Mackenzie. The vice-principal of Queen's, Dr. W. E. McNeill, is in the foreground.

A birds-eye view of the dinner at the golf club.

Past President Hogg and Vice-President DuBose seem to be combining business with pleasure.

After the council meeting the gentlemen joined the ladies for tea. Left to right: Vice-President K. M. Cameron, Past President F. P. Shearwood, Past Councillor Colonel LeRoy Grant and Councillor D. S. Ellis.

of the West of that time, both as a university teacher and as an administrator. He then spoke of his later work as principal at the University of Alberta, and at Queen's. He concluded by citing Dr. Wallace as one eminently deserving of the honour which the Institute had conferred upon him.

The president of the Institute then, with a few words of appreciation handed to Dr. Wallace the parchment certificate of his honorary membership in the Institute.

Principal Wallace in reply expressed his gratitude, and pride in the honour which had been done him. With dry Scottish humour he recalled various experiences in the early days in the West when he was in closer contact with engineering works than he had been in later times. In closing he pointed out the serious task now lying ahead of the engineering profession, not only in the prosecution of the war but in the great work of reconstruction afterwards.

Meanwhile the chairman had been looking over the assembly, noting the presence of five past presidents, he promptly called for a few words from those who had not already spoken. Messrs. Shearwood, Desbarats, Challies and Hogg rose in turn and gracefully expressed their congratulations to Dr. Wallace and also to the Institute. One of our Montreal members, Professor McBride, of McGill University, now president of the Canadian Institute of Mining and Metallurgy also conveyed his felicitations to the new honorary member. Dean Clark of the Faculty of Applied Science at Queen's, one of the senior honorary members spoke briefly.

Although the fact was perhaps not generally realized, the occasion was really President Mackenzie's first official visit to the branch. He marked the event by a happy speech which was not only diverting, but also contained serious touches meriting careful consideration. After briefly discussing Institute affairs he touched upon the idea so generally held, that engineers should plunge into public life, and pointed out that the qualities which make a man a good engineer did not necessarily fit him for public life. Later he dealt with the need for the development of an entirely new point of view by the peoples of the earth if peaceful relationships among them are to be maintained, an event which will require great sacrifices and the abandonment of many historical traditions.

After this very successful dinner, the tables were removed and the room cleared for dancing. Bridge tables were set up, and everyone had an opportunity to chat and discuss questions of the hour.

Since the success of such affairs depends so largely upon those attending, the members of the Kingston Branch feel very grateful to those who came from the other branches and from headquarters and who were such welcome guests.

The out-of-town guests included: President and Mrs. C. J. Mackenzie, Ottawa; Dr. A. Surveyer; Mr. and Mrs. F. P. Shearwood; Dr. J. B. Challies and Miss Challies; Mr. C. K. McLeod; Mr. and Mrs. L. Austin Wright; E. J. Carlyle; deGaspé Beaubien; R. J. Durley; Huet Massue; Mr. and Mrs. McNeely DuBose; Professor W. G. McBride, all of Montreal; J. H. Fregeau, of Three Rivers. Mr. and Mrs. T. A. McElhanney, Mr. and Mrs. W. H. Munro, Mr. and Mrs. G. J. Desbarats, of Ottawa. Mr. R. L. Dobbin, Mr. D. J. Emery and Mr. Ball, of Peterborough. Dr. and Mrs. A. H. Harkness, Mr. and Mrs. H. E. Brandon, Dr. and Mrs. T. H. Hogg, Mr. and Mrs. S. R. Frost, all of Toronto. Mr. and Mrs. E. V. Buchanan, of London.

LAKEHEAD BRANCH

H. M. Olsson, m.e.i.c. - *Secretary-Treasurer*
W. C. Byers, Jr.e.i.c. - *Branch News Editor*

A dinner meeting was held on April 23rd at the Royal Edward Hotel in Fort William, commencing at 6.30 p.m.

The chairman, H. G. O'Leary, presided at the meeting which was attended by 30 members and guests.

Mr. E. J. Davies introduced the speaker of the evening, Mr. R. R. Holmes of the Thunder Bay Paper Company, who spoke on **The Treatment of Boiler Feedwater.**

There are four results that should be obtained in treating any feedwater: (1) Heating and evaporating surfaces of the boiler have to be kept free from scale; (2) Boiler metal must be protected against corrosion; (3) The carry-over of liquids or solids must be avoided in the steam leaving the boiler; (4) Embrittlement of the boiler metal must be prevented.

Lake Superior water has a hardness of 2.5 to 3.0 grains per gal. and can be safely used for average fire-tube boilers with a rating of from 1,000 to 5,000 lb. per hr. used for heating and hoisting operations. If a boiler evaporating 40,000 lb. per hr. with 25 per cent make-up, used water with 3.0 grains per gal., then the scale would precipitate at the rate of about 3,000 lb. per year with a drop in efficiency of 7.5 per cent. Besides lowering efficiency, the presence of scale in high rating boilers may cause over-heating and rupture of the tubes.

The best and most costly method of preventing scale formation is by the use of an evaporator, which is only used in large central power stations.

Water softeners are more widely used, the simplest being the zeolite softener, which is a continuous and completely automatic operation. The lime soda softener while not as simple as the zeolite softener, probably gives better results. The lime soda softener has the advantage over the zeolite softener by removing most of the compounds forming the hardness rather than passing them on as soluble sodium compounds.

Corrosion in boilers is usually caused by dissolved oxygen in the feedwater, although, other causes may be dissolved carbon dioxide or acid condition in the feedwater. The greater proportion of the oxygen and the carbon dioxide is easily removed by the use of a deaerator. In the deaerator the water is boiled under a vacuum and recondensed; the oxygen and carbon dioxide being removed by evacuating equipment.

When water is slightly acidic, a great deal of trouble is experienced with corrosion and pitting, especially in economizer tubes. The ideal pH for feedwater is from 8.0 to 8.5. If the pH is below 7.5 serious corrosion can be expected.

Corrosion due to electrolytic action can be prevented by suspending zinc plates in the boiler and making an electrical contact with the boiler shell.

Boiler plate embrittlement is a term commonly applied to intercrystalline cracks which develop in the presence of high concentrations of caustic. Three conditions are necessary for the occurrence of caustic embrittlement: (1) The boiler water must have high alkalinity; (2) There must be a crack in the boiler plate or seam where the caustic solution can become concentrated; (3) The boiler plate must also be stressed beyond the yield point.

In the past year or two the linings which are used to absorb oxygen in the feedwater have been gaining favour in the treatment for embrittlement. In almost all cases of embrittlement part of the trouble has been due to poor workmanship or defective material. No cases of embrittlement have been reported in forged steel, welded, or internally caulked rivetted boiler drums. All failures have occurred in boilers of rivetted construction which were externally caulked or both externally and internally caulked.

Lake Superior water shows an analysis as follows: Hardness 2.6; total alkalinity 3.0; chloride 0.35; other contents are practically negligible. The hardness present is almost all calcium bicarbonate. Very little sulphate hardness is present in this water and thus the lime soda softener is the best type of softener and will precipitate the bicarbonate out of the water. The zeolite softener will merely exchange the calcium bicarbonate for sodium bicarbonate and when this material reaches the boiler it increases the alkalinity. Most of the corrosion, in feed lines, caus d by waters in the Lakehead district, can be prevented fairly effectively by the use of a deaerator, which will remove most of the dissolved oxygen and carbon dioxide.

Mr. S. E. Flook gave a vote of thanks to the speaker and his motion was seconded by Mr. R. B. Chandler.

LONDON BRANCH

H. G. Stead, Jr.E.I.C. - - *Secretary-Treasurer*
A. L. Furanna, S.E.I.C. - *Branch News Editor*

The branch held its first supper meeting outside of London on May 21st, 1941, at the Gettas Restaurant in St. Thomas. This meeting was the result of an invitation extended to the branch by Mr. W. C. Miller on behalf of the St. Thomas members. The programme consisted of dinner and the showing of the Engineering Institute's movie of the failure of the Tacoma Narrows Bridge.

After dinner, Mayor P. Laing of St. Thomas was introduced by the chairman, R. W. Garrett. He welcomed the members and guests of the Institute and expressed the hope that the London Branch would accept his invitation to return to St. Thomas for other meetings. Mr. J. A. Vance then gave a short report on the Maritime Regional Council Meeting which he attended recently in St. Johns, New Brunswick. Mr. Vance also said he was very much impressed by what he saw in the east coast of Canada at war.

Before Mr. T. L. McManamna started to show the film, Mr. H. F. Bennett gave the meeting many details concerning the structure of the bridge. This bridge was built at an estimated construction cost of $6,400,000.00. It consisted of a suspended structure having a total length of 5,000 ft., divided into a centre span of 2,800 ft. and two side spans of 1,100 ft. each. The roadway was 26 ft. wide for two-lane traffic and flanked on both sides by a 4 ft. 9 in. sidewalk. This was the most slender suspension bridge ever built. The minimum vertical clearance for navigation was 196 ft. The two main towers were 425 ft. high and built to feature the newest advance in suspension bridge designs. They were "flexible," that is although the towers were rigidly anchored in concrete at the bottom, the top could move as much as 5 ft. either way in the direction of the longitudinal axis of the bridge. The two main cables supporting the span were 14¼ in. in diameter, consisting of 6,300 parallel wires and having a total length of 5,772 ft. each. The life of the structure was only a little more than four months. It was dedicated on July 1, 1940, and collapsed on November 7, 1940.

The opening scenes of the reel showed the bridge in its characteristic undulating motion with a frequency of 36 cycles per minute and a moderate amplitude. This was the condition before 10.00 a.m. on that fateful morning of November 7th. Traffic was still crossing the bridge. Suddenly the frequency of the motion increased and for the first time the two main cables became out of phase by 90 degrees. That is, when one side of the span was at the peak of its vertical motion the other side was at its minimum. During this period the oscillating motion, at times, seemed to exceed that of gravity and the amplitude at the extreme edge of the sidewalk was in excess of 28 ft. vertical with a complete cycle occurring in four seconds. This violent twisting motion continued until just after 11.00 a.m. when the centre span collapsed in a 42-mile-an-hour wind.

The film also showed pictures of the testing model on which a number of tests had just been completed. From the series of resultant proposals rendered, it is believed that, had time permitted, this catastrophy would have been averted.

Judging by the enthusiastic discussions which followed this film it is little wonder that the Institute is anxious to have it shown at all its branches.

MONCTON BRANCH

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

The annual meeting of the branch was held on May 30th. F. O. Condon, chairman of the branch, presided. The annual report, showing the activities of the branch for the past season, and the financial statement, were presented. On motion, it was decided that the branch shall buy a hundred-dollar Victory bond, during the coming War Loan Campaign. The chairman announced that as a result of nominations made at the previous meeting, branch officers for 1941-42 would be as follows: Chairman, F. O. Condon; Vice-Chairman, H. J. Crudge; Secretary-Treasurer, V. C. Blackett; Executive Committee, B. E. Bayne, G. L. Dickson, T. H. Dickson, R. H. Emmerson, E. R. Evans, E. B. Martin; Ex-Officio, H. W. McKiel, G. E. Smith.

MONTREAL BRANCH

L. A. Duchastel, M.E.I.C. - *Secretary-Treasurer*

On April 28th, L'Association des Anciens Elèves de L'Ecole Polytechnique de Montréal invited the members of the Institute to hear Mr. N. W. McLeod deliver a paper entitled **The Place of Soil Technology in Modern Highway and Airport Construction.** The meeting was held in the new auditorium of L'Ecole Polytechnique and the paper dealt with soil classification, fundamentals of soil grading, principles of sub-grade and base course construction, characteristics of wearing surfaces, importance of adequate laboratory control. The paper was illustrated with practical demonstrations and lantern slides.

On June 12th the Canadian Vickers Limited were hosts to members of the branch who were given an opportunity of seeing ships and aeroplanes in various stages of construction. The interest shown was demonstrated by the fact that over 300 members attended this visit and were given the opportunity of inspecting engine and boiler construction and other industrial work.

News of Other Societies

Items of interest regarding activities of other engineering societies or associations

THE WORK OF THE ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

Discussions at New York by E.C.P.D. Committee on Professional Training

Continuing its exploration of all promising means of smoothing the transition of the young engineering graduate from the supervised and rather closely directed life of his college years to the confident and successful practice of engineering, the Committee on Professional Training of the Engineers' Council for Professional Development met at New York on May 29. Mr. S. D. Kirkpatrick, Vice-President of the American Institute of Chemical Engineers, was in the chair, supported by Mr. O. B. Schier, Chairman of the Junior Committee on Professional Training. The Engineering Institute of Canada, which, since October, 1940, has been one of the bodies participating in the E.C.P.D., was represented on the committee by Professor C. R. Young, of the University of Toronto.

While an official report of the proceedings to the Executive Committee of E.C.P.D. is still in preparation and is not at present available, information concerning certain matters of fact placed before the Committee on Professional Training has been made available to *The Engineering Journal.*

Most of the discussion turned on matters brought out by Mr. George W. Dyson in an admirable review of the answers to a questionnaire sent out in the autumn of 1940 relative to student guidance, relations with young engineers and policy and organization. While most of the replies particularly concerned questions of student guidance, some of them threw helpful light on the relations of the engineering societies to young engineers.

Junior Groups in the Societies

Although junior groups of the various engineering societies have not always proved to be successful, they have in certain cases been found to be definitely advantageous.

This is likely to be so where the section or branch of the society has a large pool of young members from which to draw, as, for example, the Metropolitan (New York) section of the American Society of Mechanical Engineers. One of the most valuable activities of this body has been the organization of study groups to prepare for examinations in connection with professional licensing.

Chemical engineers in Metropolitan New York and in the Philadelphia-Wilmington area have organized junior groups that are apparently functioning successfully. In the latter area a number of informative plant inspection trips have been held, usually on Saturday mornings.

In areas where the junior membership of the individual societies does not warrant a separate organization, successful groups have in some instances been organized under the auspices of a local engineering society. In this connection the work of the Providence Engineering Society and the Engineers' Club of St. Louis has been noteworthy. The Providence group undertakes to stress personal contacts and self expression rather than technical advancement.

Discussion groups are held to be of particular value to the junior engineer, since they not only give him an opportunity to express himself under particularly favourable circumstances, but also subject him to the "give and take process" prevalent in such meetings.

Engineering schools in certain cities are offering courses of evening study, accredited by the E.C.P.D., leading to a degree. In certain cases where sufficient enrolment for complete degree programmes cannot be obtained, courses in specialized fields have been organized by the students themselves. In New York City, for example, member societies of the E.C.P.D. sponsor review courses particularly designed to assist young engineers preparing for their professional engineer's licence.

Some opinion was expressed at the meeting that since the problems of junior engineers are much the same as those of their more mature professional brethren, no good purpose is served by segregating them in a distinct group. It was contended that the best results are obtained when a genuine spirit of comradeship exists between all age groups. The big problem is to "break the ice" between the older and the younger members and in doing this the initiative must come from the older members. A sure way of making the young engineer at home amongst his elders is to give him something to do. Several of the societites participating in the E.C.P.D. make it a point to include a junior member or two on every committee. In this way they serve an unofficial but nevertheless effective apprenticeship in the work of managing professional societies.

ANNUAL MEETING OF CANADIAN INSTITUTE OF STEEL CONSTRUCTION

C. S. Kane, Dominion Bridge Company, Limited, Montreal, was elected to the presidency when the Canadian Institute of Steel Construction held its annual meeting in Montreal last month. Luncheon was taken at the Mount Stephen Club with 55 attending. Assistant Steel Controller D. S. Wood spoke informally. Mr. Kane succeeds G. P. Wilbur of Dominion Bridge Company Limited, Toronto.

C. S. Kane, M.E.I.C.

Vice-presidents are G. G. Henderson of Canadian Bridge Company, Limited, Walkerville, for the Central Division, and C. W. Marshall, Dominion Structural Steel, Limited, Montreal, for the Eastern Division.

The executive committee is divided into three groups representing respectively the Central, Eastern divisions and the Mills. For the Central Division, representatives are G. P. Wilbur, Dominion Bridge Company, Limited, Toronto; F. P. Flett, Truscon Steel Company of Canada, Limited, Toronto; Thomas Boyce, Disher Steel Construction Company, Limited, Toronto; and R. E. Nicholson, Algoma Steel Corporation, Limited, Toronto. For the Eastern Division the representatives are J. E. Bertrand, Canadian Structural Steel Works Company, Limited, Montreal; G. V. Roney, Farand and Delorme, Limited, Montreal; and H. W. Welsh, MacKinnon Steel Corporation, Limited, Sherbrooke. Representing the mills are H. J.

Leitch, Algoma Steel Corporation, Limited, Montreal; Huntly Gordon, Dominion Foundries and Steel Limited, Hamilton; A. H. Pepper, Dominion Steel and Coal Corporation, Limited, Montreal; and E. M. Seale, Canadian Tube and Steel Products, Limited, Montreal.

PULP AND PAPER MILLS TRAIN EMPLOYEES FOR WAR WORK

To relieve the present shortage of skilled machinists and to speed production of war supplies, training-schools have been created in the pulp and paper mills throughout Canada under the direction of a special committee of the Canadian Pulp and Paper Association. Pulp and paper mills have already supplied a large number of skilled workers to war industries and the current educational plan seeks to build up a reserve of trained men to fill the places of those who have been released or loaned for war work.

The educational plan, far-reaching and of major importance, is the result of co-ordinated efforts on the part of the pulp and paper industry in Canada. The schools provide a relatively short but balanced training in practical shop work, and to date applications to take the courses have exceeded the number of men that can be handled. The scheme calls for individual selection of men and individual training; the work of both student and mentor is given voluntarily.

In each of the companies which have adopted the plan, men and staff are getting on with the job with real enthusiasm and progress. It has been welcomed by the men at the plants, with the result that hundreds of workers are now taking a short practical course in machine shop work.

Because time is limited and in order that this training plan may be of the utmost usefulness to Canada, the training period has been limited to twelve months as a maximum. Actually, since the training is on an individual basis many men make substantial progress in less than the twelve-month period. There is no doubt that men who satisfactorily complete any of the given courses will be able to take their places in industry and rapidly acquire the balance of manual skill necessary to assume positions of responsibility in their chosen trades.

The plan consists of two parts: home study courses to provide theoretical training, and practical machine shop instruction conducted simultaneously with the home study to develop required manual skill. The plan also offers an opportunity to provide the necessary theoretical training more quickly and at an appreciably lower cost than could be arranged under any other circumstances.

Since the pulp and paper industry's training plan makes a definite contribution to Canada's war effort, progress is being closely watched by Government officials in Ottawa who heartily endorse this practical method of speeding up production of supplies and materials for war purposes.

Library Notes

Book notes, Additions to the Library of the Engineering Institute, Reviews of New Books and Publications

ADDITIONS TO THE LIBRARY

TECHNICAL BOOKS

Air and Gas Compression:
By Thomas T. Gill, New York, John Wiley & Sons, Inc., 1941. 181 pp. 9¼ x 6 in., $3.00

Dana's Manual of Mineralogy:
By Cornelius S. Hurlbut, New York, John Wiley & Sons, Inc., 1941. 480 pp., 9¼ x 6 in., $4.00.

The Manuscript:
Published by John Wiley & Sons, Inc., 1941. 75 pp., 6¼ x 9¼ in., $1.00.

PROCEEDINGS

Institution of Mechanical Engineers:
Proceedings, July-December, v. 144.

REPORTS

Canada Department of Labour:
Prices in Canada and other countries, 1940. Ottawa, 1941. Wages and hours of labour in Canada, 1929, 1939, and 1940. Report No. 24, Ottawa, 1941.

Canada Department of Mines and Resources, Mines and Geology Branch, Geological Survey Memoirs:
Jacquet river and Tetagouche river map-areas, New Brunswick; Nelson map-area, east half, British Columbia. Memoirs 227, 228.

Canada Department of Mines and Resources, Mines and Geology Branch, Geological Survey:
Preliminary report MacKay Lake area, Northwest Territories; Great Slave Lake to Great Bear Lake, Northwest Territories, Ingray Lake map-area, Northwest Territories. Papers 41-1, 41-2, 41-3.

Canada Department of Mines and Resources, Surveys and Engineering Branch:
Altitudes in eastern Ontario, Ottawa, 1941.

Canada Department of Mines and Resources, Surveys and Engineering Branch, Water Resources Paper:
Surface water supply of Canada, Pacific drainage British Columbia and Yukon Territory, Ottawa, 1941.

Canadian Engineering Standards Association, Specification:
Standard specification for welders' helmets, hand shields and goggles and for general purpose anti-glare goggles. S69-1941. Ottawa, 1941.

Civil Service Commission of Canada:
Thirty-second annual report for the year 1940. Ottawa, 1941.

Electrochemical Society, Preprints:
The mercury-mercurous iodate electrode; (1) standard potential; (2) reproducibility. Preprints 80-1, 80-2.

United States Department of Commerce, Building Materials:
Indentation characteristics of floor coverings, BMS 73.

United States Department of the Interior, Bulletins:
Open-cut metal mining; metal-mine accidents in the United States, 1938. Nos. 433, 435.

United States Department of the Interior, Geological Survey Bulletin:
Phosphate investigation in Florida, 1934 and 1935; Geophysical abstract 99, October-December, 1939; Transit traverse in Missouri, part 8, west-central Missouri, 1906-37; Goodnews platinum deposits, Alaska; pre-Cambrian geology and mineral resources of the Delaware water gap and Easton quadrangles, New Jersey and Pennsylvania; geophysical abstracts 101, April-June, 1940. Nos. 906-F, 915-D, 916-H, 918, 920, 925-B.

United States Department of the Interior, Geological Survey Water-Supply Paper:
Geology and ground-water resources of the Lufkin area, Texas; Effect upon ground-water levels of proposed surface-water storage in Flathead Lake, Montana; Surface water supply of the United States, 1938, pt. 1, North Atlantic Slope Basins; Surface water supply of the United States, 1939, pt. 9, Colorado River basin; surface water supply of the United States, 1939, pt. 12, Pacific slope basins in Washington and Upper Columbia River basin; surface water supply of the United States, 1939, pt. 13, Snake River basin. Nos. 849-A, 849-B, 851, 879, 882, 883.

United States Department of the Interior, Geological Survey Professional Paper:
Additions to the Wilcox Flora from Kentucky and Texas, 193-E.

United States Department of the Interior, Bureau of Mines, Technical Paper:
Mining practices and safety at the Lava Cap Gold Mining Corporation mines, Nevada City-Grass Valley district, California; accidents in the Oklahoma petroleum industry in 1937; analyses of Washington coals. Nos. 618, 619, 620.

United States Work Projects Administration, Bibliography of Aeronautics:
Supplement to part 37—airports, 1941.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet the books are not in the Institute Library, but inquiries will be welcomed at headquarters, or may be sent direct to the publishers.

ACOUSTICS

By A. Wood. Interscience Publishers, New York, 1941. 588 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $6.00.

Both the theoretical and practical phases of the subject are considered in this comprehensive and detailed work. Following the chapters on wave motion, diffraction, vibrations and other elements of classical theory much space is devoted to modern topics, such as ultrasonic waves and sound recording and reproduction. There are many illustrative graphs and pictures.

Air Raid Precautions Handbook No. 5, STRUCTURAL DEFENCE, 1st ed.

Issued by the Home Office, Air Raid Precautions Dept. London, His Majesty's Stationery Office, 1939. 58 pp., diagrs., charts, tables, 13 x 8 in., paper, 2s. (obtainable from British Library of Information, 620 Fifth Ave., New York, 60c.).

Fundamental principles and data derived from research and experiment are presented in this handbook. In the first two chapters the theoretical and practical effects of explosive bombs are considered in some detail. The subsequent chapters deal with the requirements and principles of design of structures to resist such attacks, both for the construction of new buildings and the adaptation of existing ones.

ANTIAIRCRAFT DEFENSE

Military Service Publishing Co., Harrisburg, Pa., 1940. 603 pp., illus., diagrs., charts, tables, 10 x 6 in., cloth, $2.00.

The main function of this volume is to present a study of antiaircraft artillery from the .30-caliber machine gun to the 105-mm. gun, together with all the accessories that make up the antiaircraft regiment. The comprehensive treatment of the subject includes also formations and manoeuvres, tactics of units, field fortifications and defense against chemical warfare. Appended are a glossary of terms, condensed drill tables for units and a list of War Department publications, from which much of the material has been taken.

CORRECTING OIL BURNER DEFICIENCIES, with Special Application to Pressure Atomizing Oil Burners

By Z. Kogan. Zuce Kogan Consulting Service, Chicago, Ill., 1941. 152 pp., illus., diagrs., charts, tables, 9½ x 6½ in., cloth, $5.00.

The variation in efficiency between test runs and general operation in oil-burning power plants is considered by the author, a consulting engineer, to be due to dependence on certain traditional concepts which no longer apply. Under the following headings: mixing of oil and air, furnace heating zone, fineness of atomization and burner applications, he presents new concepts and techniques for correcting oil-burner deficiencies, particularly in pressure burners.

(An) ENGINEERS' MANUAL OF STATISTICAL METHODS

By L. E. Simon. John Wiley & Sons, New York, 1941. 231 pp., illus., diagrs., charts, tables, 10 x 6½ in., cloth, $2.75.

This book is a summary of certain working parts of the sciences of probability, statistics and logic, and is designed to assist the practical man in industrial or engineering work. Since the book is written primarily for use in an ordnance school for instruction in statistical techniques, the illustrative examples are generally taken from standard procedures or research at arsenals and proving grounds. The principles are, however, applicable to other inspection or quality control problems.

FLIGHT, First Principles

By B. Wright, J. J. Smiley and R. Martin. 283 pp.

FLIGHT, Construction and Maintenance

By B. Wright, W. E. Dyer and R. Martin. 259 pp.

American Technical Society, Chicago, Ill., 1941. Illus., diagrs., charts, tables, 9½ x 6 in., cloth, $2.50 each.

These two volumes present in a simple, practical manner the fundamentals of aviation and airplane manufacture. The book on first principles covers aerodynamics, soaring theory and parachutes, and contains an illustrated glossary. The second volume deals with blueprint reading, airplane materials, construction methods, repair work and propeller practice. A series of quiz questions with answers appears at the end of each book.

A GOOD MECHANIC SELDOM GETS HURT

By H. R. Graman. American Technical Society, Chicago, 1941. 94 pp., illus., 7 x 5 in., paper, 50c.

The object of this collection of safety rules is to give the beginning craftsman an idea of what to look out for when working in a machine shop. For simplicity the safety precautions for each machine have been grouped together. A set of review questions on safety in the machine shop appears at the end.

Great Britain. Dept. of Scientific and Industrial Research. Methods for the Detection of Toxic Gases in Industry, Leaflet No. 12, ORGANIC HALOGEN COMPOUNDS

London, His Majesty's Stationery Office, 1940. 6 pp., tables, 9½ x 6 in., paper, (obtainable from British Library of Information, 620 Fifth Ave., New York, 5c.).

The poisonous effects of the more important organic halogen compounds are indicated and precise directions given for a simple method for their detection. As in the case of tests given in previous leaflets, the object is not an extreme degree of accuracy but a rapid indication of the relative safety of the atmosphere.

Great Britain. Dept. of Scientific and Industrial Research, BUILDING RESEARCH

Wartime Building Bulletin No. 14. CENTERLESS ARCH DESIGNS

His Majesty's Stationery Office, London, 1941. 15 pp., illus., diagrs., charts, tables, 11 x 8½ in., paper (obtainable from British Library of Information, 620 Fifth Ave., New York, 30c.).

Continuing the material on centerless arch work described in Bull. No. 6, the present bulletin gives several designs for segmental arch structures and notes and curves for the design of other segmental arch rings. For illustration, the application of the system to a factory scheme is discussed.

IMPERIAL INSTITUTE, ANNUAL REPORT 1939

London, South Kensington. 90 pp., illus., 10 x 6 in., paper (obtainable from British Library of Information, 620 Fifth Ave., New York, not for sale, limited distribution, apply).

The investigation carried out by the various scientific departments are summarized, and other activities of the Institute, such as exhibitions and library work, are described. Pertinent information is also given concerning the personnel of the Institute and its relations with other organizations.

Industrial Relations Digests

IV. JOB CLASSIFICATION AND EVALUATION

V. POLICIES IN THE ADJUSTMENT OF WAGE RATES

VI. BASIC TRAINING POLICIES

Princeton University, Industrial Relations Section, Princeton, N.J., 1941. 8 pp. each, tables, 10 x 7 in., paper, 20c. each.

The three pamphlets listed above continue a series of digests prepared for use in companies facing rapid expansion because of defense orders. They are based on information received currently from a large number of representative companies.

INSULATION OF ELECTRICAL APPARATUS

By D. F. Miner. McGraw-Hill Book Co., New York and London, 1941. 452 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $3.00.

This key to insulation problems for the designer and user of electrical apparatus presents a well-rounded correlation of theory and design. It discusses present knowledge of dielectric behaviour, describes the problems encountered in insulating the major forms of electric power equipment and how they are solved, and shows what tests are of value in determining the performance of insulation. A condensed directory of plastics is appended.

INTERNATIONAL ACETYLENE ASSOCIATION, 40th Annual Convention Official Proceedings held at Milwaukee, Wisconsin, April 10-12, 1940

Publ. by International Acetylene Association, New York, 1941. 284 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, apply.

A complete record of the sessions of the 1940 convention is presented in this volume. In addition to the reports of various committees, the membership list and other information about the association, the text of some fifteen technical papers on brazing, welding and cutting is included. There is a subject index to the papers.

LAND ECONOMICS

By R. T. Ely and G. S. Wehrwein. Macmillan Co., New York, 1940. 512 pp., illus., diagrs., charts, tables, maps, 9½ x 6 in., cloth, $4.00.

In the first five chapters the various aspects of land utilization, both natural and by design, are discussed generally. The remainder of the book treats of the specific uses, for human benefits, to which land areas are devoted; of the problems which arise and of ways in which these uses may be most efficient. There is a final chapter on conservation, aad a large bibliography is appended.

MACHINE TRADES BLUEPRINT READING

By R. W. Ihne and W. E. Streeter. American Technical Society, Chicago, 1941. 138 pp., blueprints, diagrs., charts, tables, 11 x 9 in., paper, $2.00.

The first part of this book, which includes a glossary of shop terms, has been designed to teach all the basic information necessary to interpret a print. The rest of the book is composed of actual production blueprints, each of which is accompanied by a question sheet intended to bring out the important points embodied in the drawing.

MARINE'S HANDBOOK

By Major L. A. Brown. 7 ed. United States Naval Institute, Annapolis, Md., 1940. 242 pp., illus., diagrs., charts, tables, 9½ x 6 in., paper, 75c.

Comprehensive coverage of the requisite basic information for enlisted men is provided in question and answer form in this Marine Corps manual. All subjects are gone into in detail, with many descriptive and explanatory illustrations. The purpose of the handbook is to enable noncommissioned officers and men, particularly of the Reserve, to achieve certain standards of performance.

METHODS OF STUDY OF SEDIMENTS

By W. H. Twenhofel and S. A. Tyler. McGraw-Hill Book Co., New York and London, 1941. 183 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $2.00.

The authors present a brief, non-mathematical, yet complete treatment of methods of study of sediments. Standard methods of sampling for various types of sediments are described, methods of analyses are given, and various forms of graphical representation of the characteristics of sediments and sedimentary rocks are shown. Coal and oil shales receive particular attention, and further references accompany each chapter.

(Continued on page 377)

PRELIMINARY NOTICE

of Applications for Admission and for Transfer

June 14th, 1941

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 at the next meeting.

L. Austin Wright, General Secretary.

*The professional requirements are as follows:—

A 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 or 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 attainment 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

ALTON—JACK, of Windsor, Ont. Born at Bexhill-on-Sea, Sussex, England, March 3rd, 1903. Educ.: Woolwich Polytechnic, London, 1918-20; New Zealand Univ. Eng. College, 1924-25; Regent St. Polytechnic, London, 1927-37; A. M. Institution of Structural Engrs., London, England. 1918-20, jr. dftsman., Royal Arsenal, Woolwich; 1920-21, asst. dsgr., Trussed Concrete Steel Co., London; 1922-27, dftsman and estmtr., G. Fraser & Sons, Ltd., Auckland, N.Z.; 1927-29, dftsmn., Ledward & Beckett, London; 1929-33, dftsmn. Marconi Wireless Tel. Co., London; 1933-38, asst. dsgr., Installn. designs divn., Marconi Wireless Tel. Co., London; 1938-39, dftsmn., and 1939 to date dsgning. engr., Canadian Bridge Co. Ltd., Walkerville, Ont.

References: F. H. Kester, P. L. Pratley, P. E. Adams, E. M. Krebser, C. M. Goodrich, G. G. Henderson, G. V. Davies.

BULLICK—CLARENCE JOHN, of Barrancabermeja, South America. Born at Uttoxeter, Ontario, February 20th, 1910. Educ.: B.A.Sc., Univ. of Toronto, 1934. 1930 (summer), Ontario Land Survey; 1934 (summer) runner on diamond drill; 1934-35, mech. shops Imperial Oil, Sarnia; 1935, design and dfting. C.I.L., Windsor; 1936, i/c drilling, field work and dip needle survey, Lang Lac; 1937-39, design and dfting, Imperial Oil, Sarnia; 1939 to date, asst. engr., Tropical Oil Co., Barrancabermeja, Colombia, South America.

References: R. W. Angus, G. Colpitts, L. E. Mitchell, G. Rayner, J. H. Addison.

DEMBICKI—STEVE, of the Y.M.C.A., Montreal. Born at Calgary, Alta., Oct. 9th, 1916. Educ.: B.Sc., Univ. of Alberta, 1940, and M.Eng., McGill, 1941. July, 1935 to Sept. 1936, switchman at Cons. Mining & Smelting Co., Trail, B.C.; 1937 (summer), helper in Zinc Roasters, and 1938 (summer) ,tester in zink tank rooms, C.M. & S. Co.; 1939 (summer) first aid work for B.C. Forestry Dept., Chase, B.C.; 1940 (summer), helper in zinc roaster at C.M. & S. Co., Trail, B.C.; at present metallurgist with Defence Industries, Ltd., Verdun, Que.

References: W. G. McBride, R. DeL. French, F. M. Wood, C. M. McKergow, E. Brown.

DUFORT—CLEOPHAS LEROUX, of Montreal, Que. Born at Montreal, Oct. 24th, 1882. Educ.: B.Sc.A., I.C., Ecole Polytechnique, 1905. 1901 (summer), inspr. of dredging works, Federal Govt.; 1903-4 (summers), surveying, Lacroix & Piche; 1905-7, Mtl. Locomotive Works, Ltd., detailing shop drawings for fabrication of steel structure for buildings; 1907-8, John Eichlay, Jr., Pittsburg, Pa., designing and detailing shop drawings; 1909, shop drawings Dominion Bridge Co.; 1909-10, town planning, Raoul Lacroix, Architect; 1910-12, with Marius Dufresne, C.E., supervising and directing genl. muncpl. constrn. works, City of Maisonneuve; 1912-18, i/c Engineers personnel and inspn. of outside works, supervision of execution of works; 1918-19, supt. to work ochre deposits, l'Annonciation, Que.; 1919-20, dftsman. Phoenix Bridge Co. Ltd.; 1920-33, Colonization Dept., Quebec; 1933-37, ch. engr., Colonization Dept., Prov. Quebec; 1937-38, City Engr., Town of Drummondville; 1938 to date, Registrar, Corpn. of Prof. Engrs. of Quebec.

References: J. B. Challies, O. Lefebvre, A. R. Decary, S. A. Baulne, A. Surveyer, A. O. Normandin, H. Cimon, L. A. Wright, R. E. Jamieson.

FLEMMING—CLARENCE PATRICK, of 130 Quinpool Rd., Halifax, N.S. Born in Halifax, Sept. 11th, 1911. Graduate in Civil Engrg., Nova Scotia Tech. Coll. 1937. 1935-37 (nights), dfting for Super Service Stations, Ltd.; 1935 (summer), inspr. of pavement and asstng. with progress estimates in field office; 1936-37 (summers), Nova Scotia Dept. of Highways, inspr. and instrumentman, and ch. inspr. of grading and pavement on penetration paving; 1937-38, inst'man and asst. engr. and dftsman., N.S. Dept. of Highways; 1938-41, United Service Corp. Ltd., Halifax asst. engr. i/c constrn. and mtce., incl. design of building, dfting, specifications, office work and supervising constrn.

References: R. W. McColough, S. Ball, F. G. H. MacPherson, H. Thorne, F. H. Sexton.

MacKENZIE—IAN DONALD, of Shawinigan Falls, Que. Born at Montreal, Aug. 5th, 1917. Educ.: B.Sc., Queen's University, 1940. 1939 (summer) jr. asst. geological survey of Canada. May 1940 to date, asst. consultant geologist, Shawinigan Engrg. Co., incl. field superintendance of grouting operations at LaTuque. Also 1940 (June-Dec.) field supt. of dam repairs at Shawinigan Falls, Que.

References: I. B. Crosby, J. A. McCrory, R. E. Heartz, G. Rinfret, H. J. Ward.

SPRIGGS—WILLIAM, of 32 Oxford Road, Baie d'Urfe, Que. Born at Birmingham, England, March 25, 1898. Educ.: B.Sc. (Elec.) McGill Univ., 1923. 1921 (summer), rodman, Dom. Govt. Survey; 1922 (summer), apptce. Shawinigan Engrg. Co.; 1923-24, 1 year graduate student course with Westinghouse Elec. Mfg. Co., Pittsburgh, Penn.; 1924-26, design and supervn. of instlln. of remote metering and indicating equipt. for Westinghouse Elec.; 1926 to date, with Shawinigan Engrg. Co. as follows; elect. design and supervision of design work for power stations, and at present specialist in automatic and remote control, relay protection, alarm and indicating systems.

References: J. Morse, J. A. McCrory, R. E. Heartz, C. R. Lindsay, G. R. Hale, C. V. Christie, P. Ackerman.

FOR TRANSFER FROM STUDENT

AKIN—THOMAS BERNARD, JR., of Windsor, N.S. Born at Calgary, Alta., April 3, 1908. Educ.: B.Sc. (Civil) Nova Scotia Tech. Coll., 1932. 1930 (summer), asst. engr. on survey and constrn. of 66,000 volt transmission line; 1931 (summer), i/c small survey party making survey of flowage; 1932-35, asst. mgr., Minas Basin Pulp & Power Co., Hantsport, N.S.; 1935-37, supt., and 1937-41, mgr., Canadian Keyes Fibre Co. Ltd., Hantsport, N.S.; at present Pilot Officer, R.C.A.F. (Montreal). (St. 1932).

References: S. Ball, W. P. Copp, I. P. MacNab, W. G. MacDonald, J. W. March.

MILLER—LINDSAY, of 61 Hill St., Kingston, Ont. Born at Cambuslang, Scotland, Nov. 4th, 1910. Educ.: B.Eng. (Mech.) McGill Univ., 1933; 1928 (summer), levelman on Rapid Blanc Devt., Shawinigan Engrg. Co. 1929-32 (summers), inspr. on constr. work, M.L.H. & P. Cons.; 1933-36, tester, and then asst. to the control engr., Consolidated Paper Corp. (Wayagamack Divn.); 1936-37, dftsmn., International Paper Co., Hawkesbury; 1937-40, dftsman., J. R. Booth Ltd., Ottawa At present dftsman. with Aluminum Co. of Canada, Kingston. (St. 1932).

References: K. M. Winslow, W. T. Dempsey, M. N. Hay, C. M. McKergow, J. B. Baty.

Employment Service Bureau

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party. Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted upon request after a lapse of one month. All correspondence should be addressed to THE EMPLOYMENT SERVICE BUREAU, THE ENGINEERING INSTITUTE OF CANADA, 2050 Mansfield Street, Montreal.

SITUATIONS VACANT

CONSTRUCTION SUPERVISOR with experience in heavy construction for either long or short term contract in British Guiana. Applications should be addressed to Box No. 2330-V.

GRADUATE ENGINEER with at least two years practical experience in a tool room to act as an instructor in the Apprentice School of a large industrial concern. Apply Box No. 2344-V.

MECHANICAL DESIGNING DRAUGHTSMAN with experience for permanent position with firm engaged in war work. Apply Box No. 2375-V.

ARCHITECTURAL DRAUGHTSMEN required immediately by large industrial concern for their Montreal office. Apply Box No. 2376-V.

FIELD ENGINEER, aggressive, capable, preferably one with a university degree in chemical engineering and who has some knowledge of boiler plant operation to sell and service boiler feed water treatment chemicals. Candidate must possess personality conducive to good salesmanship having good educational and family background. Remuneration will be $1,500.00 a year and travelling expenses when away from Headquarters. Write fully education, experience and present occupation, giving references. Personal interview will be arranged only by written application to Box No. 2394-V.

HIGH GRADE ARCHITECT urgently required for work in Montreal on industrial plant project. Apply Box No. 2399-V.

JUNIOR CHEMICAL AND METALLURGICAL ENGINEER for plant installation and operation work. Apply Box No. 2400-V.

STRUCTURAL OR GENERAL DRAUGHTSMAN for plant extension work. Apply Box No. 2401-V.

JUNIOR MECHANICAL GRADUATE with about one to five years experience for work in South America. Apply Box No. 2402-V.

MUNICIPAL ENGINEER, conversant with road construction, paving, construction and maintenance of sewers and water services, for a town in Ontario. Salary from $2,400 to $3,000 per year according to experience and qualifications. Send applications with full particulars to Box No. 2403-V.

SITUATIONS WANTED

GRADUATE ELECTRICAL ENGINEER, University of Toronto, five years experience drafting and design in connection with electrical instruments and small motors. Also experienced in design of small jigs and fixtures and general machine design. Desires permanent position. Apply to Box No. 1486-W.

GRADUATE MECHANICAL ENGINEER, M.E.I.C., 14 years' experience as factory manager in machine tool factory and as consulting industrial engineer in widely diversified metal working trades improving factory and office methods specially cost accounting, desires permanent position. Apply to Box No. 1730-W.

GRADUATE CIVIL ENGINEER, M.E.I.C., 15 years engineering on this continent and five years overseas. Experienced in design and construction of dams, hydro-electric and industrial plants. Field engineer for construction on dams and transmission lines, considerable experience in concrete work. Desires position preferably as field engineer or construction superintendent. Apply Box No. 1527-W.

ELECTRICAL ENGINEER, Age 32 with the following experience—Eight years field work in general construction, supervision, estimating and ordering materials. At present employed in general construction but wants to enter the electrical field. Apply Box No. 1992-W.

MECHANICAL ENGINEER, JR.E.I.C., and member of the American Society for Metals. Since graduation (Toronto '33) has specialized in the metallurgy, processing, and heat treatment of steel, aluminum and aluminum alloys. Also five years successful sales experience and is thoroughly familiar with materials specifications of all types. Now thirty years of age, available at once, and can furnish the best of references. Desires permanent position. Apply Box No. 2365-W.

LIBRARY NOTES

(*Continued from page 375*)

THE MOTOR SHIP REFERENCE BOOK for 1941

Compiled by the Staff of "The Motor Ship" Temple Press, Ltd., London, E.C.1, 1941. 324 pp., illus., diagrs., charts, tables, 8½ x 5½ in., cloth, 7s. 6d. net, or 8s. post free.

This annual publication on Diesel motor ships presents technical information on oil engines in general and on specific types, and contains an alphabetical list of all vessels completed to December, 1939, with a partial list for 1940. Lloyd's rules for the construction and survey of motor ship machinery are included, and there is a list of builders of marine Diesel engines in all countries.

PLANT-PRODUCTION DIRECTORY

Vol. 1, No. 1. First edition, 1941. Industrial Directories, Chicago, Ill., 578 pp., illus., 12½ x 11 in., cloth, $10.00.

The major part of this new industrial directory is devoted to an alphabetical listing of industrial products with the manufacturers of them. Other information given includes sources of supply for industrial chemicals, a large section of mathematical tables and mechanical data, a trade name index and a complete alphabetical list of manufacturers with addresses only.

PRACTICAL ELECTRICAL WIRING, Residential, Farm, and Industrial

By H. P. Richter. 2 ed. McGraw-Hill Book Co., New York and London, 1941. 521 pp., illus., diagrs., charts, tables, 8½ x 5½ in., cloth, $3.00.

Practical methods of electrical wiring are explained in plain language for the man who does it. All kinds of light and power wiring for home, farm and factory are described, and the basic theoretical principles are clearly presented. This second edition, including the appended tables of data, has been based on and revised in accordance with the new 1940 National Electrical Code.

PUBLIC WORKS ENGINEERS' YEARBOOK, 1941

American Public Works Association, Chicago, 1941. 424 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, $3.50.

The papers presented at the 1940 Public Works Congress and the Western Regional Conference are included in the current volume of this yearbook. They are broadly grouped under the following headings: public works administration; city and regional planning; streets and highways; traffic control; and sewerage and sewage disposal. Other important material and the business proceedings of the American Public Works Association are also included.

RAILWAY FUEL AND TRAVELLING ENGINEERS' ASSOCIATION

Fourth Annual Proceedings, Hotel Sherman, Chicago, Ill., Oct. 22nd to 25th, 1940. Railway Fuel and Travelling Engineers' Association, Chicago, Ill., 1941. 339 pp., illus., charts, tables, 9 x 6 in., lea., $3.00.

The full text of the committee reports and special papers presented is included in this publication of the detailed proceedings of the Association's annual meeting. The membership list, constitution and by-laws appear at the end of the volume.

SOIL MECHANICS

By D. P. Krynine. McGraw-Hill Book Co., New York and London, 1941. 451 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $5.00.

This book presents the principles used in the design, construction and maintenance of foundations of structures and structures made of earth material. Engineering applications of these principles are discussed; field and laboratory soil investigations are described; and the settlement of structures, its causes, prevention and damage are considered. The physical properties of soil materials are studied, and many important conceptions and principles, such as idealized earth masses and continuity of strains, are fully dealt with. Problems and references accompany each chapter.

STUDENT AND EMPLOYEE SAFETY IN COLLEGES AND UNIVERSITIES

National Safety Council, Chicago, Ill., 1941. 82 pp., illus., maps, charts, tables, 9 x 6 in., paper, $1.00.

This pamphlet points out some of the hazards involved in college shops and buildings, in athletics and in campus traffic. Suggestions are given for preventive measures to eliminate accidents which are the result of unsafe environmental conditions or unsafe human behaviour.

TABLES OF SINE, COSINE AND EXPONENTIAL INTEGRALS

Vol. 2, prepared by the Federal Works Agency, Work Projects Administration for the City of New York, conducted under the sponsorship and for sale by the National Bureau of Standards, Washington, D.C., 1940. 225 pp., tables, 11 x 8 in., cloth, $2.00, advance payment required.

The functions indicated are tabulated in this volume over the range between 0 and 10 at intervals of 0.001. Differences have been listed for purposes of interpolation, although for the range from 0 to 2, Vol. I should be consulted for greater accuracy in this respect. Several supplementary tables and various reference lists are included.

(The) TELEPHONE IN A CHANGING WORLD

By M. M. Dilts. Longmans, Green & Co., New York and Toronto, 1941. 219 pp., illus., diagrs., woodcuts, maps, 8½ x 5½ in., cloth, $2.50.

The telephone as a "great American institution" is the theme of this book. Historical and anecdotal information is presented upon the development of the telephone, operator service, directories, by-products and radiotelephony. The increasing effect of the telephone upon many phases of everyday life is emphasized.

TEXTBOOK OF GEOLOGY, Pt. 2, Historical Geology

By C. Schuchert and C. O. Dunbar, 4 ed., largely rewritten. John Wiley & Sons, New York, 1941. 544 pp., illus., diagrs., charts, maps, tables, 9 x 6 in., cloth, $4.00.

As in previous editions, the history of the geologic changes on the earth is presented chronologically. A prologue of several chapters presents basic conceptions for interpreting geological records, and the whole subject is treated in a simple manner for the beginning student. In order to take account of new facts the subject matter has been considerably revised.

Industrial News

Industrial development — new products — changes in personnel — special events — trade literature

FILE CLEANERS

S. A. Felton & Son Co. (Canadian Div.), Hamilton, Ont., have published a data sheet which illustrates four well-tried designs of "Felton's" file cleaners with specifications and prices in each case.

GROUND CONNECTORS

Canadian Line Materials, Ltd., Toronto, Ont., are distributing Bulletin Form No. 6018, issued by the Burndy Engineering Company, Inc., New York, N.Y., which illustrates fourteen types of "Burndy Ground Connectors."

Five methods of grounding are shown diagrammatically.

HYDRAULIC SCRAPERS

Form No. A-113-639, a 16-page booklet, issued by La Plant-Choate Mfg. Co. Inc., Cedar Rapids, Iowa, gives complete details of the hydraulic controls and other features of hydraulic "Carrimor" scrapers ranging in size from 2.9 to 8.2 cu. yds.

INDUSTRIAL INSULATION

Fiberglas Canada Ltd., Oshawa, Ont., have published a 16-page booklet which deals with the use of Fiberglas insulating products for various industrial uses. An illustrated, descriptive page is devoted to each of the following types of the product: moulded and blanket type for pipe insulation; insulating block for high temperature application; permanent form insulation in bats and panels, and with metal facings; metal mesh blankets to insulate boilers, tanks, cylinders, ducts, etc.; insulation cement, finishing cement, and O-C Mastic for monolithic protection and finish of tanks, ovens and pipes, etc.; duct insulation for concealed or exposed work; insulating wool for marine work and general purpose insulation; sewn blankets for many industrial applications. A section of brief specifications is also included.

INTERIOR AND EXTERIOR PAINTS

"Norface" paint for interior and exterior use on residences, factories, hospitals, public buildings, etc., is described in a four-page folder issued by Northern Paint & Varnish Co. Ltd., Owen Sound, Ont. Contains details of the properties of these paints, how to use them and the advantages. Also samples of colours.

JOINT SEALING COMPOUND

Bulletin No. 208-F, published by Quigley Co. of Canada, Ltd., Lachine, Que., features "Q-SEAL," a plastic expansion joint sealing compound for threaded, flange, gasket, and metal-to-metal joints in pipe lines and equipment carrying high pressure steam, oils, gasoline, tar, creosote, acids, ammonia, brine, and other commodities.

METAL AND WIRE FORMING MACHINE

The A. H. Nilson Machine Co., Bridgeport, Conn., are distributing a four-page bulletin, No. 75A, entitled "Nilson Presents the New Automatic Metal and Wire Forming Machine" which describes the various features of this machine with specifications covering four different models. Contains photographic illustrations and a cross-sectional drawing.

NICKEL ALLOY STEEL CASTINGS IN INDUSTRY

In a booklet of 28 pages and cover published by The International Nickel Co. of Canada, Ltd., Toronto, Ont., the use of nickel alloy steel castings in industry is shown by many illustrations of typical applications for railroads, oil production and refining, power plants, mining and milling, excavating and dredging, steel rolling and forging, construction projects, and miscellaneous equipment. Data on compositions, properties, etc., are also included.

CONDENSERS AND COOLERS

Worthington-Carbondale shell-type condensers and coolers are featured in a 12-page bulletin, No. C-1100—B-13, published by the Carbondale Div., of Worthington Pump & Machinery Corp., Harrison, N.J. This bulletin is well illustrated with equipment and installation photographs. The descriptive matter deals with multi-pass, small multi-pass and vertical coolers and condensers, with special reference to non-priming brine coolers, ice tank coolers and the Worthington-Carbondale "Spiro-Flo" vertical condensers.

CONVECTORS

A four-page folder of the Chatham Malleable & Steel Products, Ltd., Chatham, Ont., describes and illustrates the "Chatco Heat Speed" convectors, which are available in many types and enclosures, four of which are illustrated in the folder. These convectors are adaptable to any room where radiators are used. A sectional illustration shows the construction features.

CONVEYOR AND ELEVATOR BELTING

Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont., have published a 62-page book entitled "Rubber Belting Data-Conveyor and Elevator." A compilation of information intended for the users of conveyor and elevator belting, combining the results of technical research and practical field experience, this manual provides a ready reference in determining the proper belt for various types of service commonly encountered. The book should prove invaluable as practically every detail of interest to users of this type of belting is clearly dealt with.

"DUNLOP SERVES THE EMPIRE"

Under the above title the Dunlop Tire & Rubber Goods Co. Ltd., of Toronto, Ont., has produced a pictorial review of the application of this product to the many and varied activities of the fighting forces and industries engaged in the production of munitions of war. Interesting illustrations taken on land, on sea, and in the air, graphically emphasize the importance of this product. The booklet contains 12 pages.

PROTECTIVE PAINT

Northern Paint & Varnish Co. Ltd., Owen Sound, Ont., have issued a four-page folder which provides full details describing Nor-Cote No. 400, an abrasion resisting, skid-proof, protective paint for steel, wood or cement. Contains also information covering the Company's anti-corrosive, acid-resisting and pure metalead paints.

RUST PREVENTATIVE

A folder featuring "Carter's Rust Preventative" for the prevention of rust and corrosion of metal surfaces, both interior and exterior, has been published by Canadian Cork Co. Ltd. of Montreal, Que. Recommended by the makers for industrial plants, ice plants, cold storage plants, dairies, packing houses, etc.

SQUARE AND HEXAGON HOLE DRILLS

"Watts" method of drilling square, hexagon and octagon holes is illustrated and described in a folder recently released by Watts Bros. Tool Works, of Wilmerding, Pa. Any engine or turret lathe, drill press or hand screw machine provides the power while the "Watts" angular drills and full floating chucks do the work.

UNIT HEATERS

Entitled "Chatco Heat Speed" Unit Heaters, a four-page folder issued by Chatham Malleable and Steel Products, Ltd., of Chatham, Ont., contains a complete description of the horizontal and vertical projection type heaters which are available with both steam and hot water. A sectional drawing describes the principal features of the heater and a number of sketches illustrate typical installations.

VOLTAGE REGULATORS

Ferranti Electric Ltd., Toronto, Ont., are distributing a four-page folder in which the company discusses war time voltage problems and describes three general types of Ferranti automatic step-voltage regulators which are available either as single- or three-phase units in any voltage up to 115,000.

WELDED STEEL BASE PLATES

Booklet No. 1882, published by Link Belt Limited, Toronto, Ont., covers the company's line of welded steel base plates for adjusting pillow blocks and common flat boxes for shaft alignment. Type "A," for horizontal adjustment only, and type "B," for both horizontal and vertical adjustment, are tabulated for mounting pillow blocks of shaft sizes up to eight inches. Dimensions and weights are given.

OIL TESTING INSTRUMENTS

A 32-page catalogue, No. 699E, issued by C. J. Tagliabue Mfg. Co., of Brooklyn, N.Y., contains complete illustrated descriptions with specifications covering the Company's oil testing instruments for petroleum products, including "Tag" A.S.T.M. penetrometers, and enclosed scale penetrometers, hydrometers for general laboratory use, and various other oil testing instruments and apparatus including calorimeters, viscosimeters, etc.

COLD HEADED DIE STEEL

Jessop Steel Co., Washington, Pa., are distributing an eight-page bulletin No. 141, which describes the Company's "new process" steel for cold-header dies and punchers, which is a clean, non-porous steel developed especially to meet the severe service conditions encountered when cold-heading bolts, screws, rivets, nails, buttons, and other small metal objects. Contains complete information on the heat treatment of this steel.

THE ENGINEERING JOURNAL

THE JOURNAL OF THE ENGINEERING INSTITUTE OF CANADA

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"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public."

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CARRIER CURRENT TELEPHONY

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This article is intended to be an introduction to carrier telephone methods, and a general description of the systems now in use. Carrier telephony is really wired wireless, whereby a number of separate telephone messages are transmitted simultaneously on a single electrical circuit by employing a separate alternating current, called a carrier current, for each of the separate messages. This carrier current, is modulated, that is, it is made to vary in accordance with the variations of current representing the telephone message. At the receiving end, the current variations representing the signals are reproduced from the carriers by suitable detectors or demodulators. As in radio, the different carriers must differ sufficiently in frequency so that they may be separated from each other at the terminals by the use of proper electrical circuits.

When a voice frequency is made to modulate a carrier wave, there result what are known as the upper and lower sidebands, groups of frequencies lying one on either side of

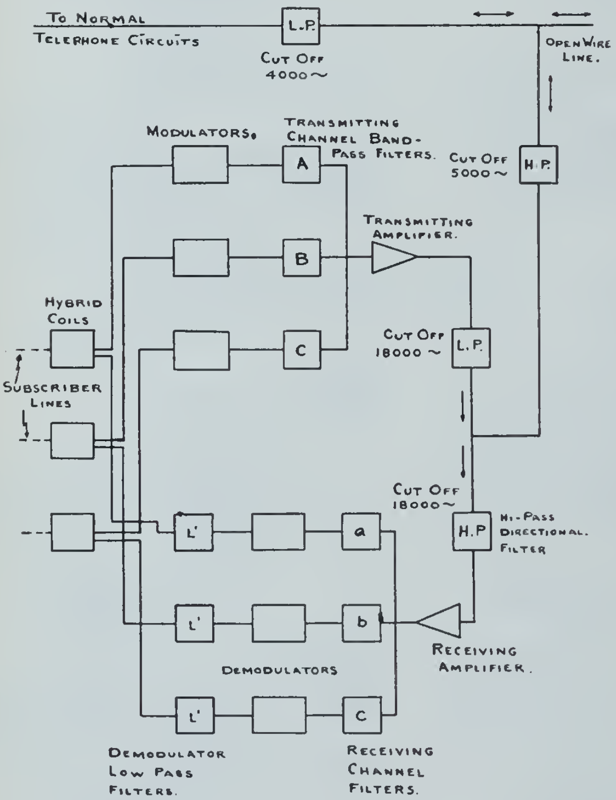

Fig. 1—Eastern terminal of a type C carrier system.

the carrier, which carry the intelligible speech. In most modern carrier systems, only one of these sidebands is transmitted, both the carrier and the other sideband being removed. This effectively halves the space required on the frequency scale for each carrier conversation, and thus increases the number of circuits possible over a given pair of lines.

The Bell Telephone Type C carrier system will now be described as illustrating the main features to be found in all open-wire carrier applications except the new broad band system which will be described later. The type C system provides three carrier channels above the voice frequency channel, and transmits a top frequency of about thirty kilocycles. This was considered to be the highest frequency that ordinary open-wire lines could transmit without too great attenuation. For each channel, the carrier is suppressed and only a single sideband transmitted. The necessary voice band width was set at about 3000 cycles, which requires a carrier frequency separation of 4000 cycles, because the band-pass filters used have not perfectly sharp cut-off characteristics. Different frequencies are used for transmission in the two directions over each channel, the upper sidebands of carrier frequencies at 6000, 10,000 and 14,000 cycles being used for transmission from east to west, while the lower sidebands of carriers at 22,000, 26,000 and 30,000 cycles are used for the west to east conversations. Thus filter selectivity may be used at the repeater stations and the terminals to separate the two groups of frequencies used for opposite directions of transmission.

The diagram in Fig. 1 shows the basic arrangement of apparatus at one terminal of a line carrying an ordinary voice frequency channel plus the three-channel Type C carrier system. This is seen to be an eastern terminal for the lower group of frequencies is used for transmitting.

The currents used in carrier transmission are prevented from reaching the subscribers' lines by means of a low-pass filter included in the normal telephone line which has cut-off just above the voice range. Similarly a high-pass filter in the line connected to the carrier apparatus prevents the absorption of the normal telephone currents by this apparatus. Then directional filters are employed to separate the east and west bound groups of frequency bands, and in addition, band-pass filters are required to separate the individual channels in each group.

Following a subscriber's line to the outgoing toll office, the line is here divided into an outgoing and an incoming circuit. Since the frequencies at this point are all in the voice range however, the separation of incoming and outgoing conversations is secured by the common hybrid coil system shown in Fig. 2. Instead of terminating the sending and receiving branches in a transmitter and receiver respectively, they terminate in what are, in effect, conjugate branches of an alternating current bridge. If the impedance of the artificial line exactly simulates the impedance of the voice frequency line, any electromotive force applied between the points a and b does not cause any current to flow in the branch c-d of the carrier current circuit. Thus there is zero coupling between the input and output circuits of the carrier system, and hence persistent oscillation, i.e., singing, cannot be set up.

From the hybrid coil, each outgoing circuit passes to a modulator employing suppressed carrier. The two sidebands pass on to a band-pass filter which rejects the unwanted sideband. A similar process is undergone by the other two channels. The three bands selected for transmission which come from the three transmitting band-pass filters designated A, B and C, are then united in a single circuit and amplified to the level desired for transmission over the line. From the amplifier they go out through the low-pass directional filter on to the transmission line. The function of this low-pass filter is to prevent the transmitting circuits from absorbing energy from the line which should go to the receiving circuits, and is designed to largely attenuate everything above the lower or east-west group of carrier channels.

In the case of transmission from the western terminal of the line, a similar modulation and selection of frequencies takes place, but here the outgoing conversations are transmitted by the upper frequency channels and enter the line through a high-pass directional filter. These conversations arriving at the east terminal cannot pass into the transmitting circuits because they are blocked by the low-pass filter. They therefore pass through the high-pass directional filter in the receiving branch and then through the receiving amplifier. Leaving the amplifier, the three bands are separated by a group of receiving band-pass filters a, b, c, and then each is passed to a demodulator. The demodulator low-pass filters are necessary to eliminate undesirable high frequency products present in the demodulator output. Thus only the voice currents are passed on to their res-

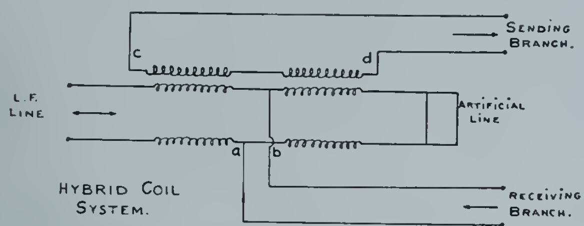

Fig. 2—Common hybrid coil system.

pective telephone stations through the hybrid coils and subscribers' lines. This traces a complete signal path over the carrier system, from subscriber to subscriber.

Because a vacuum tube is a one-way device, allowing energy to flow through it in one direction only, a very similar scheme of directional filtering must be employed at each repeater to guide the east and west-bound groups into separate amplifiers. At the end of the repeater the two groups of channels are combined.

It is obvious that many more circuits could be obtained on a single pair of conductors if the carrier frequency range could be widened. Three different methods of achieving this enhanced frequency range have been developed, and they are all classed as broad-band systems.

The first is applied to open wire transmission lines, which with their large gauge and wide spacing, are favourable to

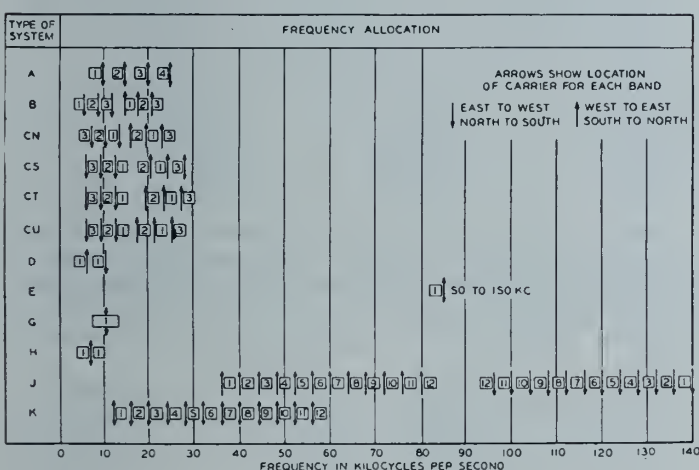

Fig. 3—Frequency allotments for the Bell Telephone's carrier systems.

high frequency transmission. However, this exposed type of structure is difficult to keep free from unwanted currents induced by nearby telephone circuits, by power lines, lightning or other outside disturbances. The limiting factor in using high frequencies on open wire lines has generally been induction or crosstalk between nearby circuits, and until recently 30,000 cycles, the top frequency of the Type C system, represented about the upper limit.

Crosstalk on open wire lines is reduced by applying transposition systems which, at high frequencies, must be made very frequently and precisely. The wires of a pair are crossed over at predetermined intervals so that the induced potentials and currents tend to balance out. There have been important developments in the art of transposition designing during the last few years; also the spacing between the two wires of a pair is being reduced from 12 inches down to 6 or 8 inches so that there is a greater distance between adjacent pairs, and less direct pick-up by each pair. These improvements make it possible to raise the frequencies transmitted to about 140 kilocycles.

The new service, known as the Type J, provides twelve two-way telephone circuits in a frequency band between 36 and 140 kilocycles. There are 24 carriers in all, the lower 12 of which carry the west to east conversations, and the upper 12 carrying those in the opposite direction. This system may be operated on the same pair with a Type C system. With a J system, a C system, and a voice circuit, a total of sixteen telephone circuits may be obtained from one pair of wires.

The chart in Fig. 3 shows the frequency allotment for

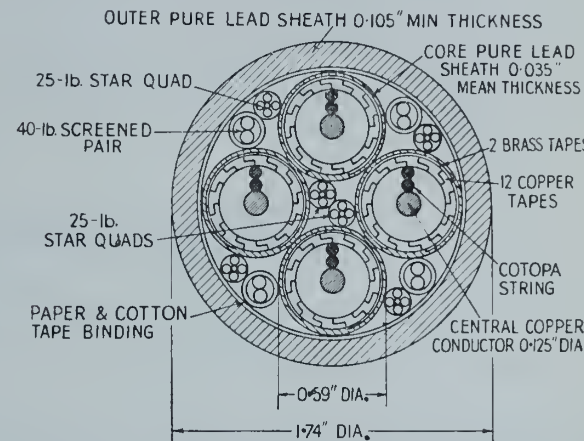

Fig. 4—Cross-section of a coaxial cable made of four coaxial cores, twelve pairs of 25 lb. star-quad and four pairs of 40 lb. screened

the Bell Telephone's carrier systems. Of particular interest are the Type C and Type J systems for use on open wire lines, which have already been described.

The Type K system has been developed for unloaded cables, and provides twelve telephone channels on each pair, using frequencies from 12,000 to 60,000 cycles. The band below twelve kilocycles is not used except for pilot and control circuits. Above that frequency, the attenuation of the unloaded cable pair rises at a steady rate with frequency, and equalization of the loss is made easier.

The fine-gauge, paper-insulated pairs in existing cables do not make inherently good high frequency conductors, as their attenuation is too high, and repeaters are necessary too often. This is offset to some extent by the shielding effect of the lead sheath, which largely excludes external disturbances, and thus permits greater amplification at repeater points than can be used with open wire circuits. Even so, repeaters will be required at much more frequent intervals than for the open wire line, for a corresponding frequency of transmission.

Different pairs are used for transmission in the two directions, making four wires in all. One reason for this is that repeaters are needed so often that the directional filters which would be necessary at each repeater point to separate the opposite directions of transmission on a single pair, would unduly increase the costs. The same frequencies are used for both directions of transmission however, so that shielding is essential between the oppositely-directed transmission paths, and this is obtained by using different cables for the two directions of transmission.

The logical extension of the principle of multi-channel carrier working leads to the replacement of the separate cables for the two directions of transmission by two pairs of conductors designed to carry, as carrier channels, all the circuits required. Each pair consists of a specially designed concentric system of conductors known as the coaxial cable, and this is the third broad-band system. It is the most intriguing of all, as it has been used to give 400 circuits using a frequency range up to two million cycles, on only two pairs of conductors. The coaxial conductor combines something of the favourable low attenuation characteristic of the open wire lines with the interference-free characteristic of shielded cable circuits.

The outside tube of the coaxial unit is a good metallic shield at high frequencies. If currents are induced from external fields such as power circuits, static or lightning, they tend to confine themselves to the outside surface of the tube because of skin effect. In fact the shielding is of such a high order that crosstalk and interference from outside sources or between coaxial pairs is negligible.

Carrier telephony has also been used to provide telephone communication over high voltage transmission lines to save the cost of stringing extra telephone lines below power lines. However, the problems arising from this application are due to the power circuits themselves and the fundamental technique is the same as has been described.

Until the broad-band carrier systems were introduced, the carrier telephone system found its chief application on open wire lines. Because of the high cost of terminal apparatus it was economical only for use over relatively long distances, where it was economical to spend much money on the terminal apparatus, in order to save on the cost of lines. It was often used only to provide increased facilities until such time as a trunk cable was required, or where it was not physically possible to provide additional wires over a given toll line or cable route.

The broad-band systems recently developed use much greater frequency ranges than had been practicable in the past, and hence many more channels per conductor pair.

It now appears that a large part of the growth in the future will be provided by carrier methods: the cable and open wire systems particularly where these lines already exist, the coaxial system where new structures are needed, and in particular, on the heavy traffic routes.

However, considerable complicated equipment is still required, and for the immediate future, these various systems will probably be provided only on the longer routes.

WORLD'S SUPPLY OF ALUMINUM

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Metallic aluminum was first isolated in 1825 by the Danish chemist, Oersted, when he obtained a few globules of "the metal of clay" by a chemical method. Its commercial production was commenced in 1856 by Deville in France, by a slow and expensive method, the product costing about $90.00 a pound. One of the earliest commercial uses in a sizable quantity was the protective cap on the Statue of Liberty in New York harbour. It is interesting to note that Napoleon III subsidized the industry at its birth, thinking it might be useful for warlike purposes.

The process for recovering aluminum in use to-day, which inaugurated the industry's rather spectacular rise, was discovered in 1886 simultaneously by Charles M. Hall in the United States and Paul L. Heroult in France, each working independently. They laid down the essentials for the electrolysis of alumina, namely the use of fused cryolite capable of taking alumina into solution and then decomposing this solution electrolytically to release the metal. It was the invention, between 1870 and 1880, of the electric dynamo that made available the large amount of power necessary for the successful operation of this invention.

Because of these huge power requirements it is, therefore, natural to look for the development of the aluminum industry in those countries having potential sources of electric power such as Switzerland, France, Norway, the United States and Canada, where hydro-electric power is available, and Germany with her coalfields.

For a clear understanding of the economics of aluminum production in the various producing countries, and the importance of aluminum as compared with other leading industrial non-ferrous metals, it is essential to realize the phenomenal expansion of production as shown by yearly world output figures.

At first the output was very low. It is reported that in 1885 only a little over 15 tons were produced, but even this for such a new industry was quite an achievement. However, the rise was quite rapid and by the period of World War No. 1 annual production had increased to over 167,000 tons. After 1918 there was a slump followed by a rise, until in the boom years around 1929 an output of almost double the 1917 production was reached. During the depression which followed, production was on the decline, but rose again from 1934 to 1939 when a new high of over 800,000 tons was reached. With the present expansion all over the world for war requirements, 1940 and the next few years will prove the peak production years in the history of the industry.

Copper, lead, zinc and aluminum are the four leading non-ferrous metals. Their production, considered on a weight basis, of course, features the heavier metals, but when considered on a volume basis, copper, zinc and aluminum were practically equal in 1938. In that year the amounts by volume and weight were as follows:

Copper..........	288,000 cu. yds.	2,165,585 short tons
Zinc..........	284,000 "	1,710,000 "
Aluminum........	276,000 "	624,000 "
Lead............	193,000 "	1,829,741 "
Nickel...........	14,000 "	105,000 "

Aluminum can be rolled, extruded, drawn, forged, pressed, spun and powdered or cast into sand, permanent mould or pressure die castings. With this range of properties and possible variety of products, it is no wonder that aluminum has come to hold such an important place in the industrial world.

Of the three essentials for the production of aluminum one, as already pointed out, is abundant electrical energy; the others are ample supplies of bauxite and coal. As will be shown later, good transportation for raw materials is also an important factor.

It is interesting to note that the principal items required to make one ton of aluminum are as follows:

25,000 kwh. of electrical energy,
4 tons of bauxite,
4 tons of coal,
1/3 ton of soda,
3/4 ton of carbon electrodes,
Small amounts of cryolite and fluoride salts.

Bauxite, the principal commercial ore of aluminum, derived its name from Les Baux, a little town in southern France where the ore was first discovered in 1821. Since then bauxite has been found in many localities throughout the world, chiefly in tropical or semi-tropical countries. In bauxite the aluminum is present as an oxide associated with varying amounts of impurities—iron, silicon and titanium oxides—free and combined water. Iron oxide, being red, colours the ore, and depending on the amount of iron present, ores from different localities vary from white, grey and pink to light brown and dark red.

Following is a list of the principal countries producing bauxite, with their outputs for 1938:

	Short Tons
France	750,685
Hungary	594,000
Surinam (Dutch Guiana)	414,920
British Guiana	420,640
Italy	396,920
United States	347,500
Yugoslavia	436,000
U.S.S.R.	275,000
Dutch East Indies	269,500
Greece	197,875
Misc.—Malay States, India, Brazil, Roumania, Germany	78,060
World Total	4,181,100

The initial processing of the bauxite ore is a chemical treatment in which, by the Bayer process, the ore is treated in a hot soda solution under pressure which separates the alumina (white, aluminum oxide) from the insoluble impurities commonly called red mud. It is in this part of the process that coal is required to provide the heat and steam pressure necessary to speed up the chemical reaction. The alumina, thus separated, is dried and then charged into electric furnaces where it dissolves in the molten cryolite bath. The passage of an electric current through the bath reduces the aluminum oxide to metallic aluminum and oxygen. The metal, being heavier than the molten cryolite, sinks to the bottom of the furnace while the oxygen reacts with the carbon electrodes, forming carbon dioxide, and passes off as a gas. At periodic intervals the electric furnaces are tapped and the metal cast into pigs which are ready for remelting and alloying in the fabricating plants.

Only a few of the principal bauxite producing countries have the necessary coal and electric power for converting the bauxite into aluminum and even in this limited group, insufficient bauxite of the right grade, transportation problems between mines and power plants, or a lack of adequate electric power, all hinder the economical production of aluminum. There is, consequently, a very large international trade in bauxite.

Following is a list of the principal aluminum producing countries of the world in order of their assumed 1940 capacities.

	1938 (Short tons)	Assumed 1940 Capacities (Short Tons)
Germany	177,500	286,500
U.S.A.	143,200	220,000 (300,000—1942)
Canada	72,750	173,000
Russia	48,300	66,200
France	50,000	66,200
Italy	28,450	44,100
Norway	18,730	34,150
United Kingdom	25,700	33,100
Japan	18,730	30,000
Switzerland	29,750	27,550
Misc.—Hungary, Austria, Sweden, Yugoslavia, Spain	14,370	12,100

The yearly output figures of any one country do not necessarily give a true picture of the economics of the aluminum industry in that country. This is particularly true in the case of Germany, which at the present time leads the world in tonnage output despite the fact that it does not have available limitless supplies of the necessary raw materials. Considering the tremendous increase in aircraft production in Germany, it is obvious that the Nazis have, regardless of cost, attempted to make themselves self-sufficient and have largely subsidized the industry in order to feed their vast war machine. It is interesting to note that since 1932, Germany's aluminum production has shown an almost tenfold increase to the output of 1939 and this represents almost one quarter of the total world production. Italy, Russia, Japan and even Norway and Switzerland have developed aluminum industries against economic barriers, although Norway and Switzerland have some justification inasmuch as those countries possess natural hydro-electric facilities.

The ideal aluminum reduction plant would be one situated beside abundant bauxite deposits, adjacent to coal mines and with limitless cheap electric power readily available. The transportation of these raw materials, therefore, would not be a problem. Such an ideal location has not as yet been discovered although France most nearly approaches this condition.

In considering the economics of the aluminum industry, so many factors must be taken into consideration that definite rating of each country as to its suitability becomes almost impossible. In the following table an attempt has been made, nevertheless, to group the important world producers and the three essential raw materials—power, bauxite and coal, together with transportation—and to rate each country in relation to the others, A representing excellent, B, good; C, average; D, fair, and E. poor. This classification is only a personal opinion, because for example for transportation alone, we would require very exacting comparative cost figures, depreciation of rail and boat facilities, an intimate knowledge of such conditions as port, storage and loading investments and the cost of labour in the various countries; all matters which have a direct bearing on the economics of producing metal regardless of the quality and abundance of the raw materials. Obviously, therefore, such a grading as has been made on this list can serve only as a rough guide, since all the many facts relating to the subject are not available.

	Power	Bauxite	Coal	Transport and Other Facilities
Canada	A	E	A	B
U.S.A.	B	B	A	C
Germany	B	D	A	C
Russia	C	D	C	E
France	B	A	A	A
Italy	D	C	E	B
Norway	A	E	E	C
United Kingdom	D	E	A	B
Japan	E	E	C	C
Switzerland	A	E	E	D

Power

Hydro-electric power in the industrial east of Canada needs no explanation. Northern Ontario and Quebec abound with waterways—potential sources of great power developments. Likewise, Norway, Switzerland have hydro-electric power in abundance. The United States is not so fortunate in that there is cheap power available only in New York State, the Southeast and the far West. France has good power developments but as most of these are built at the foot of deep valleys, utilizing high water heads but small volumes, the power plants have been limited in size. Expansion can only take place by building more of these small power units, a very undesirable and uneconomical condition for large scale production. Russia has large power units, the most famous of which is the Dnieprostroi development, but the difficulty with the power developments in Russia, a fact which also holds for many of the best developments in Norway and Switzerland, is that they do not have a water accumulation in lakes back of the power plant to ensure a uniform volume of power throughout the entire year. As a result many of the Russian plants for part of the year are actually short of power, whereas in Canada, with the great chain of lakes and rivers in the north and the abundant snowfall, storage basins are kept at practically a constant level throughout the entire year. Power in Italy and Japan is very costly but being subsidized by the government, cost is a minor consideration. The situation in Germany is different because practically all of their electric power is produced from coal. Thus it is not surprising to find that the German reduction plants have nearly all been built in districts where brown coalfields exist and under these conditions power is made almost as cheap as in the average hydro-electric plant.

Bauxite

Of the important producing countries, France is the only one which has within her own borders abundant supplies of good grade bauxite. In the United States good deposits exist in Arkansas, Alabama and Georgia, but these will by no means provide sufficient ore for the large American industry, and most of the bauxite used at present by the States is imported from Dutch Guiana.

Germany, Russia and Italy have some deposits but they are mostly of an inferior grade. Germany and Italy depend largely on imports from the Balkan countries.

All other producing countries are without deposits of their own and are wholly dependent on imports.

Canada has to bring ore from distant British Guiana, but the quality of this ore is probably the best in the world. Transportation facilities by boat direct from the mines to the smelter are ideal, thus offsetting to a considerable degree the fact that we do not have any bauxite in our own country.

Coal

Canada, United States, Germany, France and the United Kingdom all have an abundant supply of coal. Russia and Japan both have limited deposits, while Italy, Norway and Switzerland are largely dependent on imports.

Transportation

Transportation—including necessary facilities for the handling of ore or raw materials—is a factor which cannot be rated with any certainty. Undoubtedly, France, with coal, bauxite, and power plants practically on the same property, has no transportation problem. Canada, Italy and the United Kingdom, importing as they do by sea, are in a more favourable situation than are most of the other countries. Norway and Japan, for instance, must haul by boat and then transport by rail considerable distances inland, greatly adding to the cost of transportation. The United States, while possessing a very efficient inland transportation system, has of necessity to make long haulages by rail as well as by boat in order to bring together all these raw materials from so many scattered sources of supply. In Gremany they have a real problem, for practically all their ore has to come from the Balkan states by rail or river barge. Much of this traffic is on the Danube river, but because of the narrows at the Iron Gates, the boats and barges are small and shipping small tonnage is costly.

From this very cursory and generalized survey of the aluminum industry it is apparent that Canada should rightly hold a foremost place among world producers. True, there have been difficulties to overcome. At the mines in British Guiana there have been housing and sanitation problems as well as the difficulties of operating in tropical countries far from sources of supplies and equipment repairs. Our long winters in northern Quebec necessitate accelerated imports during the navigation season to provide stocks of raw material for the winter months. This, in turn, has required huge storage sheds and exceptionally large dock facilities to accommodate these supplies. Few people realize that the aluminum industry in Canada has developed and operates in Arvida the largest aluminum plant in the world, supplied by power from Isle Maligne, its own power house, which is the third largest power-house in the world—560,000 hp.—exceeded only by the American Boulder Dam and the Russian Dnieprostroi developments. Port Alfred, the fourth largest port in Canada, also was built for the aluminum industry's immense boat traffic.

By perseverance and hard work this important industry has been built up in Canada—an undertaking now more than ever vital to the nation and to the British Empire, for Canada's entire output is going into aircraft and other essential war equipment.

THE SOLUTION OF SIMULTANEOUS LINEAR EQUATIONS IN STRUCTURAL ANALYSIS

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The chief difficulty in the application of the three-moment equation lies in the ready solution of the algebraic equations which result from it. This equation, in its most general form, leads, when written out in detail, to a set of n three-term simultaneous linear equations containing the moments at the supports as unknowns. These equations have a special character and advantage can be taken of it to effect a systematic process for the solution of them.[1]

The form of these equations is:

$$A_{r,r-1}\, M_{r-1} + A_{r,r}\, M_r + A_{r,r+1}\, M_{r+1} = Z \qquad (1)$$

where r runs from 1 to n, there being $n+2$ supports numbered from 0 to $n+1$.

The $a_{r,r}$, which are the numerical coefficients, are quite independent of the Z_r. The former depend on the elastic properties of the structure, including the spans and moments of inertia, while, in addition, the latter include the loading, settlement of supports, etc. Moreover, the $a_{r,r}$ form a symmetrical matrix and also in simple cases $a_{1,0} = a_{n,n+1} = 0$. We shall make use of this special character of the equation.

It is a simple matter to show, by means of the theory of linear transformation, that such a set of equations may be solved in the form

$$M_r = \sum_{i=1}^{i=n} b_{r,i}\, Z_i \quad , i \text{ running from } 1 \text{ to } n \qquad (2)$$

in which the $b_{r,i}$ are functions of the $a_{r,r}$ and are not affected by the Z_r. They also, therefore, form a symmetrical matrix, i.e. $b_{r,i} = b_{i,r}$.

If equations (2) be substituted in equations (1), the result is

$$a_{r,r-1} \sum_{i=1}^{i=n} b_{r-1,i}\, Z_i + a_{r,r} \sum_{i=1}^{i=n} b_{r,i}\, Z_i + a_{r,r+1} \sum_{i=1}^{i=n} b_{r+1,i}\, Z_i = Z_r \qquad (3)$$

If the summations be written out and the terms collected according to the Z_i, one finds:

$$\begin{aligned} &(a_{r,r-1}\, b_{r-1,1} + a_{r,r}\, b_{r,1} + a_{r,r+1}\, b_{r+1,1})\, Z_1 \\ &+ \ldots\ldots\ldots\ldots\ldots\ldots \\ &+ (a_{r,r-1}\, b_{r-1,k} + a_{r,r}\, b_{r,k} + a_{r,r+1}\, b_{r+1,k})\, Z_k \\ &+ \ldots\ldots\ldots\ldots\ldots\ldots \\ &+ (a_{r,r-1}\, b_{r-1,n} + a_{r,r}\, b_{r,n} + a_{r,r+1}\, b_{,+1,n})\, Z_n = Z_r \qquad (3a) \end{aligned}$$

This equation would be satisfied if all the coefficients of the

[1] The occurrence of such systems of equations in structural analysis is not confined to the three-moment equation.

Z's were zero, except the coefficient of Z_r, and this coefficient were unity.

Then,

$$a_{r,r-1}\, b_{r-1,k} + a_{r,r}\, b_{r,k} + a_{r,r+1}\, b_{r+1,k} = 0 \qquad (4)$$

would be true for all values of k except the one value $k=r$, for which case:

$$a_{r,r-1}\, b_{r-1,r} + a_{r,r}\, b_{r,r} + a_{r,r+1}\, b_{r+1,r} = 1 \qquad (5)$$

Now let

$$b_{r,k} = c_r\, b_{r+1,k} \qquad (6)$$

Then

$$b_{r-1,k} = c_{r-1}\, b_{r,k} \qquad (6a)$$

Substituting equations (6) and (6a) in equation (4), one gets

$$b_{r,k} = -\frac{a_{r,r+1}\, b_{r\ 1,k}}{a_{r,r} + a_{r,r-1}\, c_{r-1}} \qquad (7)$$

so that

$$c_r = -\frac{a_{r,r+1}}{a_{r,r} + a_{r,r-1}\, c_{r-1}} \qquad (7a)$$

In a similar manner, let

$$b_{r,k} = c'_r\, b_{r-1,k} \qquad (8)$$

then

$$b_{r+1,k} = c'_{r+1}\, b_{r,k} \qquad (8a)$$

and

$$b_{r,k} = -\frac{a_{r,r-1}\, b_{r-1,k}}{a_{r,r} + a_{r,r+1}\, c'_{r+1}} \qquad (9)$$

so that

$$c'_r = -\frac{a_{r,r-1}}{a_{r,r} + a_{r,r+1}\, c'_{r+1}} \qquad (9a)$$

Also, substituting equations (6a) and (8a) in equation (5) and putting $k=r$, one gets:

$$b_{r,r} = \frac{1}{a_{r,r-1}\, c_{r-1} + a_{r,r} + a_{r,r+1}\, c'_{r+1}} \qquad (10)$$

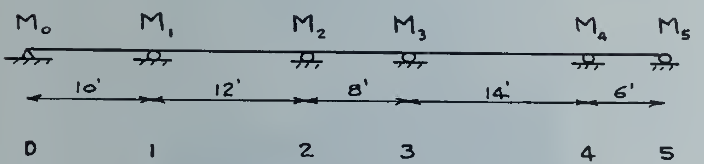

Fig. 1

It is, of course, obvious that difficulty will be encountered should the denominator of equations (7a), (9a) and (10) respectively turn out to be zero. In this case, however, it can be shown that the equations (1) are not compatible. The computation may usually be carried out on a slide-rule except in those cases in which the denominators are nearly zero. In such case more significant figures will have to be employed, making the use of a calculating machine or logarithms necessary.

Now where $a_{1,0} = a_{n,n\ 1} = 0$, starting with these values the c_r and the c'_r may be progressively computed from

TABLE I.

r	$a_{r,r-1}$	$a_{r,r}$	$a_{r,r+1}$	c_r	c'_r	z_r
1	0	44	12	—.273	0	—2,728
2	12	40	8	—.218	—.313	—2,240
3	8	44	14	—.331	—.205	—3,256
4	14	40	0	0	—.350	—2,960

equations (7a) and (9a). The $b_{r,r}$ may then be determined from equation (10) and finally from them all of the $b_{r,k}$ can be formed from equations (6) and (8).

These values, when placed in equations (2) give the M_r which is the ultimate object of the process. The work should be carried out in tabular form but in order to save space the form of the tables will not be given.

In order to display the process as one of systematic computation, the following simple example has been chosen as an illustration. A continuous girder, having a constant moment of inertia of its cross-section carries a uniform load of 4,000 lb. per linear foot over six supports as shown in Fig. 1.

The three-moment equation is for this case.

$$L_a\ M_a + 2\ M_m\ (L_a + L_b) + M_b L_b = -\tfrac{1}{4} L_a^3 w_a - \tfrac{1}{4} L_b^3 w_b.$$

By inspection all of the a_r can be written down and all of the Z_r can be readily computed. Obviously $n=4$, and the various numerical values have been entered in Table I. The Z_r are in foot-kips.

Next the c_r and c'_r are computed.

For example:

$$c_1 = -\frac{12}{44} = -.273$$

$$c_2 = -\frac{8}{40 - .273 \times 12} = -.218$$

Table II is next filled in. To do this start at the lower right hand corner and compute:

$$b_{4,4} = \frac{1000}{-14 \times .331 + 40} = +28.28$$

TABLE II.

k \ r	1	2	3	4
1	+24.8	—7.77	+1.59	—0.557
2	—7.77	+28.5	—5.83	+2.04
3	+1.59	—5.83	+26.8	—9.37
4	—0.557	+2.04	—9.37	+28.3

TABLE III.

Z_r	M_1 +	M_1 —	M_2 +	M_2 —	M_3 +	M_3 —	M_4 +	M_4 —
—2,728		67,700	21,200			4,340	1,520	
—2,240	17,400			63,800	13,100			4,570
—3,256		5,180	19,000			87,200	30,500	
—2,960	1,650			6,040	27,700			83,900
	—53,830		—29,640		—50,740		—56,450	

by equation (10). Here 1000 has been used instead of unity in equation (10) for convenience. This will make all of the $b_{r,k}$ 1000 times too large. Since, however, the Z_r are in foot-kips, when they are multiplied by the b_{rk} the result will be in foot-pounds as shown in Table III.

Starting with $b_{4,4}$ the remaining $b_{r,k}$ are computed upwa:d by successive multiplication by the c_r. Next $b_{3,3}$ is computed from equation (10) and the other $b_{r,k}$ upwards from it by multiplying by the c_r and downwards from it by using the c'_r. Since $b_{r,k} = b_{k,r}$ the computations can be checked at each step.

The solution of the equations is completed by filling in the Table III which contains the products $Z_r b_{r,k}$ and needs no further comment.

Thus, we have

$M_1 = -54,830$ foot-pounds
$M_2 = -29,640$
$M_3 = -50,740$
$M_4 = -56,450$

which will be found to satisfy the original equations.

There is an additional advantage in this procedure because when the loading is changed only the Z_r become altered. The $b_{r,k}$ remain the same. Thus, for different loadings only the Table III need be repeated. This fact also makes the method very useful for the computation of influence lines.

AIR TRAFFIC CONTROL

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The main purpose of air traffic control is, as the name will indicate, essentially to reduce the risk of collision in the air, or on the airport, and to speed up the safe dispatch of aircraft as much as possible.

The necessity for air traffic control probably better emphasises the tremendous progress which aviation has made than does any other individual development. Although most control towers have been installed in Canada because of the congested conditions which would result when the Empire Air Training Scheme is operating at capacity, traffic control has been found necessary at most of the main airline terminals in the United States because of commercial traffic alone. A similar condition may very well follow in Canada. In fact, Vancouver found its volume of civilian flying sufficient to justify the expense of installing a control tower as a civic project over four years ago. It seems very probable that the increase in traffic will make the operation of air traffic control centres essential even after the war.

Classes of Air Traffic

There are two classes of air traffic: these are terminal traffic and airways traffic. Terminal traffic is composed of aircraft flying within a 25-mile radius of the terminal airport, while airways traffic is considered to be all aircraft flying along or across the designated civil airways which connect the various air terminals. These civil airways, incidentally, are defined as "A flight path twenty-five miles in width and extending twenty-five miles beyond the terminals, along which have been established the necessary ground facilities."

Light Gun Control

Let us first explain the procedures used in controlling terminal or airport traffic, first by visual means and secondly by radio means. All aircraft not equipped with radio are handled with a signal light gun. Figure 1 shows the light gun used in the Lethbridge control tower. This gun consists principally of a small 50 candlepower bulb mounted in front of a highly polished reflector which concentrates the light rays into a parallel-ray beam. With this arrangement the light, in spite of its low candlepower, is visible for a distance of ten miles in daylight. A red and a green lens are mounted with suitable controls so that they may be quickly swung between the bulb and the reflector. It is thus possible to give a green, red, or white signal at will. Since the rays are concentrated into a small spot which does not increase in diameter with distance, only the aircraft towards which the gun is pointed can see the signal. A suitable set of cross hair sights are mounted on top of the gun enabling the operator to aim the light accurately on the aircraft concerned.

The movement of a non-radio-equipped aircraft arriving from Calgary, for example, landing, and later departing for Vancouver, is as follows: On arriving over Lethbridge Airport, the pilot will circle the airport control tower to the left at 500 to 1000 ft. above ground level. (Altimeter reading 3500 to 4000 ft. above sea level). If the runway favoured by the wind is being used at the moment, he will receive an intermittent red light from the tower. He will then climb to at least 1000 ft. and continue to circle the field until he receives a steady green light from the tower—the signal that it is all clear to land. It is the pilot's responsibility to watch the tower from time to time during his approach to make sure that his landing clearance is not cancelled by a further intermittent red light before he actually completes his landing. After landing the aircraft comes to a stop and does not move until after receiving an intermittent green, which indicates that it is all clear to taxi. During taxying, the pilot must keep a lookout for other aircraft and an eye on the tower for further signals. During this time he may receive an intermittent red ordering him to stop, or an intermittent white indicating that he is to pull clear of the hard surfaced runway, and hold his position. If the tower operator wishes the aircraft to pull clear of the paved runway and taxi on the grass, he will send out a series of intermittent white and green flashes with the traffic gun. The outgoing aircraft will taxi out to a point opposite the tower and hold until given taxi clearance. When he reaches the take-off point the pilot will face across wind away from the tower until he is ready for take-off clearance. When ready, he will swing around in the direction of take-off or slightly facing the tower and will receive take-off clearance as soon as the runway is clear. He should not park on the end of the runway while testing his engines before take-off, but well to one side so that incoming aircraft will not have to land over him. After

Fig. 1—Light gun used for controlling airport traffic

taking off, the outgoing aircraft will receive no further light signals from the tower, but will merely comply with the rules of the air as outlined in Civil Air Regulations. In passing it might be well to mention that the aircraft acknowledges all signals by rocking its wings in the air and by moving its rudder and ailerons when on the ground. Aircraft equipped with a radio receiver only also acknowledge tower radio signals in this manner.

Traffic Control by Radio Communication

All airport control towers are equipped with a radio voice transmitter operating on a frequency of 278 kilocycles, for the control of aircraft equipped with radio. Any aircraft equipped with a receiver which can be tuned to the radio range band—200 to 400 kcs.—will receive control instructions from the tower regardless of whether they are fitted with a transmitter or not.

Radio control is far superior to light gun control in that it is possible to give specific information to the pilot regarding the wind condition, pertinent traffic and any other information which may be considered useful. The pilot may, if he has a radio transmitter, ask for and receive any information which he desires. This is useful, for example, to pilots going into a strange airport, who are doubtful about some field condition or other point. A definite routine is used in handling incoming and outgoing aircraft equipped with two-way radio.

Approximately 25 miles out, an incoming aircraft will call the airport control tower on his normal transmitting frequency (or one of his frequencies if he has on all the commonly used frequencies), the aircraft's call will be received on that receiver which is tuned to the frequency in question. After the tower has acknowledged the call, the aircraft will report its position, altitude, and estimated time of arrival at the airport. The tower will repeat this information as a check, and then give the runway being used by traffic, altimeter setting, and the essential traffic, if any. This will be acknowledged by the aircraft.

Taking Trans-Canada Airlines Trip 3, westbound from Regina, as an example, the radio patter will go something like this:

"Trans-Canada Trip 3—Lethbridge Tower."

"Lethbridge Tower—Trans-Canada 3, go ahead."

"Trans-Canada 3—Lethbridge Tower, by Taber at five eight, at six thousand, estimate the field at zero nine, beginning descent from six thousand at five nine."

"Lethbridge Tower—Trans-Canada 3, by Taber at five eight, at six thousand, estimate the field at zero nine, beginning descent from six thousand at five nine—wind south west variable, twenty to twenty-five, favouring the northeast-southwest runway—altimeter setting twenty-nine, eighty-seven—two, nine, eight, seven—your traffic is a formation of five Air Force Ansons, departed Lethbridge at fifty-six—five six—for Regina, cruising at five thousand. There are several Moths flying locally."

"Trans-Canada Trip 3." (Note that during conditions of poor radio reception the aircraft would repeat back the above information in his acknowledgment as a further check).

A second inbound check is given approximately five minutes out. This is similar to the first except that more details concerning landing conditions and local traffic are given at this time. It also gives the traffic control officer a further check on the position and speed of the aircraft and permits him to handle his local traffic accordingly.

Air Landing Clearance

This is the third and last routine communication in the air. It is carried out just prior to starting the landing approach. An example of this is as follows:

"Trans-Canada 3—Lethbridge Tower, landing clearance."

"Lethbridge Tower—Trans Canada 3—wind unchanged, two Moths holding clear of the runway on the south side—you are clear to land, wheels down."

"Trans-Canada 3, wheels down."

The comment "wheels down" is given at the request of some operating companies as an extra reminder to the pilot to lower his undercarriage before landing. Belly landings are expensive!

As the aircraft comes to the end of its landing run, the tower will give it taxi clearance; or this may be first requested by the pilot. Specific taxi instructions regarding runways or taxi strips to be used may also be given at this time. Such as: "Pull off to the north side of the runway and hold your position, there is an Air Force Hudson approaching behind you;" or "Taxi back by way of the east-west runway."

The control of outgoing aircraft when radio equipped follows much the same procedure as non-radio-equipped aircraft. That is in regard to the clearances required and given. It is of course, much more specific, as previously mentioned. After the aircraft has taken off and is about five miles from the airport, he will give a position report and request clearance from the tower to the radio range, to his operating company, or to the Air Force station to which he wishes to listen. Normally all outbound aircraft which have filed a flight plan specifying a definite cruising altitude at which they intend to fly (an instrument flight plan) must give a report over definite pre-arranged locations as the flight progresses. They will also be given traffic information and instructions. For this reason, they are required to keep a constant watch on some definite frequency, such as that allotted to their own company, or to the radio range station closest to them. All itinerant aircraft will receive their traffic information from the radio range station to which they are tuned.

Airways Traffic Control

Once the pilot has obtained a clearance from the airport traffic control tower, and is making a flight along a civil airway, he comes under the jurisdiction of airways control. The system of airways control used in Canada at present is being patterned after the procedure laid down by the Civil Aeronautics Board of the United States, but since it is still in the process of development, it naturally is not yet functioning with the same efficiency as the older American service. Rapid progress is being made, however.

It is only in the last few months that any airway control has been considered necessary in Canada, although a circular was issued by the Civil Aviation Division of the Department of Transport in July, 1938, outlining approved practices. This will presumably be followed when all control

Fig. 2—Control tower at Kenyon Field, Lethbridge, Alberta.

towers are completed and in operation. This circular (O/44/38) will be discussed to give an idea of the approved system.

Contact Flight Rules

All flights along a designated civil airway can be completed in one of two ways: either by contact flight rules (known as CFR), or by instrument flight rules.

An aircraft flying by contact flight rules carries out all essential navigation by visual reference to the ground. In order to complete such a flight the pilot must at all times have at least the minimum ceiling and visibility conditions laid down by the Government (Controller of Civil Aviation —O 63/40). If the minimums drop below the allowable limits the pilot must land at the first possible opportunity. He must, under no circumstances, attempt to climb through the overcast. No radio equipment, special blind flying instruments, or instrument flight training is required to complete a flight under contact flight rules.

Instrument Flight Rules

The airways control centres are concerned chiefly with flights made under instrument flight conditions, since, during contact flight conditions, the visibility is sufficient to make the risk of collision on airways negligible. For this reason a pilot need not specify at what altitude he intends to fly when operating under contact flight rules. This, of course, does not apply to an instrument flight. The conditions laid down for making a flight under instrument flight rules not only specify that the aircraft must be equipped with two-way radio, special instruments, and qualified personnel, but a flight plan containing all essential information as regards route, altitude, proposed departure time, speed, estimated time of arrival, etc., must be submitted to the traffic control officer, at the nearest station, for approval before departure. The pilot is also responsible to notify the airways control of his progress along the route by means of his company radio, or through the nearest radio range station. They will relay the message to airways control by interphone or teletype. He must obtain permission before changing his flight level or any other item in his flight plan. Airways control will keep all other aircraft notified through available radio facilities.

On arrival over the terminal airport during instrument conditions the aircraft will if necessary be given an altitude and course to maintain until the air below him and the approach to the field is clear. He will then be given his "approach clearance" which permits him to descend through the overcast, or make "let down" as it is termed. As soon as he can see the ground, that is he is "contact," the pilot makes a landing under the direction of the air-control tower. The next machine which has been holding above him is then permitted to start its "let down."

Sometimes at a busy airport there may be several machines stacked up at thousand-foot intervals waiting for the machines below them to let down and land. The instructions for holding an aircraft prior to an instrument let down given by the airways control are generally worded roughly as follows:

"Hold on south leg of Lethbridge range between station and point five minutes south until further advised."

The subject of airways and airport traffic control is far too large to discuss from every angle in this paper. However, the above outline will give a general idea of how aircraft are prevented from flying into each other even in weather conditions that make it impossible for the pilot to see further than his own wing tips. The fact that there has never been a collision of aircraft operating under civil airways control on this continent is an indication of the efficiency of the system evolved.

The pilots also appreciate the fact there is always someone watching out for them on the ground and giving them useful information when they require it. This applies just as much to the small radio-equipped light aeroplane as it does to the biggest airliner.

Future Outlook

At the rate that aviation is expanding, on the civilian side as well as the military, many traffic problems at airports and their immediate vicinity may develop in the not so distant future. Many interesting methods are likely to be devised to solve this problem. Some of these are likely to be:

(a) The dissipation of the traffic over a larger area. There is plenty of air for everybody to fly if everybody does not try to use the same spot at the same time. Many factors will help in the dissipation of the traffic. Some of these will be more airports and airways, more extensive use of seaplanes and amphibian aircraft; more extensive use of autogyros, helicopters and other types which do not require large airports; the further segregation of types—airliners to use one airport; smaller, slower types to use another.

(b) Changes in the design of aircraft, to give a greater speed range, more manoeuvrability, more fool-proof handling qualities, and a better field of vision.

(c) Improvements in the design of both aircraft and ground station radio equipment. Ultra high frequency apparatus has already gone a long way towards fully reliable reception even in conditions of severe electric disturbances.

(d) The more universal use of radio in aircraft. The time will come when a non-radio-equipped aircraft will be looked upon in the same light as we now look upon an automobile without an electric starter. This will make for faster handling and less confusion.

Future Traffic During Instrument Conditions

Terminal traffic has already become number one airline operating problem at one or two of the large metropolitan airports in the United States, although it is likely to be some little time before such a condition arises in Canada.

To quote from an article by Capt. Fred Smith, of Canadian Colonial Airlines in October's *Aero Digest.*

"Only in polite company do pilots and flight superintendents call it "Terminal Air Traffic." To them it constitutes the greatest single source of fatigue encountered in the year's work. In the airlines' pocketbooks it has caused a sizable loss of revenue, since it has necessitated cancellation of short-haul schedules during perfectly flyable weather due to probable unreasonably long delays over destination airports... Recently, because of increased schedules, it has become usual during the rush hours, for upwards of a dozen airplanes to become stacked up over the airport's (New York's La Guardia Field) environs waiting for a chance to use the single radio range... One evening last spring there were 22 planes waiting to use it. Since, on peak traffic occasion approximately 300 planes per day operate into and out of this one airport (and these usually bunch between noon and eight o'clock in the evening), it can be readily realized the immensity of the problem presented. The runway may not be used for take-off when a plane is approaching or making its landing. A double number three runway, one for take-off, one for landing, would be an immediate relief, but not a solution to the problem."

There are many means that may be employed to reduce this problem of congested traffic over a terminal airport during instrument conditions. Some of these are being acted on at the present and will be put into effect shortly.

(a) Double runways. One for take-offs and one for landings. This will enable more movements to be made per hour.

(b) Instrument landing equipment. This would speed up "let down" procedures and would eliminate the necessity of second attempts at "let downs" with the resultant waste of time. This is being installed in ten centres in the United States this year with another fifteen to follow shortly. It is to be hoped that Canada will get similar equipment as it would be worthwhile for the completion of more trips which would otherwise have to be cancelled for low ceiling and visibility even if it were not needed immediately as an aid in the terminal traffic problem.

(c) Alternate airports. At least two airports equipped with blind landing facilities for every metropolitan centre.

(d) Bigger aircraft. Greater cargo per movement, thus reducing the number of movements necessary to handle a given volume of cargo.

(e) There has also been some development work on an infra-red ray apparatus which, when perfected, will enable a pilot to see through clouds. This naturally will be a tremendous advantage to flying of all types and will practically eliminate the necessity for rigid control that exists to-day during instrument conditions.

FUNDAMENTALS OF PROFESSIONAL EDUCATION*

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An address delivered at the Sixth Annual Meeting of the Allegheny Section of the Society for the Promotion of Engineering Education, Pittsburgh, Penn., on October 25th, 1940

I have been asked to speak on the fundamentals of professional education. It is difficult to speak on fundamentals without being superficial. It is so easy to use stock phrases. It is so easy to say that the task of professional education is to equip a man with something to profess and to give him the ability to use well that which he professes. It is so easy also, to add that to make him truly professional his education must cultivate his mind, and further, because of the ethical tone of all professions, it must train him to use his professional powers for the well-being of society. It is so easy to do this that it is tempting to do it and no more. But when one has finished these "Good words, and well pronounced," one has said nothing that anyone can disagree with, and nothing of effective importance.

One way of making more concrete these general statements, is to examine the world in which the professional student of to-day must practice his profession. This is a very different world from that in which Bacon could truthfully say, "Knowledge in itself is power." For since the time of Bacon the world has undergone a deluge of objective knowledge, great in mass, and great and growing greater in its rate of accumulation. That objective knowledge has changed the character of all professional work and hence of all professional education.

Although scientific knowledge has gone on and on expanding, and in expanding has increased our control over nature, all of the mysteries of life are as great to-day as they were in the time of Bacon. For the meaning of life and death and personality have not been made easier to understand by all that has been learned about the universe of the stars and the universe within the atom.

The expansion of science instead of creating bases for faith, has removed the old moorings to which we tied our faiths and our sense of values. Hardly more than a generation ago those moorings were so secure and the port in which our faiths and sense of values rested was so sheltered that the great mass of people never ventured out into the open sea of fundamental inquiry. But that security has gone. As a result, philosophers have had to become scientific and the great scientists, in their effort to ease the distress of soul that their discoveries have caused, have often become philosophical. And common men, as a Harvard student said in his graduation poem, when they think about values and about what makes life worthwhile and significant,

"...weary-eyed with too much light,
Cry from their dream-forsaken vales of pain,
'Give us our gods, give us our gods again ' "**

As science has advanced, engineering has applied it to life. Through doing this engineering has changed from the roots our way of life and of work and even of war. In the process, social institutions and values that were stable have become insecure. Great to-day is the violence and great the confusion of tongues as to what is good and what is ahead in government, industry, and society.

This means that if our professional training is to equip a man for useful professional attainment it must equip him to go out into insecurity and to face perplexity unabashed. In such a world knowledge is abundant but no longer power in itself. We cannot successfully prepare a man for professional life by merely providing him with information and techniques ready for use. Instead, we must equip him to go back to fundamentals and to be able to work out from origins both values and practices, and in that sense be original. To provide capacity for such fundamental originality is the basic task of all professional education.

Its attainment is made difficult by the fact that the human mind, like the human body, tends to calcify around any material that stays static within its organism. If we give a student precise information and answers and let these lie inert in his mind, they are likely to calcify and produce a crustacean thinker—a man whose thinking is enclosed in a shell of fixed ideas and formulas. Such a mind, like all crustaceans, is exceptionally capable of shielding itself from exposure to the pain of changing reality; but like all crustaceans it is also peculiarly incapable of adapting itself to fundamental change or of controlling changing reality. Worse still, if instead of giving a student that inert knowledge through his own discovery, we give it to him as of our authority, we have created a type of mind similar to the hermit crab, with somebody else's shell that it drags around, a ponderous mass impeding thinking; into which, whenever reality becomes disagreeable or threatening, it can retreat and say, "There are the accepted answers."

If on the other hand, calcification creates a central spine, as it does in the vertebrate, it gives power and adaptability. I believe this is as true of mental as of anatomical organisms. Hence, if we are to give our students this sturdy adaptive power of thought, we should allow calcification of thought only in regard to basic principles as to which we can say, "These are so fundamental that you can safely let them become the solid spine of your thinking." This is not as simple as at first appears, for the problem is by no means merely one of teaching the student science, or even plenty of it. For if we make the scientific core too much an end in itself we are likely to produce a mental skeleton whose inelastic muscular vestiges are dried against its bones.

You will notice on the football field, that the sturdy graceful men who play, not merely have backbones, but that their backbones are extraordinary in their adaptive flexibility. When one of them tackles or throws a pass, his spinal posture must be right for the task or it won't succeed. So, although in the process of professional education we must create solidity at the spine, this basic spine if it is to be good must be produced by a process of growth and exercise which makes it flexible and which develops around it strong muscles of thought.

Professional education must provide an understanding of science. But professional education must go further and provide at *the same time* exercise in the use of science to solve practical problems of technology. Then the growth of spine and muscle will be concurrent and each adapted to the other. If we attempt to teach either in isolation—if we do not make science useful as we teach it, or if we teach technology as the mere learning and manipulation of formulas and techniques instead of the application of fundamental science to concrete problems—we will have made it difficult for science and technology to play their proper parts thereafter in powerful vertebrate thinking.

This applies particularly to teaching the so-called technical tools. To try to teach them separately as things in themselves is to render them unsuited to creative use. If a man is a good craftsman, he can always acquire and learn to use any special tool that he needs. If he is a really good craftsman, he will grind the tool he buys to fit his particular job. Often he will make his own special tool. Intellectual tools are similar. In this age of printing they are widely available and the purchase price is small. If we teach the man the art of acquiring them from the printed word, and

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**Hermann Hagedorn, in "A Troop of the Guard."

the art of using them, and the art of remodeling them, we have given him something more valuable and more adaptable to the future than any quantitative fullness of his technical tool chest. Besides we may then find that the few tools which we have given him in the process of developing these arts are finer than if the provision of the tools and not of the arts had been our aim. Thus, in this as in other respects, it is a fundamental of professional engineering education that it make its aim the development of capacity for basic originality in the use of science and technology, not the provision of the greatest quantity of surface technological proficiencies.

In this respect, as in all others, what a student learns depends upon what he does and two things are outstanding in determining a student's activity. One is the character and the quality of mind of the teacher. If the teacher is a man of full habit and if he is a man of basic originality, his way of thought, his way of conversation with his students, his way of dealing with them, will unconsciously instill itself into them. Give me great persons and great thinkers as teachers before all else.

The other primary factor in determining what a student does and learns is how his attainments are measured. Ask almost any student who is willing to be frank with you what causes him to work at particular things and in particular ways in his daily work, and the answer generally will be—"What 'scores', in the exercises and examinations." For these coming events cast influential shadows before.

There is a type of examination that reminds me of a form of fishing practiced by peasants in Japan. These humble men make their living by training cormorants, large diving birds, to fish for them. The fisherman places a ring around the cormorant's neck, large enough to permit the bird to breathe, but not large enough to let it swallow a fish. He rows out into the fish pond. The cormorant dives for the fish. When it gets back to the boat the fisherman pulls up the ring and out comes the fish. But the cormorant, though he has been through the exercise of fishing, has gained no nourishment.

All too many examinations are similar to this. The only difference is that we stock our intellectual fish ponds with our own types of fish, and when in the examination we pull the ring we take pride that the fish which comes forth comes without scar or modification caused by its sojourn in the student's mental gullet. Under such conditions students who reproduce their mental fish exactly as they received them in the text or lecture stand high. And yet the digestive juices of such students never reach what they have fished out so as to modify it or to give them sustenance from it.

If we are going to teach capacity for true originality, our tests and class work must face our students from time to time with genuine perplexity. This alone gives opportunity to learn true discipline of mind. If a student looks at a problem and doesn't know the answer, he is not truly faced with perplexity if he knows the formula or the method by which, with a few substitutions, he can get the answer. Instead of facing him with perplexity that is merely facing him with "capitalistic certainty"—an investment in a "sure thing," the return on which must be postponed until the known manipulations provide the answer.

True perplexity occurs when the student doesn't know any ready-to-use formula or means of solution and has to take thought as to how to devise one—when he has to return to fundamental principles in order to work between formulas or beyond them. With such true perplexity, even after he gets the answer, he is not sure that it is right because, having created the formulas or measures all along the way, he cannot be sure that better ones might not have been found. But if he has worked out his process of solution from the core, he will have learned the beginning of the art of fundamental originality. Out of his perplexity will come power and confidence that can survive in the perplexity of the world into which he later must go.

Now this means that we cannot teach a student to think under his own steam, to use President Doherty's term—we cannot teach him to use creative originality, if we regiment him. Yet if we permit undisciplined educational self-indulgence, we are in danger of producing a jellyfish mind without a spine at all—scientific, technical, or otherwise. To solve this conflict discipline must be raised above the level of regimentation. And to do this it is necessary to have wide enough gaps between tests and between assignments to permit large enough problems or tasks to involve the use of creative power and not merely the manipulation of technical minutiae. Furthermore, for the word "exercise" we should seek to be able honestly to substitute the words "experiment" and "original problem." That I fear can be done in only a few institutions. It is so easy to teach the laboratory or the technical manual of arms, and so hard to give opportunity to learn strategy Yet, the lifting of discipline above regimentation is truly a fundamental of good professional education.

The extensiveness of objective knowledge has faced professional education with another difficulty. In nearly all fields the mass of scientific and technological data and practice is so great that when teachers look at it they can hardly escape from gasping, "How can we teach all this in the time available ? Years ago when people didn't know so much, to teach was easy. But now we need more hours of class work and more hours of study than it is possible to get. We must hurry, hurry, hurry, just to teach engineering students all they need to know." They are right in this. If anyone suggests that an engineering school which aims to teach students all they need to know, should also take the time to teach students to think for themselves, the answer is clear. It cannot. It is not possible to teach an engineering undergraduate all he needs to know in his profession and at the same time train him fully how to use that knowledge. If we are going to do the one, we cannot do the other.

But that does not mean that engineering education is condemned to the level of merely imparting engineering information and techniques. The dilemma arises from a non-structural conception of wisdom and power. In teaching a new science or technology, to borrow a simile from Dean Winternitz of Yale, there is a small circle of knowledge, in which the core and periphery are one, and on this account it is easy to teach all there is to know. As the science or technology matures the area of knowledge expands. But the amount of time for instruction remains the same and it becomes impossible to cover the entire circle of knowledge without being utterly superficial. Hence the teaching of each course tends to take the central area for granted. It tends to assume that fundamentals were covered once for all in some elementary course, and tends to concentrate itself upon a band of advanced knowledge around the circumference of the subject. As time goes on and the science and technique expand, the band at the periphery which there is time to teach inevitably grows narrower and narrower and its contact with the core of basic principle more and more remote.

As a consequence the teaching of mature techniques tends toward technical tenuity. The knowledge may be taught with clarity and order. Its surface relationships may be clearly shown. But while such teaching may provide an understanding as perfect as a map, the understanding tends to be as superficial as a map. It develops no thought structure in the student reaching into the central core. The student learning equation after equation, formula after formula, has little time to think, "How did that formula get that way ? How should it be adapted to this situation by going back to deeper levels for reconstruction ?"

Yet teachers who seek to teach the ever-increasing mass of technical knowledge in a more solid way find themselves in the position of the ancient Chinese when they were trying to carry bigger and bigger loads over sand with solid wheels. They had to have bigger and bigger wheels until the wheels got so big they couldn't draw them. Then somebody invented the hub and spoke, and that not only cut the weight way down but strengthened the wheel.

The spoked wheel of knowledge is likewise better in every way and the connection of the periphery with the core is much more clearly defined. Thus the very mass of technical knowledge should urge us to teach well, not badly. For while it is true that it is hopeless to try to teach a student all he ought to know, it is equally true that it is undesirable to do so. What is important to teach a student is how to discover and use what he needs to know when he is faced in later life with concrete problems, and how to learn from his experience. He should be taught those spokes that he needs to get from the hub of basic science to the rim of concrete experience; and having them and the art of using them he can meet the problems of life as they come and learn the lessons of life as they go. Taught in this way, he will start out equipped to *become* a professional man, instead of leaving college well encased in frames of reference and formulas which will tend to shelter him from further learning. He will not be completely informed but he will have acquired the elements of the art of learning from experience that will enable him gradually to move ahead of the routine of his field and reach professional stature.

In this age, such instruction is peculiarly important. For due to engineering invention, students when they graduate enter an institutional world where it is difficult to get free from regimentation. In large companies the young graduate must usually fit into institutional routines, and this means in most instances that only routine problems will reach him for years. Hence unless young engineers have been equipped with a sturdy capacity for basic originality before they get into industrial institutions, it is difficult indeed for them to survive the inevitable institutional treadmills and to rise above routine competency to professional skill.

The pressure for time to teach the mass of technical proficiencies has not only tended to overcrowd with surface instruction the hours of technical study, but it has also tended to squeeze out of the curriculum all else, including those things that equip a man to stand on his own feet among men and in his community. Yet a merely technical man, no matter how proficient, is a fragile and vulnerable person in the world to-day.

Some of you, I know, have seen Barrie's play, "The Admirable Crichton." In it a British lord, who handled himself with great distinction within the narrow boundaries of his own social group, was shipwrecked on a desert island. There he had to come in contact with realities other than those to which his social status had hitherto exposed him. In a little while he became a slave of his butler, who was better equipped to meet the cruder necessities of island life.

Technical graduates *if narrowly taught* run the risks of the lord in that play. When such technicians leave the sheltering environment of their laboratories or drafting rooms, they are in danger of finding that their personalities have been over-narrowed by an exclusively technical education. When they progress to a level in their careers where leadership calls for power to deal with men, or when they encounter the social problems so largely caused by the progress of their own technology, they are likely to find that they lack competency.

Such competency is not something that can be easily acquired after professional education is over. When my son hurt his knee and was in bed for a period of time, I was astonished at how much attention the doctors gave to insuring that the injured leg was exercised, "because," they said, "if the leg isn't exercised it will atrophy and will not grow as it should, and once it gets behind the rest of his body in growth, there will be no way we can restore it to proper length." In the same way during the period of professional growth exclusive emphasis on technology may cause other parts of the personality to atrophy possibly beyond repair.

What is essential in this respect is the development of the student as a cultivated and competent engineer and citizen —as one who adds to strictly technical powers a capacity to take his place professionally as a leader of men and as a wholesome member of his community. Just to give him courses in English literature, English composition, economics or industrial relations, even if we can provide time in the curriculum without overcrowding it, does not necessarily do this. Usually the student patiently submits to such courses and then sloughs them off. A few students may carry them through life as appendages. In their vertebral development, however, although the vestiges of these courses may remain as living tissue, they remain tumors unassimilated in the organism. Or to use President Doherty's concept of education as a tree with many stems, they are like mistletoe, sometimes attractive parasites, but neither a part of the trunk nor one of the limbs of the student's professional development.

This is most likely to occur when the social sciences and the humanities are not taught as an integral part of the student's professional education. Hence a final fundamental of professional education is that its broadening elements should be integral, not external—that students should be developed in human and social power, not by "side courses," but by ways of study that interpenetrate their technical professional development. And, as other speakers on this program will demonstrate, this can be done and done with true benefit to sound technical education.

The task of professional education, then, is fundamentally to develop power to learn and to solve, not to provide fullness of information and of technical tools. It is a problem, not of informing, but of providing development through disciplined activity that is raised above regimentation. It involves the selection of significant subject matter through which to give this disciplined exercise—and in this respect the use of subject matter relating to man and to society is important. But far more important than subject matter is the character of the teacher and of his teaching.

Good teaching can combine discipline with fundamental originality. It can face the student with a genuine perplexity that causes him to escape from stereotypes and to break through routine to fundamental thought. It can cause methods as well as data to cease to be inert; to become flesh and dwell within the student; to be material which he uses and remolds under a vigorous, trained and flexible style that is truly his own. It can make his professional style so fundamental that it strengthens his power in every field, not merely in that of his university study. It can give him confidence to meet the perplexities of this world unabashed as a citizen as well as an engineer. In a word, professional education, by its teachers and by its teaching, should develop capacity for fundamental originality in learning from experience and in meeting the problems that life brings. How fully this can be done by engineering education has been richly shown by great engineering teachers and great engineers.

OUR CITIES—THEIR ROLE IN THE NATIONAL ECONOMY

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Of all our national resources—natural and manmade—the most important, and the one in terms of which all the others have to be judged, is human life. The safety, welfare and happiness of the men, women, and children who compose the Canadian people constitute the only justification of government. They are the end for which all our resources—land, water, minerals, forests, animals, technology, institutions and laws—are merely instruments.

The manner of life of our people, the problems they face, and the hopes and desires they cherish for improvement in their existence and the advance of their civilization should be the supreme concern of government.

Even since Confederation, three quarters of a century ago,—one man's lifetime—the mode of life, the problems and the aims of our people have undergone many significant changes. Of these, probably none is more important than the transition from a crude and simple handicraft economy to an advanced type of modern industrialism, and from a rural to a predominantly urban mode of living.

Urban Canada in 1867

When the Dominion of Canada embarked upon its career as a confederation of provinces within the British Commonwealth, the cities of Vancouver, Calgary, Edmonton, Regina, Saskatoon, Verdun, Sydney, Fort William, Moose Jaw, and a host of others were either idle prairie plains or undeveloped farm lands. The City of Winnipeg was an outpost of the Hudson's Bay Company (Fort Garry), with a population of 241, and Moncton was a hamlet of some 600 souls. There were only three cities with a population of over 50,000; Montreal having 130,833, Quebec 59,699, and Toronto 59,000. Uniform currency had not yet been established and the trans-continental railroad was still but an idle dream.

Municipal services were few and comparatively inexpensive. It was the day of wooden sidewalks and dirt roads, of oil-lit street lamps and volunteer fire brigades. Sewage and water systems were crude or undeveloped, and garbage was burnt in the back yards. Secondary schools were still in the future, while primary schools were concerned largely with the simple teaching of the three R's. Civic libraries, municipal hospitals and supervised playgrounds were non-existent.

The limited services which municipalities rendered were almost wholly related to the servicing of land and buildings. As such, they were of tangible benefit to the land owner. Custom had it that every good citizen owned his own home, no matter how humble it might be.

Further, the ownership of property was the principal evidence of wealth. Investment in business enterprises, either direct or through the medium of the stock exchange, was of a limited nature and confined to but a fraction of the population. Moreover, urban land values were experiencing a boom period. Land and property was a "safe" investment, because taxes and building costs were low enough to permit a fair return, with the added prospect that the real estate buyer could expect, in those expanding days, to find his property materially increasing in value.

The 74 years that have elapsed since Confederation have witnessed a transformation in the urban scene.

During this period, thousands of new towns and cities have emerged. In 1867, Canada was an overwhelmingly rural domain. By 1891, out of every thousand persons in the community, 682 were resident in rural communities; 318 in urban centres. By 1921, the population was approximately evenly divided between rural and urban, there being 505 in rural and 495 in urban communities out of every 1000. But by 1931, urban Canada had leaped forward, 463 being rural and 537 being urban out of each 1000 population. In the decade 1921-31, urban communities had absorbed nearly 77 per cent of the total increase in population, with the result that the urban population by 1931, had exceeded the rural by 667,330. In the decade since 1931, the trek to the cities has continued without interruption and probably at an accelerated pace. The industrial boom which is accompanying the war period will undoubtedly bring about great and probably permanent shifts in population, a good deal of which will be from the rural areas to urban centres.

This shift of the population to urban areas carries with it a fundamental change in the occupational structure of the nation, as is evidenced by the fact that in 1891, 51.2 per cent of Canadian workers were gainfully employed in agriculture, while in 1931, the percentage had fallen to 34. This suggests that in less than half a century, to be exact 40 years, our country has profoundly altered its mode of life during which it has been transformed from a rural frontier settlement into a full-fledged urban industrial society.

This development is not peculiar to Canada, for it characterizes the development of the United States and is also symptomatic of other countries of the world, especially those of western Europe that have been touched by the machine technology, and consequently have undergone similar changes. But while the old world grew by degrees over a period of many centuries from a town economy into its present urban cast, Canada started as a wilderness on the outskirts of civilization and took the leap from primitive primary pursuits associated with its land, forests and streams, and in the matter of a few decades, has blossomed into a mature urban industrial economy.

The figures on the extent and rapidity of urbanization in Canada, dramatic as they are, fail to convey the full significance of what the rise of cities has done to our civilization. The crowding of an increasing number and proportion of our people into relatively restricted areas has meant for them a revolution both in the way of living and in the ways of making a living, and has in turn been reflected in the changed character of our national life. Part of this change is conditioned by the fact that ever larger aggregates of population and ever widening areas are being brought within the orbit of a central dominant city. The recent experience of the five leading cities of the Dominion will exemplify this trend. Between 1921 and 1931, Canada's population grew 18 per cent whereas that of Greater Vancouver increased by 50 per cent, Greater Montreal by 39 per cent, the Hamilton area by 36 per cent, Greater Toronto by 31 per cent and Greater Winnipeg by 28 per cent. By 1931, these five urban areas embraced over 23 per cent of the Dominion total. More than ten per cent of the total population of the Dominion is now concentrated in the Montreal metropolitan area, an area of approximately 50 square miles.

Causes of Urban Development

steam

The growth of cities since about the beginning of the 19th century is primarily attributable to the scientific discoveries and mechanical inventions which facilitated the development of power-driven machinery. Of these revolutionizing innovations none was probably more fundamental than the application of steam as a source of power for industry and transportation to supplement and replace the previously available sources of power, especially water. Prior to the steam era, few cities exceeded 100,000 and it is doubtful whether any city, even such renowned centres as Rome, Peking or Nanking, ever exceeded one million in population. Not until the great economic and social changes that we identify as the Industrial Revolution had been set in motion did the modern great city become possible. The emergence of the great city, however, itself in turn became a major force in revolutionizing man's existence.

Steam not only made possible a vast increase in man's potential means of subsistence and, consequently, in his numbers, but, indirectly, by releasing a rapidly increasing proportion of the population from the actual tilling of the soil, it became an overwhelming force in the cityward migration and played a major role in determining the internal structure of the city and of the economic organization of which it became the nucleus. In the pre-steam era, because of the crude, inefficient, and expensive means of transportation which man had at his disposal, the provisioning of large cities was difficult, as was the supplying of raw materials and the distribution of finished products over a wide area. Consequently most manufacturing was local.

Apart from the military necessity of concentrating the largest number of inhabitants and structures within the smallest possible walled area, the city before the age of steam had no need for marked concentration into a "downtown" or central—business district, which is a distinguishing mark of the modern city. Steam has operated as a concentrative force through its direct use as power. Since steam is most cheaply produced in large quantities and must be used close to where it is produced, from which point the power it generates can be extended only over limited distances by means of shafting, belts and pulleys, it fostered the concentration of manufacturing processes and large units of production. But since it could not be used economically for local transportation, its use as power in manufacturing tended also to concentrate managerial and wholesale distributing activities and, above all, population near the factory. Moreover, the great economies in long-distance transportation, which steam made possible, further accentuated the concentration of industry and population into large urban centres, which because of their favourable situation from the standpoint of production and markets, continued to attract ever more industries, commerce, and population. The large, densely built up and rapidly growing city with a single centre where transportation lines and hence traffic converge, derives its principal structural features in large measure from the centripetal influence of steam.

ELECTRIC POWER AND THE GASOLINE ENGINE

All the while that steam was moulding the pattern of urbanization, two other forces were converging upon the scene. Whereas steam has had a concentrative effect, electricity and the internal combustion engine, which became available after the pattern of most Canadian cities had already become fixed, have tended to have precisely the opposite effect. The dispersive influence of electricity is due to the fact that it can be transmitted economically even now over distances up to about 300 miles, and that it can be used as power with almost equal efficiency in large or small units. It also has decided advantages over steam for rapid local transportation. It has at least the potentiality of exercising a centrifugal influence upon cities as contrasted with the centripetal force exerted by steam. Up to the present, however, electricity through its use as power for the fast electric elevator and for urban and suburban transit, has mainly accentuated concentration as in the skyscraper and in the overdeveloped, congested, central business district.

In addition to its use as power, electricity, as distinguished from steam, has a quality which has to be reckoned with as a reconstructive element in urban life, the urban structure and our entire social order, namely its use in communication. This use in the form of the telegraph, the telephone, and the radio has only recently been felt and appreciated. It gives promise of having at least as great an influence in reshaping our cities and our civilization during the twentieth century as steam did during the nineteenth.

If to the influences of electricity we add the flexibility, the speed and the individualization of transportation effected by the internal combustion engine as embodied in the automobile and the airplane, we may say that these new technological devices are likely to alter the structure of the urban community and national life profoundly, whether or not we consciously use them as instruments to improve our mode of living.

One further factor which should not be lost sight of in understanding how the 19th and 20th century city civilization came to be, is the contribution of modern methods of sanitation. Life for large masses of people removed from and yet closely dependent upon a constant supply of water, food, fuel, and raw materials is in itself conditioned by a high degree of technological development and the perfection of administrative organization. But the task of conquering the hazards of life among a vast congested population, such as inhabits a great city, in the face of disease, can be appreciated better if we consider that before the advent of modern sanitation the deaths in cities of the western world regularly exceeded the births by a considerable margin. If, in addition, we recall that the population of the western countries was frequently afflicted by epidemics that swept away a large portion of their inhabitants and that this is still in a measure true of backward countries, we can realize the significance of modern sanitation for urban existence. The ample provision of pure water, the perfection of centralized sewerage and waste disposal systems, the insurance of a safe food supply, including dairy products, and the prevention and control of contagious diseases are the chief measures that for more than a century have made it possible for western cities to maintain population by lowering the death rate.

Having considered the principal preconditions for urbanization, we may now turn to examine some of the factors that are shaping this process to-day. In doing so, we shall discern certain trends that may considerably influence the city of to-morrow.

As we have previously indicated, the outstanding factor in the urbanization of Canada is the speed with which it has progressed and is still progressing. Within a single generation Canada has been transformed from a primarily rural to a primarily urban domain.

In 1867, Canadians were best characterized as a rural people; and their pursuits were associated with the primary industries. In 1941, Canadians are best characterized as urban dwellers with little prospect of any major shift countrywards.

Cities as Centres of Industry

But the city is not merely the characteristic place of residence, it is also the workshop of the nation. It is in the cities where the major portion of our industrial plants are located, and these, in turn are for the most part highly concentrated in relatively few centres.

In recent years, certain shifts in industrial location have occurred. This may indicate a trend likely to have increasing significance. The long run effect may have the result of reshaping the pattern of our industrial urban civilization.

So far, this movement has been largely confined to certain small scale industries which have tended to locate in peripheral areas contiguous to large cities. Large scale industry with large capital investments in huge and complex plants, and requiring concentrated pools of labour, has shown little or no tendency to follow. This so-called "decentralization of industry" has been a spreading out into the suburban and adjoining territories of large cities, rather than a movement from the city to the country. It is a phenomenon which characterizes every large city on the continent; and although it has given grounds for local concern, its long time economic effect is likely to be more beneficial than harmful. It should have the effect of creating a better economic balance between the large city and its surrounding countryside and in other ways establish a more functional relationship between the urban and rural population.

Industries locating or re-locating in the suburban and satellite zones of great cities have done so to gain competitive advantages derivable from such factors as lessened transport time and cost, freedom from the restraints of "big city" control, cheaper labour costs and decreased labour turn-over, and lower land values and taxes. These advantages to the industry are frequently ephemeral and sometimes are offset by the disadvantages accruing to the community itself. Moreover, the gains of the peripheral area are sometimes a loss to the central city, especially if they are politically separated, because the central city may continue to render certain public services incident to the industry without receiving proportionate tax revenue.

While there are sound economic reasons for the location of certain types of industries in the peripheral areas of metropolitan centres, or in one industrial area as against another, too frequently the decision to locate is based upon other than economic grounds. In the past, publicity campaigns, special grants and subsidies, including sometimes free sites and free plants, credits, and exemption from or special consideration in respect to taxation, have been employed to attract industries and to lead them to ignore more advantageous locations elsewhere. Such inducements as these have been offered by cities and, especially, small towns without even a guarantee from industry to maintain minimum labour standards, in the attempt to gain advantages by artificial means which they do not possess by nature. Unless communities can be persuaded to pursue sounder principles of industrial planning, large sums will be wasted on the private and community plant in the attempt to expand or strengthen the physical base of the community beyond reasonable and economic justification. This will, in the long run, saddle these communities with debt and an unbalanced and unstable industrial structure. Community industrial unbalancing operates in a vicious cycle. The weak industries of the community constantly become weaker and this, in turn, discourages new industry which might otherwise locate there.

In recent years, the use by communities of such incentives to industries as credits, tax exemption and free land has declined, although the depression for a time revived the practice. On the whole, it does not appear that such attempts to attract industries have been very successful. Of late, more attention has been given to the problem of industrial articulation. There seems to be less of a tendency on the part of both communities and industries to accept surface indications as satisfactory reasons for locations. Only scientifically sound, long-range planning can lead toward a more economical and stable national pattern of industry and prevent and mitigate the evils of substandard, mushroom community structures based upon short-sighted and potentially socially disastrous perspectives.

Cities as Commercial and Service Centres

The rapid growth of cities, particularly the larger metropolitan areas, is traceable in part to the increasing concentration within them of commercial and service activities. As industrial production has grown in volume and diversification so have the related commercial and service functions associated with its development. There are probably just as many so-called white-collar jobs in the large city, as there are jobs in industry. In the very large metropolitan cities such as New York and Chicago, clerical and other white-collar employment exceeds that of industrial labour. This is a further shift in occupational emphasis and is bound to have an influence on the pattern of urban growth, design and development. With industry and business entering more and more into mass production and mass distribution techniques, there will be a relatively larger need for persons engaged in managerial, service and clerical functions. The range of occupations, of incomes, and consequently of standards of living tends to increase with the size of the city, so that the city becomes both a product and a cause of the division of labour.

Types of Cities

Similarly, individual cities themselves acquire a specialized role in the national economy. They become differentiated partly by such characteristics as access to suitable resources, transportation facilities and labour supply. In addition to these natural and technological factors, cities in the course of time become distinguishable from one another also because of the initiative and foresight of aggressive business leaders and of the advantages derived from an auspicious start, which are cumulatively enhanced by tradition and reputation so that certain cities acquire a prestige and renown for the production of certain goods. Such factors will in the course of time shape the industrial contour of the community. Furthermore, certain industries can exist advantageously only when others upon which they depend are already established. Some cities, therefore, developed a highly specialized economic base, while others, offering more general locational advantages, attract a variety of industries and thus become more balanced economic entities.

The functional differentiation of cities, moreover, proceeds not merely on the basis of industrial specialization but is conditioned also by the commercial, governmental and social roles which cities assume. Thus we have developed some cities in Canada whose economic base rests primarily upon the extraction of natural resources from the immediate or nearby sites. Mining cities, oil cities, fishing cities and lumber cities are familiar examples of specialized urban communities. Others derive their specialized industrial character from the presence of less localized advantages. The selection of one Canadian city as a site for a steel producing centre proved eminently satisfactory despite the absence of either coal or iron ore in the immediate territory, because of the economical accessibility of the raw materials for steel manufacture derived from its position intermediate between coal fields and ore fields, combined with proximity to a good market and a source of labour and power. Again, one western city has arisen primarily on an economic basis as a transportation focus and transshipment centre, just as others have centred around a port. Still other cities are predominently commercial, others are educational centres, governmental centres or resorts. Moreover, cities that were once expanding and prosperous communities have changed their primary function in the course of time; or declined either because of the exhaustion of nearby resources, the development elsewhere of a new industry which made a prior one obsolete, the perfection of transportation facilities, changes in the rate structure, or the rise of a rival city with special advantages. Many communities have become chronically substandard as a consequence of such changes which have deprived them of their economic base.

What has been said so far by no means exhausts the factors which have contributed towards the significant role which our cities play in the national economy. But neither the time nor the occasion permits a complete picture of the forces which have been at work in the building up of our modern city civilization. The factors mentioned have been chosen merely as a background from which to approach the other aspect of this paper, which has to do with a consideration of some of the problems which the too-rapid growth of our cities have created.

Let us therefore sketch the typical features of the environment in which the modern city-dweller lives, and from which he has acquired his distinctive traits of personality and behaviour. Much as the rural and the urban ways of life may tend to approximate each other, the rural landscape and the urban landscape, from whatever angle they may be viewed, are visibly distinct. The view one gets of the cities depends of course upon the position of the observer. No city of any size can be envisaged as a whole, except from some distance of elevation, and while the topography, the size, and type of city will make a marked difference in the impression it creates, the average urban panorama has a number of general points of uniformity.

The City Viewed from the Air

If the observer views it from an aeroplane, the typical Canadian city will appear as a sprawling mass of structures of varying size, shape and construction, criss-crossed by a checkerboard street pattern which here and there assumes irregularities. The cells, or blocks, into which the city is divided seem to lack any organic grouping into units. The general impression to be derived from the arrangement is that of unimaginative, stereotyped, mechanical monotony. Only rarely will one find even a partially organic pattern throughout. Upon closer inspection it will appear that portions of the area are devoid of structures, and consist of green open spaces, or parks. Other vacant space will turn out to be public squares, railroad yards, or merely unutilized land areas of varying shapes and sizes. The observer will note that the rectangles or other shapes that make up the horizontal pattern of the city are generally built up around the edges and are a hollow in the middle, indicating that the structures line up along the streets.

More intensive examination of the city of medium or large size will show that the city is more densely built up at the core where, even if it is only a few square miles in area, one or more tall structures will loom up grotesquely, marking the location of the central business district. If the city is large the number of these sky-scrapers will be correspondingly multiplied, and they will re-appear irregularly at places somewhat distant from the city centre, indicating the location of sub-centres. The central business district will flatten out abruptly toward the edges, where the city's light manufacturing and warehouse areas may be recognized, interspersed by ramshackle structures constituting the blighted areas and slums. Adjacent to this belt are to be found the tenants' and working-men's homes, and beyond are the more densely-built apartment-house sections, tapering off rather unsymmetrically, and stretching finger-like along the main traffic streets into areas of single homes, with small gardens and open spaces. Along these radials that follow the main transportation lines, and, like a web between them, will cluster other less intensively built-up settlements. The city will thus approximate a circular, or semi-circular pattern, at the edges of which tentacles will protrude, tending to stretch the circle into a star-shaped outline. The symmetry of the total configuration is sometimes warped by water-fronts, rivers, elevations and depressions in the topography, and by the proximity of other cities.

Beyond the built-up parts of the city, there are to be found great open spaces, on which the occasional structures reveal the location of truck farms, nurseries and gardens, country clubs, and abandoned or unsuccessful subdivisions, marked by pavements and sidewalks and other improvements, but showing no, or only a few, scattered buildings. At the most favourable sites, partly obscured by woods, nestle imposing mansions, with large fenced-in grounds, resembling the feudal estates of the European countryside. At intervals along the railroad lines and through-highways, often as uninterrupted extensions of the city proper, more densely-settled areas are distributed. These are the suburbs and satellite towns. Some of these immature cities will be clearly recognizable as industrial sites, and others, but for the abundance of yards and trees and absence of building concentration, might be mistaken for residential sections of the city itself.

A Lateral View of the City

Another perspective of the outlines of the Canadian city, its profile, may be obtained by viewing it from a distance. This vertical, cross-sectional view makes the intense development of the centre seem even more grotesque, and reveals how really precipitous is the drop from the towering peaks of the sky-scrapers, which mark the business centre, to the encircling belt of much lower, often obsolescent and decaying building. The taller the sky-scrapers at the centre, the more abrupt, it seems, is the decline to the building height of the surrounding area. Apparently in a small city, a single sky-scraper can, so to speak, suck up all or most of the demand for office space, and create a vacuum of blight all around. The more imposing the sky-scrapers at the centre, the wider is the area over which they exert a blighting and depressing influence. This is reflected in actual physical deterioration, in accelerated obsolescence, vacant building sites, and in decaying commercial areas and residential slums.

The Inner View of the City

Quite another set of pictures of the urban scene is revealed to the observer, who views it from the inside, whether he is a traveller, getting a glimpse of it as he enters it by boat, railroad or automobile, or views its structures from the streets. Most American and Canadian cities have a façade which often turns out to be a false front. They are adorned at the centre as if for public display. But behind this front are hidden the shambles, the slums, and the scenes of decay, filth and disorder. To the visitor, especially if he is accustomed to wide expanses of fields, meadows and woods, the stone, brick, concrete, steel and glass out of which the physical city is built, must appear as very unnatural. In the heart of the city, huge boxlike buildings rise abruptly on both sides of the street, forming canyons that shut out light and air. Buildings of assorted design, size and structure are huddled together, wall on wall, without following any perceivable pattern of arrangement, except that outlined by the narrow strips of land that are the streets. The smoke, the grime and the din, the maddening tempo of movement of men, and vehicles, the surge of crowds, especially when the city centre fills and empties in the course of the daily pendular movement of its people—all these appear to the uninitiated as a fantastic, meaningless, and buzzing confusion. Aside from the scenes that meet the eye on the surface, there is the city underground, its sewers, water mains, light, gas and telephone lines; its basements, tunnels and subways.

Land Use Pattern

It is in the centre of the city that most of the white-collar inhabitants work. Here are the government administrative buildings, the offices of commercial and industrial firms, and of the professional and technical services; the department stores and specialty shops; the transient hotels and restaurants and theatres. In fact, here centre all those activities that transcend the neighbourhood and function for the city and its region as a whole. Here, land values are high, and real estate is sold by the square foot at fantastic prices.

Beyond the city centre are wholesale houses and warehouses, railroad yards, freight and passenger terminals, junk yards, and light manufacturing establishments, interspersed with dilapidated residences, roominghouses and tenements. This area, which contains the slums, is the forgotten section of most of our cities. Inquiry will disclose that much of the land of the area is in the hands of absentee owners, who hold it for speculative reasons, hoping that as the city grows the business district will expand, and that their land will be at a premium. Consequently, land values are inflated, but rents, in comparison, are low. Buildings are crowded and in disrepair, and sanitary facilities are inadequate or utterly lacking. The people who must live in them are deprived of the minimum requisites of healthful and decent housing.

At its periphery this area merges with the zone of workingmen's homes which, though they command relatively low rent, are in one degree of better repair than the slums. This area in turn shades into the middle-class apartment-house area, with its own local business centre. The residents of this section of the city have a higher level of income, pay higher rent, and command better facilities than those nearer the centre. The last zone of the city proper is the single family residence area, where land normally is considerably cheaper, and where consequently more spacious individual family dwellings, with garages, yards, small gardens and larger open spaces can be bought or rented. Beyond this area is the suburban zone with scattered estates, golf courses, residential communities and industrial areas, interspersed with truck gardens, farm lands, and embryonic residential subdivisions.

As the city grows, it empties its population at the centre, and these successive zones of land utilization are progressively pushed outward. In this way, one zone eats its way into the next, and in the process of conversion from one type of land use to another, considerable junking takes place. Thus the city has an internal structure and a typical cycle of growth which are significantly conditioned by the existing rights of ownership and speculation in land, and by the competitive economic regime of our society.

This, then, is the broad nature of the physical pattern of the typical Canadian city. The statement was made at the beginning of this paper that the most important factor in our national life is not our national resources, nor our man-made physical environment. The important thing, and the one in terms of which all others have to be judged, is human life. They are the end for which all these resources are merely instruments. Let us again repeat that the manner of life of our people, the problems they face, and the hopes and desires they cherish for the improvement in their existence, and the advance of their civilization, should be our single and supreme concern. Let us for a moment, therefore, and in conclusion take a look at the kind of persons, their types and characteristics, which our city civilization seems to have produced.

The mobility of the city dweller, the range, the superficiality, the anonymity, and the segmental character of his contact, account in part for his freedom from tradition, and for the rationality of his outlook. In the competition of the city, the status of a man is determined more by what he can do, or what he owns, than by his blood, or ancesters. The city man typically moves in and is a transitory part of a multitude of social groups, and is not permanently attached to anyone of them. His loyalties are thus more fickle, and he is inclined to greater tolerance, which he sorely needs in order to live among fellow-citizens who are so different from himself in heritage, interest, belief and character. Moreover, the city man is typically out for himself; he is a member of a large, rather than small, group, and associated with others for the pursuit of a common interest rather than because of sentimental ties. His relations with his fellow men, therefore, tend to be formal, rather than intimate, and he is inclined to use other men as instruments to gain his own end, rather than to regard them as ends in themselves. This may aid in accounting for what may appear to the country man as an abnormal and mercenary type of human relationship in the city.

Cities have traditionally been regarded as the home of inventions, and revolutions. They secularize the sacred beliefs, practices and institutions. They democratize knowledge, fashions and tastes, and consequently generate wants and stimulate unrest. The urban mode of life tends to create solitary souls, to uproot the individual from his customs, to confront him with a social void, and to weaken traditional restraints on personal conduct. This may aid in understanding both the achievement and the disorder characteristic of cities. The grandeur of the city is capable of stirring men's souls, and rousing their imagination. It is not merely the magnificent size of the structures, the hum of the traffic, the display of cultural wealth, side by side with the most abject poverty and degradation, but it is also the imposing demonstration of human ingenuity, the sense of personal emancipation, amidst a many-sided cultural life that stirs the city man to thought and action and gives urban existence a zest. In modern civilization, it is the city that becomes the scene where the ultimate struggle between contending forces is waged and decided.

Personal existence and social solidarity in the urban community appear to hang by a slender thread. The tenuous relations between men, based for the most part upon a pecuniary bond, make urban existence seem very fragile and capable of being disturbed by a multitude of forces over which the individual has little or no control. This may lead some to evince the most fruitful ingenuity and heroic courage, while it overpowers others with a paralyzing sense of individual helplessness and despair. The oscillation of the city man between the most extreme individual and the most concerted type of collective action with his fellow men arises out of the conflicting forces that impinge upon him. But it is precisely because of the tenuous basis of his existence that the city man is inclined to have a sense of his own interdependence with others, to have a cosmopolitan outlook, and to unite with others near and far in the pursuit of similar if not common ends.

The city dweller is not happy in his habitat. Many of them, having failed to find a satisfactory life in the city, often generate a nostalgic longing for more natural ways of living and seek a refuge in the country. Because the city has become indispensable to civilized existence, but at the same time subjects man to so many frustrations of his deepest longings, the notion of an ideal mode of life lying somewhere between these two extremes, has been a force ever since the cities have been in existence. In recent times this ideal has expressed itself in varying moods. They embody an effort to find a balance between agriculture and industry, between the open, natural landscape and the congestion of the city. Model suburbs, garden cities, greenbelts, and suburban homesteads represent different variations of this movement, and the promoters of large-scale decentralization of industry have also found argument for their programme in the attempt to combine the advantages of urban and rural life in the same community.

If conscious social effort may be assumed to play a significant role in shaping the conditions under which man lives, then the present crisis is really an opportunity calling for a prompt examination of the alternative modes of life that we might follow, or at least move in the direction of, in the post-war years. If rural life, or living in communities of small size is either wholly or in certain respects more desirable than living in small or large cities, the evidence to that effect is yet still a matter of opinion. It may well be that the future of our civilization will in large measure depend, not upon man's ability to escape from the city, but upon his ability to master and use the forces that move and control it. It is doubtful whether, without the city, we can hope to enjoy the plane of living that contemporary civilization so far has made possible. The central problem of national life in regard to cities is a problem of creating those conditions that are required to make cities livable for human beings in a machine age.

Abstracts of Current Literature

Abstracts of articles appearing in the current technical periodicals

NEW U.S. MEDIUM TANK M3

By Lieut.-Col. J. K. Christmas, Ordnance Department, U.S.

Abstracted from *Army Ordnance* (Washington) July-August, 1941

Prior to the outbreak of the war in Europe, the Ordnance Department had developed a medium tank (M2) of approximately eighteen tons' weight and had delivered a small number of these to the Infantry at Fort Benning, Ga., which was then charged with the operation of such tanks. An improved type of medium tank M2, known as the M2A1 was then developed. This type had a little heavier armor and weighed approximately twenty tons. A number of tanks of this type were manufactured by Rock Island Arsenal; some of these are now in the hands of troops, others are still under manufacture.

Early in 1939, a project was originated by the Ordnance Department to mount in the medium tank M2 a 75-mm. howitzer in addition to the turret-mounted high-velocity 37-mm. gun and caliber .30 machine guns used in the medium tanks of the M2 series. The object of mounting the 75-mm. howitzer was to add to the tank a weapon capable of firing high-explosive shell, shrapnel, and smoke shell, in order that the medium tank might furnish direct light artillery support for tank and other mechanized units and in order that the medium tanks might take full advantage of the many outstanding qualities of light artillery fire, not only against personnel but against many classes of unarmored material targets.

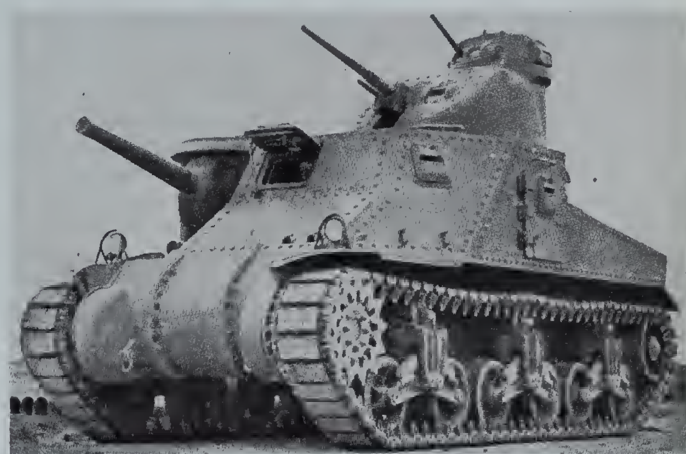
This project was completed in the winter of 1939 at Aberdeen Proving Ground, Md. The tests, both at the proving ground and by the Infantry Board at Fort Benning, were so successful that recommendations were submitted by the proving ground in the early part of 1940 that all medium tanks to be manufactured or completed thereafter should be fitted with a 75-mm. weapon, mounted for fire generally to the front, in addition to the 37-mm. high-velocity armor-piercing gun mounted in the turret for all-around fire. This project was not immediately acted upon. However, when the Congress in the spring and summer of 1940 made available funds for the manufacture of a large additional quantity of medium tanks, and when the lessons of the war in Europe were more and more being brought to our attention, the importance of this project soon was realized together with the great importance of tanks generally. Valuable information and advice were obtained particularly from Great Britain, birthplace of the tank in 1915. It was decided to apply the principle of mounting a cannon of 75-mm. caliber to any new medium tanks to be manufactured.

In the summer of 1940, the War Department reorganized our mechanized cavalry and our infantry tank units into an Armored Force, with the result that the tactics and equipment requirements of our mechanized units were placed in somewhat different hands and some new desired tactical characteristics were added to the armored fighting vehicles to be used by the Armored Force. The fighting tank had somewhat belatedly come of age and at last had been recognized in the military family!

The design of the medium tank M3 was started in September, 1940, and completed the first day of March, 1941. Experienced tank drafting personnel were lent to Aberdeen Proving Ground from Rock Island Arsenal for this redesign.

In the design and development of the medium tank M3 at Aberdeen, the following procedure was, in general, employed. General layouts first were made of the major components and assemblies involved. These layouts then were roughly reduced to full-scale wooden models, which usually led to some revision of the design in the interest of better functioning, strength, or convenience in use. As a result of study of the preliminary wooden mock-ups, the layouts were revised and a more careful and more detailed full-scale wooden mock-up or model again made, this time for greater attention to details.

From the revised layouts, detailed working drawings were made, and from these drawings full-scale actual metal components were manufactured, just as required in the production tank, and were fully tested to determine that they were satisfactory in every way. When this test had been made, the detailed working drawings were given a final check and issued to the various manufacturers. In order to expedite the work, the manufacturers, (that is, the prime contractors who were to manufacture the medium tank)



The medium tank M3 mounts a 75mm cannon, a 37mm gun, and two machine guns

were furnished preliminary prints so that they might plan their shops, order the necessary machine tools and materials, and in general set up their manufacturing facilities.

During the process of development, the various prime tank manufacturers, as well as the manufacturers of the principal components commercial units and accessories, had engineers almost constantly at the proving ground. This practice had the advantage of acquainting the manufacturers with what they were required to make and of acquainting the Ordnance Department with the very latest in manufacturing processes, in engineering development, and in commercial components available for incorporation in the new tank. The advice of experts was thus obtained on the hundreds of special engineering problems involved in the manufacture of this tank.

It should be understood that the design of an armored fighting vehicle, such as the medium tank M3, can in no case be called the work of one man, or even of a few men. Like the airplane or the naval vessel, the fighting tank incorporates within itself a very large proportion of the best technical advancements available in science and industry. Our automotive, steel, rubber, and electrical industries all have contributed to its development. Valuable assistance also was obtained from those activities of the Ordnance Department concerned with fire-control instruments and cannon. Close co-operation was maintained with the Signal Corps with respect to radio equipment and with the Armored Force which is to use the tank for the serious business of defending America. Co-operation with the latter was carried on particularly through a resident representative of the Armored Force at Aberdeen.

Some idea of the work involved in developing and designing this new medium tank may be gathered from the fact that a tank in its entirety contains approximately 25,000 separate parts, covered by nearly 6,000 drawings. Some of these drawings are of commercial origin as in the case of the instruments, engine, generator, and batteries. Owing to the number of contractors, subcontractors, and agencies of the Ordnance Department involved in the manufacture of this tank, it was necessary to distribute from Aberdeen Proving Ground between October, 1940, and March, 1941, some 75,000 prints, as well as thousands of letters and specifications concerning design and manufacture. Formal and close co-operation among all concerned was further maintained by frequent meetings of our Tank Committee, usually at Aberdeen. At these meetings, the drawings and model components were explained and discussed fully and frankly. On this committee were represented the office of the Chief of Ordnance, Aberdeen Proving Ground, the tank manufacturers, the principal subcontractors, and the Ordnance districts responsible for inspection.

The pilot medium tank M3 was built as follows: Rock Island Arsenal manufactured what may be referred to as the chassis; that is, the tank less the turret assembly. The cannon was manufactured at Watervliet Arsenal, the sights at Frankford Arsenal, the turret assembly at Aberdeen Proving Ground. The pilot was completed in March and was formally demonstrated in manoeuvres and firing before the Chief of Ordnance, officials from his office, from the Office of Production Management, and representatives of the tank manufacturers and subcontractors at Aberdeen Proving Ground on April 4, 1941.

A few weeks later, the American Locomotive Company, the Baldwin Locomotive Company, and the Chrysler Corporation each formally delivered to the Chief of Ordnance or his representatives the first production models of the medium tank, M3, thereby initiating the quantity production of this important vehicle which is the backbone of our Armored Force. It may be fairly said here that while this tank incorporates to the fullest extent the latest lessons learned from the war in Europe, it is fully an American concept and an American accomplishment. It is a relatively high-speed, manoeuvreable tank with great fire power, fitting the American policy of aggressive mobile warfare. It represents, I believe, the best integrated experience, ability, and intelligence of American industry and the American Army. By dint of hard, high-pressure, expedited work, this tank was designed and developed in a remarkably short time and put into production in a total period well under a year—and some six months earlier than estimated. This redesign was justified both because our limited funds during the years of peace had not allowed us to develop ideas which we knew should be in a tank and also because the war in Europe had brought out new ideas and had greatly reinforced the ideas of mechanization. No time was lost in getting tanks into production; for the tank manufacturers in the interim were getting their plants ready.

THE TRAINING OF THE ENGINEER

From *Civil Engineering and Public Works Review* (London), June, 1941.

Members of the engineering profession will feel considerable satisfaction at the action taken by the Council of the Institution of Civil Engineers of Great Britain in their momentous step towards the introduction of a long overdue reform in the curriculum of the engineering student.

The absence of a course of lectures on the economics of engineering, on organization and management, and on the relations of aesthetic considerations to engineering design and construction has been a constant source of weakness in the training of our young engineers.

By some strange mental apathy or by an inability of the teaching profession to realize their significance, these all-important considerations have been left in the past for the young engineer to acquire by experience. Not infrequently, economic experience has been gained at the expense of the public, and the lack of an appreciation of aesthetic principles has left behind testimonials to an inability to appreciate what is pleasing to the discerning eye.

As a commencement, the Council of the Institution has approached the Vice-Chancellor of Cambridge University with an offer to finance for a period of five years a lectureship on the subjects envisaged, in the hope that they would in due course form part of the engineering curriculum of the Mechanical Science Tripos.

The proposal put forward by the Institution has been cordially welcomed in principle by the Senate of the University and it is proposed that a beginning should be made in the next academical year. It is suggested that the scheme should be initiated by inviting a number of eminent engineers and others to visit the University to give either single lectures or short courses on subjects coming within the terms of the proposal.

To the layman it has long been a mystery how the teaching of engineering could be divorced from all consideration of the financial aspect of the profession. In spite of the closest possible association of the economic with the technical aspects, little emphasis has up till now been laid upon it, and few professions have thought it of importance to devote any part of their curriculum to the preparation of the student in what will be a dominating feature of their lives.

Many engineers, when commencing their careers, have regretted their lack of knowledge of the economic aspects of their work. In most instances the technical aspect of the engineering task to be accomplished is dominated by economic considerations. Most men who have risen to eminence in the profession have done so, not only by virtue of their technical knowledge and skill, but by their ability to co-ordinate the application of that knowledge and skill with the financial and ecomonic factors dominating the work on hand.

An example of engineering work that is pleasing to the eye and lends dignity to its surroundings remains as a lasting memorial to the skill and the taste of the men who conceived and carried out the work.

When we look back at the past, we must at times feel surprised that the results achieved have been as successful as they have. That this is so is undoubtedly due to the high general technical standard the profession demands of its members.

It is easy enough for an engineer to carry out constructional work when money is of no object. How often is such a condition encountered, and even if encountered, how far is such a state of affairs desirable ? Every engineer should be mentally equipped on entering his professional life to grapple with the economic and aesthetic aspects of his work.

The principles of organization and management should be as much an integral part of the training as any technical engineering subject in the present curriculum. In its broad sense these subjects may be taken as but part of the economic principles involved in engineering work.

The general public will in due course have reason to thank the Institution for the splendid step they have taken and the wisdom they have displayed in recognizing the importance of aesthetics as applied to their profession.

That the first proposal should come from the civil engineers themselves and not from the teaching profession, is of importance, as it bears witness to the progressive spirit that has seen in the future the necessity of keeping the profession in touch with the changing attitude of the public and the determination of the profession that its members shall take their full part in the steady improvement of the appreciation of the close relation of the technical, the economic and the aesthetic.

LORD REITH'S ADDRESS TO THE INSTITUTION OF CIVIL ENGINEERS

From *Journal of The Institution of Civil Engineers* (London), June 1941

A luncheon was held by The Institution at Grosvenor House, Park Lane, on Wednesday, 30th April, when 227 members and guests were present. Sir Leopold Savile, K.C.B., president, was in the chair.

Lord Reith of Stonehaven, P.C., G.C.V.O., G.B.E., D.C.L., LL.D., M.Inst.C.E., Minister of Works and Buildings, proposed the toast of "The Institution of Civil Engineers." He said: Having spoken last year, and not being set on talking at the best of times, although gratified by your invitation, I should have asked the president to excuse me had it not been for the creation of a Ministry of Works, of such interest and concern to you (and to the sister profession of architecture), and that one of your members was the first minister. He ought to have something to say to his own Institution about what has been done, about what is being done, about what is planned, and which, God and other departments being willing, will or may be done. I was informed yesterday that the Ministry of Works did not advertise itself enough; that few people knew how much had been done and planned in the six months since its creation, and, for the matter of that, by the Office of Works since war started. Even in time of war, even in these times of test and trial, it seems that acts do not always speak for themselves, and that ministers—Mr. George Hicks and I—ought to have been talking more than we have done, either about these acts or in place of them. Sermons in stones or books in structural steel are not enough.

A new ministry is not always popular, especially when its creation involves or should involve the transfer of authorities and responsibilities from elsewhere; but at least it can be used as a scapegoat of convenient and astonishing capacity.

I will tell you a thing or two it does. In addition to looking after Duck Island, in St. Jame's Park, it is responsible for the provision, maintenance, and repair of 14,000 Government buildings throughout the country. It is itself carrying out an immense building programme, factories of all sorts, storage, landing grounds, hostels, training establishments camps, depots—more than one million pounds of work a week. It has an office staff of 9,000, half of them technical, and a field force of 12,000. But do not imagine that this is some gargantuan department about to seize the work of individual engineers and architects. I believe in individuals, and we intend to make full use of them.

One of its achievements has been the substitution for the old priority system, with all its inconsistencies, of a system of allocation in terms of labour to departments. The amount of work permitted is limited to the capacity of the building industry. It sounds simple; but it has taken months to get it through. Whereas building proposals had reached a peak far in excess of what the industry could meet, we have secured, after vast discussion and negotiation, a reduction to the real capacity of the country, namely, about £350 millions a year. The allocation system will be in operation to-morrow; and all hopefully expect that once it is running there will be a far more efficient building effort. The more urgent construction works will be so manned as to ensure their speedy completion. This has involved much investigation—the more difficult because of the absence of statistics—but when departments produced their complete programmes some of us were, I think, surprised to find what they had in hand. Returns have been obtained from builders, contractors, and local authorities, showing the number of employees and the categories of employment and work. But these figures will be seriously incomplete until many local authorities take a more responsible view than they do to-day of their position as large employers of building labour. After three months, less than half have provided the information required: but we shall not stop until we have full and regular statistical control; we are engineers and builders, preferring to move in this field by sight and not by faith.

The Ministry has also established effective control over many building materials, in particular cement and bricks, a cause of much tribulation in the past. In its charter it was invited to institute research into such questions as the adoption of substitutes for building materials, modifications of design and specifications, standardization of design and of all materials for war economy, and to ensure that the results of past and future research are used. All this is done in close collaboration with the Building Research Station; but a Ministry of Works covers a still wider field and there is a great deal of scientific engineering research, in large-scale field experiments and the collation of information from all over the world, which it is now setting out to deal with. In standardization, the policy is to eliminate everything but the minimum necessary for war effort: that may affront the feelings of many engineers and architects; but this is no time to play for safety, nor even to study susceptibilities.

Unnecessary building, unnecessary demolition and clearance, and extravagant reconstruction are being controlled; and licences for building by private interests are now compulsory (and not easily obtainable) for £100 to be spent on any building within twelve months; it may be still further reduced, as nothing that is not contributory to the war should be permitted.

A new department was established in the Ministry two months ago to help in the rapid repair of damaged houses, services, and factories. It is organized on the basis of Emergency Works Officers at all the important target towns, supervised by Assistant Directors in charge of large grouped areas. There are engineers and architects and contractors, all working together, and from accounts they seem to be carrying out their duties with remarkable, though unadvertised, success.

I will not prolong the tale. But there are two other matters I want to mention: the first because we are aiming at such a combination of all sections and interests of the civil engineering and building industries as will not only notably increase the war effort but also make a radical and permanent improvement in their structure and operation. Discussions were initiated by my Ministry, with the co-operation of the Ministry of Labour, with representatives of the civil engineering and building industries many weeks ago with the view of securing by their better direction, a more satisfactory building output and a more efficient machine more in keeping with the serious and urgent needs of the day and better fitted to meet the post-war problems.

On the other matter: a good deal has already been said in public about the planning and reconstruction responsibilities vested in me, to advise on the machinery, constitutional and administrative, necessary for the planning and reconstruction of town and country after the war. This subject also is controversial. Do not let any one think that what I or anybody else may be doing about the machinery for planning detracts from the war effort. I said in another place that the idea of a planned and ordered reconstruction is surely an incentive to and an encouragement of war effort: and surely engineers, of all people, so careful in planning their own works should welcome planning in this larger sphere. They should, in fact, be among those who, insisting on a proper design of whatever they are about to build, must welcome a design for living not only in planned and ordered communities of concrete and bricks and timber and stone and steel, but also of highways and byways; of farms where farms should be, and flowers and grass and trees where they should be; and of industrial communities where they should be; (and definitely not where they should not be). There must be co-ordination between living and working and moving and playing, with amenities, natural and otherwise, of civilized life instead of the haphazard, confused disorder and inconvenience of our lives, or the monstrous and obscene mutilations of the countryside.

One word to engineers from my own experience in the profession. The Institution has done well to initiate and finance a course of instruction at Cambridge University under the distinguished professor of engineering there, in order that the engineer may be something more than an engineer—which, in fact, he too rarely is—and that he may have some idea of the general problems of management and of the broader issues involved in engineering works and in business generally.

On the moral issues of war and peace we in this country are on unassailable ground, and we know that there is no compromise possible. We know, too, that we have opportunities of immense service to mankind and to the world. We may be fighting for self-preservation with no bridge of escape, and desiring none, but beyond self-survival there is this opportunity of something far bigger than ourselves, in the conquest of evil and in the establishment of a better order here and throughout the world, for a better order here will depend on a better order everywhere. Put quite simply, I conceive that we are engaged in a struggle for the standard of living, economic and cultural, throughout the world. This is not a purely materialistic end; it includes and transcends the materialistic. A rise in the standard of living, if economic alone, would at best be static, and what was gained would soon be lost. Of at least equal importance is a rise in, and the permanent establishment of, the moral and spiritual standards of living, all now in the balance; and this for all peoples in all countries. And it will be for us to see that, when peace falls like a benediction on the world, it bestows for all time and for all people security and happiness, and freedom from fear and want.

Your chairman has made an announcement about Greece. In what I have said about the establishment of moral and spiritual values I see — and I think we all see — in Greece the faith for which the Empire fights, and for which we look beyond war, as an engineer looks beyond this day to the completion of the job, to the passage of traffic over his mighty bridge, to the first flow of water over the spillway of his dam. Life and war are all engineering achievements after a kind. If there were more of the engineer's outlook, his factor of safety, his factor of efficiency, his planned organization, there would be fewer disasters and difficulties in both life and war. But difficulties and disasters there must be, and bridges have been known to collapse more than once; you all know one bridge that I am talking about. Do let us see these Mediterranean happenings, particularly in Greece, in their right perspective, as an engineer surely would. There are setbacks to be encountered on every job, however carefully planned; but it is an essential of engineering, having counted the cost, to take the risk. Here in Greece was an obvious and admitted risk, but every dictate of honour and moral obligation proclaimed that the risk must be taken; and it was taken, nobly and bravely. If to us, gentlemen, as engineers, this is a week when the progress report is not quite so satisfactory as it might be, we are used to that, and we look to the end of the job.

I give you the good health of your Institution. May it flourish and continue to command the respect of the community, as in times past.

AIR BRAKES

From *Aeronautics* (London), May, 1941

Brakes for aircraft are almost becoming a perennial subject. Years ago they were seldom heard of, for the machines of those days had a comparatively high drag which acted as a reasonably good brake without extra assistance; in fact if the engine was shut off when they were flying at their best speed the effect on the occupants resembled the effect of pushing hard on the brake pedal of a modern motor-car. But nowadays things are very different. The modern aeroplane has had most of the old drag-making accessories removed, the wing area has been reduced, everything possible has been faired over, and even the radiator has been induced to give a small thrust instead of a large drag, and the same thing is true of exhaust manifolds.

The result is that the modern aeroplane is not only much faster than its ancestors, but when it has gained this extra speed it is extremely reluctant to lose it, hence the modern cry for brakes. I think everyone will agree that all fast vehicles should have efficient brakes; fast passenger trains are fitted with a device which applies a brake to every wheel; many modern motor-cars have an arrangement which enables the engine to assist the driver in applying brakes so that the power may be increased. Even ships can reduce their speed quickly—in the sailing days by putting a sail aback, and in modern times by reversing propellers.

The fact is that the power of reducing speed quickly is as much a part of the capability of manoeuvering as the capability of steering; in fact, manoeuvrability in its highest degree can only be attained when accelerating, reducing speed, turning, and in the special case of the aeroplane climbing and descending, are all under the control of the steersman. The fact that wheel brakes are fitted to all modern aeroplanes is rather outside the scope of this argument, except to show that the modern aeroplane designer realizes the importance of quick speed reduction on the ground but does not think it so necessary in the air.

For an example, let us assume that a fast fighter has dived on to the tail of a hostile bomber, and has straightened out at a speed of 450 miles an hour, while the bomber is proceeding at 250. Then, in order to stay behind the tail the fighter has to reduce his speed by 200 miles an hour, and he ought to be able to do this quickly or he will shoot in front of the bomber. In order to simplify the calculations let us suppose that the average L/D of the fighter over this range of speeds is eight. Under these conditions the drag of the fighter will be one-eighth of its weight and the deceleration will be about four feet per second. As 200 miles an hour is about 293 foot-seconds, the time taken to reduce speed from 450 to 250 miles an hour will be 293/4, or about 73 seconds.

During this period the bomber will have travelled about 5.1 miles and the fighter, whose average speed while decelerating may be taken as the mean between 450 and 250, or 450 plus 250/2, would be travelling at 350 miles an hour, so that during the 73 seconds it would cover about 7.1 miles, or about two miles more than the bomber. So that the fighter pilot must arrange that his dive finishes some two miles behind his opponent, or out of effective shooting distance. If he does not do this he will run past his antagonist and may be shot up by the latter's side-mounted guns without being able to reply.

We have now to consider what form these brakes are to take. The first that I remember being fitted to a service aeroplane were fitted to the Sopwith One-and-a-Half Strutter during the last war. This machine was in its day the best two-seat fighter ever produced. The brake consisted of arranging that the trailing portion of the lower wing near the fuselage could turn about its central axis. I think that this movable portion extended some two feet on each side of the fuselage. This scheme worked quite well, but was liable to vibrate severely at high speeds and, for this reason, I do not think it suitable for modern fighters.

Another scheme, suggested by Mr. W. E. Hick in a recent article in this journal, consisted in using a central flap across the bottom of the fuselage, in line with the wing flaps. A rough calculation suggests that about two square feet of area in this position would be sufficient to give adequate braking, and the arrangement should work very well in practice.

But there are some other schemes which should be considered. It might, for instance, be possible to lower the undercarriage either completely or partially. This would give a considerable amount of braking at high speeds, which are the only ones we are interested in, but the amount of the brake effect would of course depend on the design of the particular under carriage. Extending the chassis in this way would give a nose-diving moment the effect of which would have to be carefully considered, but probably the chief objection to the scheme is that a chassis cannot be extended and retracted very quickly, and speed is always of importance where manoeuvrability is concerned.

Small flaps projecting at right angles to the wings near the trailing edges have been used on several types of aircraft, but this arrangement is certain to increase the wing lift, which is not altogether desirable, and can be expected to produce a nose-diving moment.

The scheme I personally would prefer would be to use the propeller as a brake. It would not be difficult to arrange to turn the blades of a variable pitch propeller to a position in which no thrust existed when the engine was running statically on the ground. We might call this "zero pitch". The effect would be that the blades would act like flat plates at right angles to the wind, and the fact that they would be revolving slowly under engine power would not be of importance.

But I am afraid we should want another lever to operate this arrangement; but in this it would be in the same position as all the others. I would be extremely reluctant to add even one more lever to those the pilot already has to look after, but I am afraid it is unavoidable. Another working part must have another control. Now the lever I suggest should be completely separate from the others and should, when operated, move the propeller to "zero pitch" and at the same time throttle the engine down to the ticking-over position.

The operation of doing this and of putting things back to normal could be done very quickly. If found desirable, a small amount of negative pitch could be arranged; by modifying this a negative thrust or additional drag of any amount required could be easily produced but if this were done the engine throttle must be opened somewhat to ensure that the airscrew does not stop turning. Twin-engined aircraft could be dealt with in the same way by arranging that both airscrews could be set to "zero pitch" and that both engines could be throttled down simultaneously.

This would involve a little care in the design of the gear so as to ensure synchronization but there should not be any great difficulty about it. When required, such an arrangement would be very useful for rapid pulling up on the ground, especially if negative thrust was used. When airscrews are used as brakes when on the gound, any amount of braking force can be applied without any risk of nosing over.

AERODROME SPACE

From *Aeronautics* (London), May, 1941

Two things gather in importance as the size of the Royal Air Force increases: the provision of additional aerodromes and the fuller use of existing aerodromes. They are problems of space and of traffic control. At the La Guardia airport of New York a range control system has been proposed in order to increase the amount of traffic that can be handled there in bad weather every twenty-four hours. Even so the four-minute interval seems to be the smallest contemplated.

For the operation of large bomber forces such as the Royal Air Force will shortly dispose, traffic control systems which enable aircraft to take off and to land in all weathers, by day and by night, at short intervals of time are essential. In this work the knowledge and experience of those who, in peace time, controlled the traffic at our civil airports will be of value.

Meanwhile the search for new aerodrome sites must go on and methods must be studied whereby aircraft can operate from a small space. The military aerodrome of to-day neutralizes between 20 and 25 square miles of country. Devices—and there are such— which might drastically reduce this area must be urgently developed. The technique of the runway, with cross-wind taking-off and landing runs, must be studied. Assisted take-off might be another way of reducing the length of these runs.

In the past the higher command of the Royal Air Force has been, perhaps, too content to assume that there would always be plenty of space in this small island and that no matter how large and how numerous were our bombers, there would always be long and clear runways from which they could operate in all weathers.

In Great Britain, aircraft will soon be packed tighter than ever. The methods of traffic control must be advanced to enable them to work efficiently at high densities so that the full power of our growing Royal Air Force can be exerted against the enemy.

AIR CONDITIONING OF RAILWAY COACHES

By F. Roedler, *Zeitschrift des VDI*, January, 1941

Abstracted from *The Engineers' Digest* (London, Eng.)

The difficulty of air-conditioning in railway coaches is the limited space of from one cubic metre per head in 3rd class coaches to 2.6 cubic metres in 1st class coaches. The problem of maintaining a uniform temperature in the coach is easier to solve than the ventilation question. Open windows lead to draught and considerably increases the air resistance of the train. Special arrangements taking the form of suction and pressure ventilator are therefore indispensable.

To compare the efficiency of the air-conditioning a Kata-theremometer has been developed. The measured "dry Kata number" gives the cooling effect of the atmosphere. The actual value depends on the temperature and also on the flow of air. The ratio of air temperature T and Kata number A gives the correlation between Kata number and the comfort of the passenger. It is termed "comfort index" and Table I gives information regarding this characteristic.

"D" class cars fabricated in steel, built in 1929-30, employing low pressure circulation heating with automatic regulation for each compartment were investigated. When the windows, flaps, and roof ventilators were closed the comfort index was between 3.3 and 5.2 and the temperature was constant. The relative humidity averaged 60 per cent, and was, therefore, pleasant.

The effect of ventilation on the atmosphere in a motor coach was investigated. With no ventilation the comfort index was 5.0; this could be reduced to 4.3 by the use of suitable fans, and to 3.9 by using natural draught. To ensure the necessity for artificial air-conditioning only on hot summer days, special callottes taking the shape of perforated spherical openings were fitted into the roof.

Aeration of the seats is only bearable at room temperature from 20 deg. C. upwards, at lower temperatures the perforated callotte was fitted with a pair of flaps. It appears that at about 20 deg. C. a critical temperature exists to which is correlated an airspeed of 0.3 metres per second.

TABLE I

		Stationary Air	Velocity of Airflow in m/sec.			
			0.1	1.2	0.4	0.6
Upperlimit of comfort (warm)	t_L	22.0	22.6	23.75	25.3	26.2
	A	4.0	4.5	4.8	5.1	5.3
	$B=t_L/A$	5.5	5.0	5.0	5.0	5.0
Max. Comfort	t_L	18.8	19.0	19.5	21.0	22.0
	A	5.0	5.7	6.4	7.0	7.3
	$B=t_L/A$	3.75	3.35	3.0	3.0	3.0
Lower Limit of comfort (cold)	t_L	15.9	16.0	16.3	17.4	18.4
	A	6.0	6.7	7.6	8.7	9.2
	$B=t_L/A$	2.65	2.4	2.15	2.0	2.0

From Month to Month

News of the Institute and other Societies, Comments and Correspondence, Elections and Transfers

VISITORS TO CANADA

The great industrial development that has come with the war has brought to Canada many engineers from other countries. Perhaps the greatest number has come from England although many have come from the United States and Europe. This infiltration of members of the profession should be a fine thing for Canadian engineers. It permits of a better knowledge and understanding of the people and the works of all groups, and should result in a widening of the outlook of all concerned.

Engineers from the Old Country have come here with important missions. They have brought with them a knowledge of things which were yet new in this country; things which Canadians proposed to learn so that in time they might become experts and take over some of the burden that rested on the United Kingdom. Others have come to inspect intricate merchandise made to the order of the British Government. Still others have come on a variety of missions; some to stay for only a few days or weeks, and others to settle down in our midst.

The Polish government has a fine appreciation of the value of its technically trained manpower, and so, when the over-running of Poland seemed inevitable, instructions were given that hundreds of these engineers be sent out of the country. They are now in many parts of Europe, with the largest proportion in England. With Canada's great development, and with the accompanying shortage of highly specialized personnel in several fields, it has been found that some relief can be brought to the situation by utilizing the special skill of these people.

Poland had become highly industrialized. Her success in many lines, such as precision instruments, optical goods, machinery, synthetic rubber and so on, was fast bringing her to the top of the European field. The men who accomplished these things have escaped from the country, and some are now in Canada, lending their expert knowledge to our aircraft industry, to our hydro-electric development, and to our munitions programme.

Poland has always featured its engineers. During the life of the last republic, two of their presidents were engineers, namely: Narutowicz and Moscicki. To some extent this will explain the great industrial development. Perhaps the Polish example might be copied to advantage in other countries.

Canadian engineers will welcome all these experts who have come to our assistance, and will help make their stay pleasant. These relationships should do much to improve our outlook both now and after the war, for they will give us contacts which we would not have had otherwise.

Elsewhere in this Journal is a letter from a newly formed Polish association whose objective is to assist these engineers in the many problems they have to face after their nightmare experiences at home, and the loss of all their goods and chattels, and in most instances the severance of all family ties. They are alone in Canada; they are without funds, but they possess courage, stamina, and the desire to work towards the ultimate defeat of Nazism and their return to their homeland. Their loyalty and their skill is guaranteed by the Polish government, to whom they are all well known.

There are many strangers in our midst from many countries—fellow members of a great calling. Much good can be done for the profession if the opportunities to know and understand our distinguished visitors are seized and fully developed.

THE COST OF BECOMING AN ENGINEER

The Engineering Alumni of the University of Toronto through its Junior Panel and in co-operation with the Engineering Society of the "School" has done some investigating into the fields of costs of engineering education. These are not total costs as the university itself might see them but actual costs to the student. In each case the figure includes an amount of $290.00 to cover tuition, deposits and societies.

For those whose home is Toronto the figures are:

a. Without fraternity.................$550.00 per year
b. With fraternity.....................$635.00 per year

For students from outside Toronto, these figures are given:

a. In boarding house..................$775.00 per year
b. In university residence..............$800.00 per year
c. In fraternity........................$925.00 per year

These costs do not include transportation to and from Toronto.

These figures were developed from the returns of questionnaires submitted to the students of all years. Approximately half the students replied—sixty per cent being in Toronto and the balance from outside.

Excluding tuition the breakdown is as follows:

Food and Shelter	Home in Toronto	Home Outside Toronto
At home	......	......
Boarding-house	......	$225.00
Residence	......	255.00
Fraternity	......	300.00
Incidentals	23.50	29.25
Transportation in City	27.00	15.00
School socials	12.60	12.60
Outside socials	58.20	58.20
Incidental socials	42.90	42.90
Fraternity fees	77.00	77.00
School equipment	40.00	40.00
Clothing	65.00	65.00

This is very pertinent information. Congratulations are due to those responsible for the compilation. It is interesting to note that it is proposed to carry out a more detailed investigation next year.

OF SPECIAL INTEREST

Although at first selected simply as a suitable article for the Abstract Section, a rereading of the address of Lord Reith of Stonehaven, Minister of Works and Buildings in His Majesty's Government, on the occasion of a meeting of the Institution of Civil Engineers, indicates that special attention should be called to it so that no reader may miss it.

Lord Reith discloses some new regulations for the control of buildings and materials, but more than this he talks of a better future wherein the engineer, with others, may give and receive amenities of life which have been denied in the past.

Of this future he says, "There must be co-ordination between living and working and moving and playing, with amenities, natural and otherwise, of civilized life, instead of the haphazard, confused disorder and inconvenience of our lives, or the monstrous and obscene mutiliations of the countryside." . . . "On the moral issues of war and peace we in this country are on unassailable ground, and we know that there is no compromise possible. We know, too, that we have opportunities of immense service to mankind and to the world. We may be fighting for self-preservation with no bridge of escape, and desiring none, but beyond self-survival there is this opportunity of something far bigger than ourselves, in the conquest of evil and in the establishment of a better order here and throughout the world, for a better order here will depend on a better order everywhere."

Time given to reading this short address will be time well spent. See page 401.

WARTIME BUREAU OF TECHNICAL PERSONNEL

The forty thousand questionnaires addressed to those people who said on their national registration that they were engineers, chemists or architects, have been mailed. Additional questionnaires are going—and in many instances have gone—to others whose names were not on the list supplied by the Bureau of Statistics, but who belong to provincial professional associations, technical institutes or similar organizations. A thorough check is being made against all membership lists, to make certain that no one is overlooked.

Forms are being returned daily in great quantities. Sometimes at least a thousand have come in in one mail. At the time of writing 18,000 have come back, with the daily stream hardly showing any abatement.

As was at first suspected many persons recorded their calling incorrectly at the time of registration. It is a revelation to see what some people think constitutes engineering. The returns show that mechanics, electricians, plumbers, boiler attendants, locomotive drivers, firemen, tinsmiths, garage mechanics, repairmen, service men, machine operators, gardeners, janitors, elevator men and dozens of others think their qualifications are correctly described by the word engineer.

The Bureau is receiving many inquiries from war industries and the armed services and is supplying the records of suitable men. It is quite evident that the supply of qualified persons free to accept new positions is small. However, it should be possible to fill many of the present openings when the Bureau records are complete. At least this will show who and where are all the persons with the proper qualifications, and will indicate the degree of their availability. From such basic information it will be possible to appraise conditions properly, and to make whatever arrangements may be necessary to meet the constantly changing situation.

The plant training activities of the Bureau have expanded still farther. Besides the mining industry, the proposals for training have been outlined to a public utilities group representing the electric, gas and power companies; and to the petroleum industry. These groups have attended meetings in Ottawa under the chairmanship of the Director of the Bureau, where they have been addressed by the Deputy Minister of Labour, the Director General of Munitions, the Director of Ship Construction and others. In each instance organizations were estbalished to carry out the proposed expansion of the machine shop work-day so that more men could be trained and more materials prepared for war purposes. Plans for the training of a number of enlisted men in skilled mechanical operations for the army, all within the facilities of industry are being considered.

Meetings have been held in Ottawa, Toronto and Montreal to co-ordinate the efforts of all the agencies interested in these developments. They are many sided and far reaching, and have as their objective the complete co-operation and co-ordination of many power and plant facilities for every phase of industrial training in relationship to the war effort.

CORRESPONDENCE

Oorgaum, South India
June 27th, 1941.

THE GENERAL SECRETARY,
ENGINEERING INSTITUTE OF CANADA,
2050 MANSFIELD ST., MONTREAL, P.Q., CANADA.

Dear Sir:

Under the stress of war conditions your letter of January 20th has just come to hand. I note that the Council has been pleased to award the Leonard Medal for the year 1939-1940 for my paper entitled "Points of View on the Rockburst Problem" published in the C.I.M. & M. Bulletin for August 1939.

I can assure you that recognition of ones humble efforts by the E.I.C. is in addition to encouragement, a distinction

R. G. K. Morrison.

which one cannot fail to appreciate. I am very grateful to the Leonard Medal Committee for their good opinion of the paper, and regret my inability to receive the medal personally at either of the annual meetings referred to in your letter. For your convenience if the medal has not already been forwarded to me at this address I would be glad if it could be sent to my wife.

I enclose a picture as requested but presume the announcement has already been dealt with in your Journal, and the need for it has passed.

Yours sincerely,

(*Signed*) R. G. K. MORRISON

ASSOCIATION OF POLISH ENGINEERS IN CANADA

Ottawa, 28, 6, 41.
66, Delaware Ave.

THE ENGINEERING INSTITUTE OF CANADA,
2050 MANSFIELD St.,
MONTREAL, QUEBEC.

Dear Sirs:

We beg to inform you that owing to the arrival in Canada during the last few months of about 40 Polish technicians and the expectation of the influx of farther parties of them, we formed the "Association of Polish Engineers in Canada."

The aims of our association are: to represent its members before the Canadian authorities, to verify credentials, to obtain employment for them, financial support to members in case of need, to provide a social life among the members of the association, to maintain contact with technical associations in Canada and so on.

The Council of the association consists of Messrs. J. Korwin Gosiewski, president; M. Kurman, W. Jakimiuk, J. Meier and Z. Karczewski.

The Secretary of the association is Mr. R. J. Herget. The office of the association is located at 66 Delaware Ave., in Ottawa.

The majority of the members are graduate engineers with experience in Polish and continental war industry and they are willing to give all their knowledge and energy for work in Canadian war industry for our common cause.

We hope that our young organization will be accepted by you with benevolence and that we shall be always in close co-operation with your association.

Yours very truly,

ASSOCIATION OF POLISH ENGINEERS IN CANADA

(*Signed*) J. KORWIN GOSIEWSKI, *President.*
M. KURMAN, *Councillor.*
R. HERGET, *Secretary.*

AULAC, N.B.,
JULY 15TH, 1941.

THE SECRETARY,
THE ENGINEERING INSTITUTE OF CANADA,
MONTREAL.

We have here at the Fort Beausejour Museum all the data pertaining to the ship railway or as it was sometimes called The Chignecto Marine Railway promoted by H. G. C. Ketchum, 1882-92, for the purpose of transporting sailing ships from the head of the Bay of Fundy to the entrance of Northumberland Strait at Baie Verte.

The only thing missing from the collection is the working model, a wooden structure some eight or ten feet long and three or four feet wide by which a miniature ship is transported from one dock to the other.

The model was shown at an exhibition in Saint John, N.B., but there is now no trace of it in the building.

There is a record of Mr. Ketchum having described his railway to the members of your Institute in 1892. He had his model with him, and it is with the hope that some happy fate caused him to leave it in your care and that it can again become an exhibition piece in a public place near the spot where his Fort Lawrence dock was located that I am writing.

The gambling fraternity would dub my letter a million to one shot but the prize sought is worth the effort.

If it would be possible at this late date to find trace of this historic relic I would pass the information along to Dr. J. C. Webster, Shediac, N.B., who is responsible for our Museum with its fine collection and he would proceed to find a final resting place for it.

Yours sincerely,

(*Signed*) A. W. BULMER.

Personals

News of the Personal Activities of members of the Institute, and visitors to Headquarters

R. A. C. Henry, M.E.I.C., vice-president of the Montreal Light Heat and Power Consolidated, has been appointed chairman of the Canadian Section, Joint Economics Committee of the United States and Canada. He has been at Ottawa since the first months of the war acting as executive assistant to the Minister of Transport, and later as economics advisor to the Department of Munitions and Supply.

R. E. Jamieson, M.E.I.C.

R. E. Jamieson, M.E.I.C., has been named director general of a new Army Engineering Design Branch of the Department of Munitions and Supply at Ottawa. He will head a special inter-departmental advisory committee on army engineering design. Mr. Jamieson, who is professor of civil engineering and chairman of that department at McGill University, has obtained a leave of absence to assume his new duties at Ottawa. He is a past president and member of Council of the Corporation of Professional Engineers of Quebec, and a member of the executive of the Canadian Engineering Standards Association. He has also served on many of the various committees of the Institute.

The new Army Engineering Design branch will involve the transfer from the Department of National Defence to the Department of Munitions and Supply of all work, duties and responsibilities attendant upon army engineering design, and the transfer from the staff of the Defence Department to that of the Munitions and Supply Department of several officers and employees presently engaged in army engineering design.

Wing Commander A. J. S. Taunton, D.S.O., M.E.I.C., is now chief works officer, No. 2 Training Command, R.C.A.F., with headquarters at Winnipeg. Previously he was district engineer at Winnipeg for the Department of Munitions and Supply.

Captain A. B. Dove, M.E.I.C., is now officer commanding, 3rd Field Park Company, Royal Canadian Engineers. Before the outbreak of war he was chemical engineer with the Steel Company of Canada in Montreal.

W. E. Denley, M.E.I.C., maintenance engineer, Department of Highways and Transportation, Saskatchewan, is the officer commanding the 9th Field Company, Royal Canadian Engineers, now being organized at Dundurn Military Camp, Sask. His rank is that of Major.

M. J. Spratt, M.E.I.C., chief engineer, Saskatchewan Co-operative Elevator Company, is a lieutenant serving with the 9th Field Company, Royal Canadian Engineers, now in training at Dundurn.

D. C. Beam, M.E.I.C., is now on the staff of Wartime Housing Limited, Toronto. Since his graduation from the University of Toronto in 1928 he has been with the building Department of the City of Toronto, where he has been given a leave of absence.

Albert Holland, M.E.I.C., has a war appointment in the Dover area, England, as a civilian garrison engineer. He acts as personal assistant to the Deputy Commander, Royal Engineers, Dover.

G. W. E. Nicholson, M.E.I.C., is now resident manager with Union Bag and Paper Corporation, Savannah, Georgia. He was previously production manager with Southern Kraft Corporation, at Panama City, Florida.

H. M. Lewis, M.E.I.C., has resigned as mechanical superintendent at Pacific Mills Limited, Ocean Falls, B.C., to become manager of the new South Shore Yard of the Burrard Drydock Company Limited at Vancouver, B.C.

T. R. Durley, M.E.I.C., who was lately resident inspector in Montreal for the Associated Factory Mutual Fire Companies, has been transferred to the manufacturers Mutual Fire Insurance Company of Providence, R.I. He will be located in the Canadian office of the Company at Toronto.

W. F. Campbell, M.E.I.C., has joined the staff of the Aluminum Company of Canada Limited, at Arvida, Que. He was previously road superintendent and county engineer for the county of Haldimand, Ont.

E. A. Beman, M.E.I.C., has joined the staff of Pandora Limited at Cadillac, Que. Lately he had been connected with Wood Cadillac Mines, at Kewagama, Que.

F. H. Peters, M.E.I.C.

F. H. Peters, M.E.I.C., surveyor-general of Canada was elected to honorary membership at the first meeting of the National Congress on Surveying and Mapping held in Washington, D.C., last June.

J. V. Ludgate, M.E.I.C., who was district engineer of Municipal roads of the Department of Highways of Ontario at North Bay, has been transferred to the same position at Stratford, Ont.

J. B. Burke, M.E.I.C., who is on the staff of Alberta Government Telephones has recently been transferred from Lethbridge to Edmonton.

E. J. Bolger, M.E.I.C., is now on the staff of McLennan Gold Mines Limited at Geraldton, Ont. He was previously connected with Futterer and Reid, mining engineers, Toronto.

Captain R. C. Lane, Jr.E.I.C., is now in the 6th Armoured Regiment (1st Hussars) at Camp Borden, Ont. Previous to his enlistment he was on the staff of International Harvester Company at Toronto.

James Oliver, Jr.E.I.C., has joined the staff of Defence Industries Limited and he is, at present, located in the maintenance department of the Winnipeg plant. A graduate of the University of Alberta in 1937 he has since been engaged on several construction projects.

J. W. Lucyk, Jr.E.I.C., is now employed as a draughtsman with the Hamilton Bridge Company Limited at Hamilton, Ont. Previously he was a demonstrator in the department of electrical engineering at the University of Manitoba.

E. R. Hyman, Jr.E.I.C., has joined the R.C.N.V.R. as a lieutenant and is now located at Halifax, N.S. Previous to his enlistment he was on the staff of Trinidad Leaseholds, Limited, in Trinidad, B.W.I.

R. L. Strong, S.E.I.C., has joined the staff of the Associated Factory Mutual Fire Companies at Boston, Mass., where he expects to receive a special training. He is a graduate in engineering of the University of Toronto, and a bachelor of science in business administration from the Massachusetts Institute of Technology. For the past seven years he had been on the staff of Canadian Industries Limited at Montreal.

Leslie Wiebe, S.E.I.C., is at present employed as assistant engineer with Sutton-Horsley Company Limited at Toronto. He has been with this firm in several capacities since his graduation from the University of Saskatchewan in 1940.

D. D. Reynolds, S.E.I.C., is now working in the division engineer's office of Canadian National Railways at Regina, Sask.

H. Goodfellow, S.E.I.C., Climax, Sask., is now serving with the Royal Canadian Engineers overseas. His rank is that of lieutenant.

W. M. Newby, S.E.I.C., has secured a position on the staff of Canadian General Electric Company at Peterborough, Ont. He was graduated from Queen's University in 1940.

C. H. Vatcher, S.E.I.C., who was with Canadian National Carbon Company Limited at Vancouver, B.C., has been transferred to the Toronto office of the company. Mr. Vatcher is a graduate of the University of Toronto in the class of 1939.

I. M. McLaughlin, S.E.I.C., has joined the staff of Defence Industries Limited at Valleyfield, Que. He was graduated in mechanical engineering this spring from Nova Scotia Technical College.

VISITORS TO HEADQUARTERS

D. W. Houston, M.E.I.C., Superintendent, Street Railway Department, City of Regina, Sask., on June 7th.

P. H. Morgan, M.E.I.C., Mackenzie, British Guiana, on June 18th.

W. H. Blake, M.E.I.C., District Engineer, R.C.E., M.D. No. 7, Department of National Defence, Saint John; N.B., on June 30th.

E. M. Izard, M.E.I.C., Works Manager, Yarrows Limited, Victoria, B.C., on July 4th.

W. F. Purves, S.E.I.C., Schick Shaver Limited, Stamford, Conn., on July 7th.

J. H. Wilson, M.E.I.C., Electrical Superintendent, Quebec North Shore Paper Company, Baie Comeau, Que., on July 15th.

C. H. S. Venart, M.E.I.C., Nobel, Ont., on July 16th.

G. F. St-Jacques, M.E.I.C., Engineer, Public Service Board, Quebec, Que., on July 16th.

Professor J. A. Van den Broek, University of Michigan, Ann Arbor, Mich., on July 16th.

W. H. Sparks, Jr.E.I.C., P/O, R.C.A.F., Victoria, B.C., on July 18th.

L. P. Cousineau, M.E.I.C., Quebec Streams Commission, Cadillac, Que., on July 18th.

Obituaries

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Francis Porter Adams, M.E.I.C., died at his home at Brantford, Ont., on June 26th, 1941, after a short illness. He was born at Brantford on March 27th, 1877, and received his preliminary education at the local Collegiate Institute, and his engineering training at the School of Practical Science at Toronto. In the early days of his career he was engaged in railroad construction on the Brantford and Woodstock railroad. From 1902 to 1905 he was employed with the Ontario Peat Company designing and installing machinery at the Wainfleet plant. In the years 1907 to 1908 he worked as assistant engineer for the Grand Valley Railway Company of Brantford. In March, 1908, he became assistant

F. P. Adams, M.E.I.C.

city engineer of Brantford. During the first great war he was in France with the 10th Battalion, Canadian Railway Troops, and he returned to Canada in 1919 with the rank of Major. In 1920 he became city engineer of Brantford, a position which he retained until his death, along with that of manager of waterworks.

Among the several works which he left may be mentioned the five bridges which he designed and constructed at Brantford. Mr. Adams was among those men of vision who conceived the project of the Shand Dam and the contiguous improvements to the Grand Valley. Fortunately he lived to see those early dreams and discussions well under way.

He was a member of the Grand Valley Group of the Association of Professional Engineers of Ontario and with his fellow members did much to cement the natural ties with the Hamilton Branch of the Institute. He will always be remembered by the members of the branch for his quiet kindness to all.

Mr. Adams joined the Institute as an Associate Member in 1910.

Archibald Sinclair Cook, M.E.I.C., died on June 9th, 1941, at Clarkson, Ont. He was born at Penobsquis, N.B., on November 20th, 1873, and entered the engineering profession in 1899 as one of the field engineers in charge of the construction of various parts of the Dominion Iron and Steel Company's plant at Sydney, N.S. In 1902 he engaged in railroad construction. From 1904 to 1907 he was resident engineer with Dominion Power and Transmission Company of Hamilton, Ont., on power developments near St. Catharines, Ont. In 1911 he was appointed inspecting engineer of the Transcontinental Railway Commissioners at Ottawa, Ont. From 1922 to 1938, when he retired, he was with the Canadian National Telegraphs at Toronto.

Mr. Cook joined the Institute as a Student in 1902. He was transferred to Associate Member in 1906 and he became a Member in 1912.

John Hamilton Gray, M.E.I.C., died in the hospital at Victoria, B.C., on July 1st, 1941. He was born at St. John, N.B., on December 25th, 1853, the son of the Honourable J. H. Gray one of the fathers of Confederation. He served his apprenticeship as a surveyor in Ontario under Bolton McGrath, D.L.S. In 1871 he became engaged in the Canadian Pacific Railway surveys in Ontario. From 1873 to 1880 he did the same work in British Columbia. From 1880 to 1884 he was assistant engineer on the construction of the railway in the Fraser Canyons. From 1884 to 1887 he did location and construction work for the Esquimalt and Nanaimo Railway. During the years 1888 and 1889 he did exploration work on the Vancouver Island for the British Columbia Government. From 1889 to 1891 he was inspector of dyking works on the Fraser River, and from 1891 to 1893 he was location and construction engineer for the government on the Shuswap and Okanagan Railway. He was chief engineer on the construction of the Victoria and Sydney Railway from 1893 to 1895. From 1895 to 1901 he was chief engineer of maintenance and operation with the Kaslo and Kootenay Railway. In 1902 he engaged in private practice in Victoria, B.C. He had retired a number of years ago, and had lived at Albert Head on Victoria Island.

Mr. Gray joined the Institute in 1906 as a Member. He had been made a Life Member in 1934.

Wilmot Earl Harry, M.E.I.C., died at his home in Winnipeg, Man., on June 11th, 1941. He was born at Savanna, Ill., U.S.A., on September 26th, 1885, and was educated at the local high school. In 1904 he started as an instrumentman with the Chicago, Burlington and Quincy Railway and remained in railroad construction in the United States until 1910, when he came to work for the City at Medicine Hat, Alta. From 1911 to 1913 he worked as assistant engineer with the Canadian Northern Railway. From 1915 to 1919 he was overseas as an officer in the Royal Engineers, and in 1919 he went to Russia with the British Military Railway Mission. He returned to Winnipeg in 1920 and became connected with the Peter Lyall Construction Company of Montreal. A few years later he was in the States and for some time was connected with the New York Central Railway. He returned to Winnipeg in 1930, and in 1934 he worked for the Department of National Defence at Nakina, Ont. He returned to Winnipeg in 1937.

Mr. Harry joined the Institute as an Associate Member in 1920.

Joseph Arthur Lamoureux, M.E.I.C., died in Montreal on May 19th, 1941. He was born at Bedford, Que., on July 7th, 1873, and received his education at the Ecole Polytechnique at Montreal where he was graduated in 1898. Upon graduation he became engaged on the construction of the East Richelieu Valley Railway, and in the years 1899 and 1900 he did surveying work for the Montreal, Ottawa and Georgian Bay Canal Company. In 1900 he joined the Department of Public Works of Canada at Ottawa, and remained in the government service until his retirement in 1937, when he came to Montreal. During his numerous years of service he was connected with most of the important projects carried out by the Department of Public Works.

Mr. Lamoureux joined the Institute as an Associate member in 1909.

Patrick Philip, M.E.I.C., died at Montreal on July 14th, 1941. He was born at Londonderry, Ireland, on December 4th, 1882. He received his preliminary education at the Royal High School, Edinburgh, and his technical training at the Londonderry Technical Institute. After a few years practice in Ireland he came to Canada in 1907, and until 1910 was engaged on location and construction work with the Grand Trunk Railway. From 1910 to 1917 he was assistant to the city engineer of Vancouver, B.C. In 1917 he joined the Department of Public Works, Kamloops, B.C., as district engineer, and from 1919 to 1921 he was district

Patrick Philip, M.E.I.C.

engineer at Vancouver. In 1921 he was appointed Public Works engineer at Victoria. In 1935 he came to Montreal with the Canada Creosoting Company.

Mr. Philip joined the Institute as an Associate member in 1917 and he became a Member in 1922.

Robert Ramsay, M.E.I.C., died at his home in Montreal on July 11th. He was born at Glasgow, Scotland, on October 3rd, 1888. He received his preliminary education at Annan Academy, and obtained his technical training at Newbie Technical Classes and at West of Scotland Technical College, Glasgow. In 1910 and 1911 he worked as a draughtsman on the design of cargo vessels machinery with Messrs. D. & W. Henderson, Glasgow. From 1911 to 1913 he was engaged in the design of machinery for torpedo boat destroyers with Messrs. Yarrow & Company, Glasgow, and from 1913 to 1916 he designed machinery for light cruisers with Messrs. Vickers Limited, Barrow-in-Furness. He came to Canada in 1916 as chief draughtsman and assistant to the general manager of Canadian Vickers of Montreal. In 1923 he was appointed assistant chief engineer, and later became manager of the industrial department. In 1937 he became associated with Lambert, German & Milne, naval architects, Montreal. At the time of his death he was consulting engineer with Wartime Merchant Shipping Limited.

Mr. Ramsay joined the Institute as an Associate Member in 1924.

News of the Branches

Activities of the Twenty-five Branches of the Institute and abstracts of papers presented

NIAGARA PENINSULA BRANCH

J. H. Ings, M.E.I.C. - - *Secretary-Treasurer*
C. G. Cline, M.E.I.C. - *Branch News Editor*

The annual meeting of the Niagara Peninsula Branch was held in the General Brock Hotel, Niagara Falls, on June 26 with an attendance of fifty. Mr. A. L. McPhail presided, in the absence of the chairman, Mr. C. H. McL. Burns. The retiring secretary, Mr. G. Griffiths, introduced the newly-elected members of the Branch executive and the new secretary, Mr. J. H. Ings.

The guest speaker, Mr. E. L. Durkee, C.E., resident engineer for the Bethlehem Steel Co. at Niagara Falls, N.Y., was introduced by Councillor W. R. Manock. Mr. Durkee spoke on **Erection of Steel Superstructure of the Rainbow Bridge.** His talk was illustrated by a model of the erection layout and by three reels of motion pictures. The new bridge is being erected for the Niagara Falls Bridge Commission. The consulting engineers are Waddell & Hardesty of New York City and the Edward P. Lupfer Corporation of Buffalo. The arch ribs were fabricated by the Bethlehem Steel Company at Pottstown, Pa., the spandrel girders by the Hamilton Bridge Company and the rest of the steel by the Canadian Bridge Company at Walkerville, Ont. The bridge is of the fixed arch type with a span of 950 ft. centre to centre of supports, which is 150 ft. longer than the Henry Hudson bridge at New York. The whole load is carried by the two circular arch ribs which are spaced at 56-ft. centres and rise 150 ft. The bridge will have a reinforced-concrete deck carrying two 22-ft. roadways, separated by a 4-ft. central mall, and one 10-ft. sidewalk on the upstream side facing the falls. The steelwork supporting the deck from the arch ribs will be merely dead load and has not been designed as trusses to stiffen the arches. The fixed arch design was selected as being stiffer for the same depth of rib. Each end of each arch is anchored at the skewbacks by 32 anchor bolts set 23 ft. in concrete imbedded in the solid rock. In erection, three panels, containing 25 per cent of the weight of the ribs, were supported by cantilvering on these bolts. The rest of the weight was carried by 1$\frac{9}{16}$-in. cables from the tops of towers erected temporarily on the end of each concrete approach. The box-type ribs are 12 ft. deep with cover plates from 1$\frac{1}{8}$ to 2$\frac{1}{2}$ in. thick and are stiffened by internal plates set three feet apart and by angles. The ribs were divided into sections weighing between 50 and 75 tons each. These were lowered from the approach by an 85-ton stiff-leg derrick, moved up the arch on a material truck with 8-ft. gauge, and lifted into place by a 55-ton derrick travelling on the arch ribs. As the arches were built out from shore, the supporting cables were moved from one panel point to another, nearly 75 per cent of the erection time being devoted to rigging, erection of falsework, etc. At the centre, the arches were supported temporarily on bolted brackets and shims, the opening being varied by hydraulic jacks. The opening was measured accurately under the desired stress condition and was closed finally by 11-in. steel "keystone" pieces, specially milled to fit. The supporting cables and towers have been removed and by July 10th the steelwork will be finished. Forming will be started at once and concreting will start about August 1st.

After a lengthy question period, the vote of thanks, moved by Mr. M. B. Atkinson, was heartily approved by the audience.

SAGUENAY BRANCH

T. A. Taylor, Jr.E.I.C. - - *Secretary-Treasurer*
B. E. Surveyer, Affil.E.I.C. - *Branch News Editor*

The 1941 Annual Meeting of the Saguenay Branch of the Engineering Institute of Canada was held at Arvida, July 4th, 1941.

At 2.15 p.m., about 25 of the members assembled at the quarters of the 12th Anti-Aircraft Battery stationed in Arvida, where a most interesting tour of inspection took place under the guidance of Major I. B. MacCullum, O.C. the Anti-Aircraft Unit. Judging by the numerous questions asked, it was evident that this tour of inspection was of keen interest to all those participating.

Following the visit to the battery, a handful of the members braved the hazards of the Arvida Golf Club without endangering "Old Man Par" except on one or two holes.

At 7.00 p.m. about 45 members gathered at the Grill Room of the Saguenay Inn for dinner and the annual meeting.

The chairman, Mr. J. W. Ward, in his most able manner proposed a toast to the King, following which he established a precedent for the Saguenay Branch by proposing a toast to the president of the United States, which was heartily responded to by all members. Following the toasts, the members sat down to dinner.

At the conclusion of an enjoyable dinner the chairman introduced the guest speaker for the evening.

Professor R. F. Legget of the University of Toronto, who is in Arvida for the summer in connection with the Shipshaw power development, was the first speaker. He expressed his pleasure in being present at the meeting and conveyed the good wishes of the Toronto Branch Executive of which he is a member. Professor Legget gave a very interesting resumé of the work in progress at the Shipshaw, outlining the geological formation of this section of the Saguenay valley. He invited all members interested to see several samples of well preserved birch and balsam found in the excavation work which he has in his possession and which he estimates to be several tens of thousands years old.

Professor Legget also remarked at the splendid co-operation of the various divisions of engineering in the Saguenay Branch of the Institute, as compared to the larger centres where other organizations tended to segregate the various divisions into their own groups. Unfortunately Professor Legget was obliged to catch the train and had to cut his talk short, but the members are hoping to have the opportunity of a complete paper from him before his work is completed here.

The next speaker, Mr. McNeely DuBose, a familiar figure in the activities of the Saguenay Branch having been an active participant for 15 years, expressed his thanks and pleasure at being present, and also conveyed greetings from the Council at Montreal.

Mr. DuBose outlined the highlights of the Shipshaw development and announced the construction of a powerhouse with a capacity of approximately 1,000,000 horsepower, of which orders had been placed for 500,000 hp. In conjunction with the Shipshaw he also announced the construction of a large storage dam on the Peribonka River to provide additional water for the winter months.

The speaker next mentioned several steps being taken by the Saguenay Power Company to obtain additional power for the Saguenay district one of which was the installation of a 110,000-volt cable across the city of Montreal to transmit off-peak power from the Beauharnois system to the Shawinigan system.

Following Mr. DuBose's interesting talk was a highly informative lecture by Major I. B. MacCullum. He expressed his thanks at being invited to attend the meeting, and also his thanks to the Aluminum Company of Canada for the splendid assistance and co-operation he received as well as the fine accomodations for the battery which he described as equal to anything in Canada.

He described the equipment, and its development since the last war, used by modern Anti-Aircraft Batteries. This included the calibre of various guns, their makes, and their effectiveness. In conjunction with this he mentioned the British made 40 mm. gun as being very superior to anything built to-day.

Included in his remarks were several very interesting facts about the work of A.A. Batteries in France and especially at Dunkerque.

At the conclusion of his talk, Major MacCullum was bombarded by numerous questions by the members which he answered in a most satisfactory manner.

Before turning over the chair to the incoming executive, Mr. Ward moved a vote of thanks to the Protestant School Board of Arvida for their generosity in allowing the Branch to hold its meetings in the school during the past year. He thanked the members of the executive for their support in the past year and then introduced the new chairman, N. F. McCaghey.

Mr. McCaghey expressed his pleasure at being chosen chairman for the second time and then declared the meeting adjourned.

VANCOUVER BRANCH

T. V. Berry, M.E.I.C. - - *Secretary-Treasurer*
Archie Peebles, M.E.I.C. - - *Branch News Editor*

The final meeting on the programme of the Vancouver Branch for this season was held on Wednesday, May 21, in the Georgia Hotel. The speaker was a branch member, Mr. W. N. Kelly, and his subject was **Woodenwalls and Ironclads.** Mr. Kelly has spent his lifetime with ships and shipping, and his intimate knowledge of the historical side of his subject, combined with broad experience, provided a most interesting address.

The speaker opened by paying high tribute to the shipbuilding genius of Noah who, according to the specifications handed down to us in the scriptures, designed and constructed a vessel which ranks with many modern ships in size and tonnage. Its exact proportions are not conclusively known owing to the various interpretations and units of measurement applied in relation to our own.

Other historical references to shipbuilding were made, including the exploits of the ancient Greeks, Phoenicians, Vikings and other races who developed the art of ship construction to a high degree. These early ships used oars or sails, and made voyages over long distances in search of trade or conquest. Some of the early ships built in England were also described, to show that the sturdiness of their construction and the quality of materials used is not often matched at the present time. Beams and ribs were of oak, with copper fastenings, and sometimes the hull would be two feet in thickness. This was especially true in the case of ships of the navy.

In describing the size of ships, Mr. Kelly pointed out that three separate measurements are used. The gross tonnage is the total internal volume of the ship in tons of 200 cu. ft. The registered tonnage is the total internal volume, less deductions for space occupied by machinery, etc. The deadweight tonnage is the displacement in tons of 35 cu. ft.

The invention of gunpowder brought about a change in ship construction to resist the new-found weapons. The old woodenwalls gave place to ironclads when iron plates were used above the waterline on the outside of the timber construction used at that time. In some cases iron plates five inches thick were placed on 22-inch oak walls to resist the battering of cannon fired broadside at close range.

The next big advance was the invention of steam propulsion which began early in the 19th century. The early paddle wheel steamers used steam pressures of 26 to 30 lb. per sq. in. A number of early steamships of historical interest were described such as the *Charlotte Dundas*, the *Fulton*, and the *Comet*. The *Fulton* was built in New York and the others in Scotland, shortly after 1800. In 1865 the Admiralty adopted Ruthven's method of propulsion with screw propellers.

Other advances which have marked the building and use of ships were the compound engine using triple expansion, increased boiler pressures, water tube boilers, and the Parson's Turbine. The turbine brought about a very rapid increase in horsepower as indicated by the fact that in 50 years the horsepower of reciprocating engines increased from 5,000 to 40,000, while in five years the power of turbines increased from 9,000 to 70,000. Torpedo boats and destroyers were an application of the steam turbine. Oil fuel also contributed to rapid growth in speed and power.

Much was contributed to marine architecture by scientific studies of the behaviour of ships at sea; a work which has been carried on largely by the navy departments of various countries. In 1900 the first submarines were built for Great Britain, others having been built a short time previously for the United States and France. The address concluded with a brief description of the corvettes and other vessels being built at the present time.

A great many questions were asked and answered, and many personal experiences were recalled by Mr. Kelly and members of the audience. The meeting was a fitting conclusion to a very successful series which the Vancouver Branch has enjoyed during the winter. In the absence of the chairman, Dean Finlayson, Mr. W. O. Scott, vice-chairman, presided and a hearty vote of thanks was tendered by Mr. W. H. Powell.

News of Other Societies

Items of interest regarding activities of other engineering societies or associations

CANADIAN ELECTRICAL ASSOCIATION

The following officers were elected at the fifty-first convention of the Canadian Electrical Association held at the Seigniory Club, Que., from June 25-27. President: McNeely DuBose, M.E.I.C., General Manager, Saguenay Power Company, W. C. Mainwaring, B.C. Electric Railway Co. Ltd.; R. A. C. Henry, M.E.I.C., Beauharnois Light, Heat & Power Co.; and T. A. Brown, M.E.I.C, Gatineau Power Co,; will be the three vice-presidents for the coming year. B. C. Fairchild was re-elected secretary for the eleventh year and J. B. McCabe, Montreal Light, Heat & Power Cons., was re-elected treasurer. The new executive committee is as follows: A. C. Brittain, Gatineau Power Company, Ottawa, Ont.; A. L. Brown, Northern Electric Co. Ltd., Montreal, Que.; E. V. Caton, M.E.I.C., Winnipeg Electric Company, Winnipeg, Man.; R. N. Coke, M.E.I.C., Montreal Light, Heat & Power Cons., Montreal, Que.; H. A. Cooch, M.E.I.C., Canadian Westinghouse Co. Ltd., Hamilton, Ont,; J. H. Fregeau, M.E.I.C., Shawinigan Water & Power Co., Three Rivers, Que.; J. B. Hayes, M.E.I.C., N. S. Light & Power Co. Ltd., Halifax, N.S.; B. M. Hill, M.E.I.C., Canadian Utilities Ltd., Calgary, Alta.; Chas. Johnstone, Southern Canada Power Co. Ltd., Montreal, Que.; Geo. Kirlin, Canada Wire & Cable Co. Ltd., Montreal, Que.; F. Krug, Montreal Engineering Co. Ltd., Montreal, Que.; G. W. Lawrence, Sangamo Company Limited, Toronto, Ont.; I M. MacLean, Canadian General Electric Co. Ltd., Toronto, Ont.; A. S. McCordick, Moloney Electric Co. of Canada Ltd., Toronto, Ont.; R. A. Merritt, Winnipeg Electric Company, Winnipeg, Man.; W. H. Munro, M.E.I.C., Ottawa Light, Heat & Power Co. Ltd., Ottawa, Ont.; C. R. Reid, M.E.I.C., Shawinigan Water & Power Co., Montreal, Que.; A. Vilstrup, B. C. Electric Railway Co. Ltd., Vancouver, B.C.

CONVENTION OF A.W.W.A.

Canadian Section

Nearly 1,500 persons attended the sixty-first annual convention of the American Waterworks Association in the Royal York Hotel, Toronto, June 22nd-26th. This total comprises a Canadian registration of 382.

In view of the parent association holding its convention in Toronto, the Canadian section confined its activities to a luncheon held on the first day of the convention and a business meeting.

At this meeting, presided over by the retiring chairman, G. H. Strickland, the annual reports were presented. The officers for the new year were elected, and a number of presentations and awards were made. In his report the secretary-treasurer announced an increase in the membership of the section and a change of the status of the membership in western Canada which permits members in that part of the country to hold joint membership in another nearby section, thus affording closer contact with the affairs of the Association.

Memorial awards were presented by the chairman in the names of the late James A. MacMillan of Charlottetown, and Frederick E. Field of Montreal. The first medal was accepted by M. L. Gordon, town engineer of Truro, N.S., and the second by C. J. Desbaillets, M.E.I.C., chief engineer of water supply, Montreal, for delivery to the respective families.

The newly elected officers for the current year are as follows: Chairman, William Storrie, M.E.I.C., Gore & Storrie, Consulting Engineers, Toronto; Trustees: A. L. McPhail, Waterworks Superintendent, St. Catharines, Ont., J. W. Peart, Manager of Public Utilities, St. Thomas, Ont. The other officers of the Canadian Section elected previously are: Past-Chairman, G. H. Strickland; Section Representative of A.W.W.A. Board of Directors, J. Clark Keith, M.E.I.C.; Trustees: T. M. S. Kingston, M.E.I.C., C. C. Folger, M.E.I.C., W. E. Robertson and O. H. Scott.

ROAD BUILDERS WILL CONSIDER POST-WAR WORK

Plans for the launching of a national road building programme after the war, which should provide employment for 200,000 wage earners for a period of three years, will be one of the features to be discussed at the Twenty-sixth Annual Convention of the Canadian Good Roads Association. It is announced by the president, Honorable T. D. Bouchard, Minister of Roads, Province of Quebec, that the Convention will be held at the General Brock Hotel, Niagara Falls, on October 7th, 8th and 9th, and will be attended by ministers of highways and public works, their deputies and engineers, from every province in the Dominion.

The provincial ministers and their engineers have, following last year's convention, already started on a survey of what work can be undertaken in their respective provinces. It has been realized that the preparation of plans, working out of engineering details and acquisition of rights-of-way must be started well in advance of actual roadwork, and factual data relating to highway conditions will be submitted to the Convention for consideration.

The Executive of the Canadian Good Roads Association accepted an invitation from Hon. T. B. McQuesten, Minister of Highways for Ontario, to meet at the hub of Ontario's splendid highway system and plans are now being laid for a three-day programme that will deal specially with war-time matters, current needs for highway improvement to withstand heavy mechanized transportation, as well as with post-war rehabilitation.

The invitations now issuing point out that the provision of adequate highways, and bridge structures, are the basic needs of North America defence plans, for without them the rapid transportation of heavy mechanized forces and the expeditious movement of raw materials and munitions will be impossible.

"Skilled roadmen must be retained for road works," says Hon. T. D. Bouchard, in his invitation to the Convention. "To allow roads to deteriorate in the face of heavy increased demands for military requirements, transportation of munitions and for general commercial purposes, would lower national efficiency to a degree which no apparent financial saving can justify. New standards of construction may have to be determined and provision made for parallel and feeder roads for the transportation of farm and industrial products to commercial centres. Linking up and improving access roads with main routes must be considered, and it is the concensus of opinion among government officials that no time should be lost in studying the necessary improvements, and co-ordinating them into a comprehensive plan which will be of vital importance to the whole country.

Library Notes

Book notes, Additions to the Library of the Engineering Institute, Reviews of New Books and Publications

ELEMENTARY AERODYNAMICS

By Group Captain D. C. M. Hume

Reviewed by SQN. LD. C. W. CROSSLAND, M.E.I.C.*

Group Captain Hume has succeeded, in this slender textbook, in setting out a clear and accurate statement of the elementary principles of aerodynamics, without attempting to go into involved mathematical processes to demonstrate the proof of these principles. For an elementary book, it breathes a refreshing air of precision and accuracy, frequently lacking in such works.

The book opens with a discussion of the air and its properties and definitions of aeronautic terms. Newton's laws of motion are re-stated in terms of air forces and the laws of fluid pressure are given with reference to air. Measurement of air pressure is explained by reference to the equation:

$$P = \frac{1}{2} \rho V^2$$

and here, unfortunately, an opportunity is missed for a useful explanation of dimensional theory and the unit of mass, the slug. This unit will be unfamiliar to many students. The subject of measuring air pressure leads naturally to a brief description of the various types of wind tunnels, but the only wind tunnel balance described is the original National Physical Laboratory type, now little used. It is stated that wind tunnel tests show that the reaction on a body in an air stream is given by the equation:

$$R = \frac{1}{2} C\rho SV^2$$

Here, again, a page could profitably have been devoted to a proof of this equation by dimensional analysis.

Lift and drag, and the development of the aerofoil section from a flat plate are briefly explained, with some notes on the effect of camber.

Chapter II gives an account of streamline and turbulent air flow, the origin of drag and the stall. A discussion of lift and drag coefficients and their variation with angle of incidence follows in Chapter III, with a reference to L/D curves. The balance of the forces of flight, lift, weight, drag and thrust is also explained. The balance of forces in climb is rather confused, particularly Fig. 22, which omits thrust from the force diagram and shows the flight path as coincident with the thrust line, a condition which is scarcely likely to occur in practice. An alternative conception of climb is offered in which conditions are described which can actually occur only in accelerated flight. The chapter closes with the determination of landing speed.

Chapter IV discusses lift forces more fully, and describes chord distribution, span distribution, induced drag and wing interference in biplanes. The circulation theory of lift is briefly dealt with. Chapter V explains centre of pressure movement and the means by which trim is maintained in flight. Chapter VI defines the three axes of motion and deals with the means of control of rotation of the aircraft about these axes, that is to say, the ailerons, elevators and rudder. The definition of mass balance applies to static balances; the term mass balance usually being reserved for dynamic balance, whose function is to damp out vibration of the control surface, caused by eddies. The action of frise ailerons and differential ailerons, in balancing yawing couples in turning, is also described.

Chapter VII is devoted to static stability; dynamic stability is mentioned, but this subject is one which can hardly be dealt with adequately in a non-mathematical treatment. The explanation of auto-rotation omits any reference to yawing couples and might convey the impression that an aeroplane is capable of performing a pure autorotation continuously.

The action of dihedral in restoring lateral trim in a sideslip is over-simplified by considering only the side-slip velocity. Dihedral simply provides a geometric increase of incidence on the low wing, with a corresponding decrease on the high wing, in side-slip.

The climb, glide, roll, turn and spin are discussed in a further chapter on Manoeuvres. The last two are very clearly explained. Chapter IX, on propulsion, refers to the momentum and vortex theories of airscrews and develops the blade element theory in some detail. Airscrew pitch and efficiency are defined, and mention is made of variable pitch airscrews, gearing and balance.

A final chapter on performance illustrates the calculation of horse-power required and hp. available, the construction of the performance chart, and determination from it of top speed, best climbing speed, rate of climb and ceiling. The current passion for quiz programmes is reflected in the series of questions appended to the book.

On the whole, the book is an excellent introduction to aerodynamics, in spite of a few weak points, and maintains a much higher standard of accuracy than is usually found in its class. It deserves to be popular among student pilots, engineers, and mechanics, as it is interesting and readable, and covers the subject remarkably well, with little mathematical assistance.

* Commanding Officer, No. 17 (Technical) Detachment, Halifax, N.S.

REPORT ON BUILDINGS DAMAGED BY AIR RAIDS, AND NOTES RELATIVE TO RECONSTRUCTION

Institution of Structural Engineers, LONDON, 1941

7pp., 5½ x 8½ inches sixpence

Reviewed by S. R. BANKS. M.E.I.C.*

During the past twenty years the Institution of Structural Engineers has prepared and published reports dealing with a variety of engineering matters. The subject of air-raid precautions received attention some time prior to the beginning of the war; and the present report, based on experience gained during the severe raids of last year, is an equally timely contribution to the war services of the engineer.

It is unfortunate that rigorous censorship, in forbidding reference to specific instances, has robbed the report of much of its value, but nevertheless some of the generalized conclusions are of interest.

In the first place, the reporting committee was greatly impressed by the variety of problems that arise in the survey of damaged structures. It is pointed out the services of competent and broadly experienced engineers are required, and that considerable skill is needed to make sound decisions regarding repairs and replacements.

Secondly, it has been clearly established that modern framed buildings (of reinforced concrete or protected steelwork) have exhibited great powers of resilience and endurance under attacks both explosive and incendiary, while brick-and-timber buildings have proved to be extremely vulnerable.

Thirdly, the use of strong beam-and-column connections and the provision of frequent bracing-systems have been demonstrated to be of distinct value in localizing the effects of bombing. Also, as might have been expected, structures with a liberal factor of safety in their original design have withstood attack much better than have those where that margin was reduced to a minimum.

* General Engineering Department, Aluminum Company of Canada Limited.

ADDITIONS TO THE LIBRARY

TECHNICAL BOOKS

Mathematical Tables:

By Robert Bristol Dwight, New York, John Wiley & Sons, Inc., 1941. 229 pp., 6¼ x 9¼ in.

Mining Engineers' Handbook:

By Robert Peele, New York, John Wiley & Sons, Inc., 1941, 3rd edition. Two volumes, 5½ x 8½ in., $15.00.

Report on Buildings Damaged by Air Raids, and Notes Relative to Reconstruction:

By Institution of Structural Engineers, London, 1941. 7 pp. 8½ x 5½ in., 6d.

PROCEEDINGS AND TRANSACTIONS

Canadian Surveyor:

Proceedings of thirty-fourth annual meeting of the Canadian Institute of Surveying, February 5th and 6th, 1941.

Institution of Water Engineers:

Transactions, Vol. XLV, 1940.

REPORTS

Canada Department of Labour:

Labour legislation in Canada, 1940. Ottawa, 1941.

Canada Department of Mines and Resources:

Report of Mines and Geology Branch for the year ended March 31, 1940, Ottawa, 1941.

Canada Department of Mines and Resources, Mines and Geology Branch, Geological Survey Paper:

Report and preliminary map Houston map-area, British Columbia; preliminary report MacKay lake area, Northwest territories; preliminary map Great Slave Lake to Great Bear lake, Northwest Territories; preliminary report Ingray lake map-area, Northwest Territories; preliminary map Brazeau, Alberta; preliminary map Manson Creek, British Columbia; Vassan-Dubuisson map-area, Abitibi County, Quebec, Northeast part, Beauchastel township, Témiscaminque County, Quebec; preliminary map Morley, Alberta. Papers, 40-18, 41-1, 41-2, 41-3, 41-4, 41-5, 41-6, 41-7, 41-8.

Canadian Government Purchasing Standards Committee:

Specification for interior floor enamel; specification for enamel, glyceryl phthalate type; specification for interior enamel; procedure for the determination of gum stability of aviation fuel; specification for oil for hydraulic mechanisms and low temperature lubrication on aircraft.

Electrochemical Society—Preprints:

The production of potassium permanganate; electrophoretic filtration of a kaolin slurry; further studies on electrolyte films; the activation of ammonia synthesis by means of alkali ions; rate studies in the electrochemical oxidation of phenol. Preprints 80-3 to 80-7.

University of Minnesota Institute of Technology—Technical Papers:

Fuse failures on rural lines due to lightning; the resistance to combined flexure and compression of square concrete sections. Technical papers Nos. 28 and 29.

United States Department of Commerce, Building Materials:

Fire tests of wood- and metal-framed partitions, report BMS71.

United States Work Projects Administration—Bibliography of Aeronautics

Supplement to part 4—dynamics of the airplanes; supplement to part 21, blind flight automatic pilot ice formation; supplement to part 48—parachutes; part 49—rocket propulsion; part 50—stratospheric flight.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet the books are not in the Institute Library, but inquiries will be welcomed at Headquarters, or may be sent direct to the publishers.

AIR AND GAS COMPRESSION

By T. T. Gill. John Wiley & Sons, New York, 1941. 181 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $3.00.

This new textbook discusses the properties of gas in regard to compressibility, critical data and specific heats, as applied to the solution of the problem of air and gas compression. Illustrative problems with solutions accompany each chapter, and a set of practical alignment charts for various calculations is appended.

AIR RAID PRECAUTIONS, in Ten Parts,

reprinted by permission of the Controller of His Britannic Majesty's Stationery Office, First American edition, Chemical Publishing Co., Brooklyn, N.Y.. 1941. diagrs., charts, tables, 9 x 5½ in., cloth, $3.00.

In the ten separately paged sections of this manual are brought together and amplified the materials published previously in the A.R.P. handbook and memorandum series. Topics discussed include the organization of the air raid wardens' service, communications systems, rescue parties and clearance and decontamination work; structural defense and window protection; gas detection and identification; training procedures and the inspection, care and repair of equipment.

AIRCRAFT INSTRUMENTS, Their Theory, Function and Use.

By O. E. Patton. D. Van Nostrand Co., New York, 1941. 220 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $2.75.

Intended both as a textbook for the student and a practical manual for the aviator or mechanic, this book presents a clear, concise discussion of the various flight, navigation and engine instruments. Design and construction are described in such a way that the nature, principle, functioning and purpose of any instrument can be readily understood. Many photographs and diagrams supplement the text.

AIRCRAFT PROPELLERS, Basic Training Manual

By C. M. Harlacher, prepared and edited by H. E. Boughman. Aero Publishers, 120 North Central Ave., Glendale, Calif., 1941. 119 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $2.85.

Intended as a basic training manual, this book presents in question and answer form the fundamentals of propeller theory, construction and maintenance. The Civil Aeronautics Administration regulations are covered, and considerable space is given to detailed descriptions of certain modern adjustable propellers.

(THE) BOULDER CANYON PROJECT, Historical and Economic Aspects.

By P. L. Kleinsorge with a foreword by E. Jones. Stanford University Press, Stanford University, Calif., 1941. 330 pp., illus., diagrs., maps, tables, 9½ x 6 in., cloth, $3.50.

The whole system of related works comprising the Boulder Canyon Project (not merely the Hoover Dam construction and its resulting reservoir area) is discussed. The history of the project is reviewed, and the economic significance of this great flood control, irrigation, power and water supply system is explained in detail. Geological and engineering aspects of the various dams, canals and aqueducts are also considered. The book is well documented.

(The) CHEMISTRY OF POWDER AND EXPLOSIVES, Vol. 1

By T. L. Davis. John Wiley & Sons, New York; Chapman & Hall, London, 1941. 216 pp., illus., diagrs., tables, 9 x 5½ in., cloth, $2.75.

Intended as a text for fourth-year and graduate students, this book has been written to inform chemists concerning the modes of behavior of explosive substances and the phenomena, both chemical and physical, which they exhibit. The use of explosives in ammunition and blasting is treated only so far as is necessary to make certain points clear. This first of a two-volume set covers properties of explosives and deals particularly with black powder, pyrotechnics and aromatic nitro compounds. Other explosives will be considered in the second volumes.

CIVIL AND DEFENSE, a Treatise on the Protection of the Civil Population against Air Attach

By A. M. Prentiss. Whittlesey House (McGraw-Hill Book Co.), New York and London, 1941. 334 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $2.75.

The various means and methods of air attack are described, with the effects produced by each and indications of the scope and character of the threat to civil population. Other topics discussed include protection against high explosives, incendiaries and gases, the organization of warning and warden services, and the construction of shelters. The final chapter discusses the probable influence of civil air defense on the national life and future city development.

DANA'S MANUAL OF MINERALOGY. revised by C. S. Hurlbut, 15th ed,

John Wiley & Sons, New York, 1941. 480 pp., illus., diagrs., charts tables, 9 x 6 in., cloth, $4.00.

This is the fifth major revision of this standard work, now nearly 100 years old. As before, it is designed to meet the needs of the student of mineralogy, the mining engineer, the geologist and the amateur mineralogist. In addition to alterations and additions for the purpose of bringing the material up to date, certain changes have been made to render the book more serviceable as a text for a course in elementary mineralogy.

DRILLING AND PRODUCTION PRACTICE 1939. 675 pp., $3.50.

DRILLING AND PRODUCTION PRACTICE 1940. 263 pp., $2.50

American Petroleum Institute, Division of Production, Central Committee on Drilling and Production Practice, New York., illus., diagrs., charts, tables, 11 x 8 in., cloth.

The American Petroleum Institute annually publishes these collections of papers on drilling and production practice selected from those presented at its meetings. The papers are divided into four groups: drilling practice, production practice, materials and miscellaneous. A bibliography of district-meeting papers, following the main text, contains abstracts and references as to where complete papers have appeared.

FIELD GEOLOGY

By F. H. Lahee. 4 ed. rev. and enl. McGraw-Hill Book Co., New York and London, 1941. 853 pp., illus., diagrs., charts, tables, 7½ x 5 in., lea., $5.00.

Intended both as a textbook for students and a manual for geologists and engineers, this book treats the subject of geology from a field viewpoint and assumes an elementary knowledge of general geology. The first twelve chapters are concerned with the recognition and interpretation of geologic stuctures and topographic forms as they are observed. The succeeding eleven chapters deal with geological surveying, computations, the preparation of reports, geophysical methods and the nature, construction and interpretation of geologic and topographic maps. There is a bibliography.

FLUORESCENT LIGHT and Its Applications

By H. C. Dake and J. De Ment. Chemical Publishing Co., Brooklyn, N.Y., 1941. 256 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $3.00.

The types and theory of luminescence are explained, and the methods of examination of fluorescent substances are described. Separate chapters are included upon the sources of ultraviolet radiations and on fluorescent and radioactive minerals, and some fifty-five pages are devoted to the uses of ultraviolet light in many fields. There is a large, broadly classified bibilography.

FOUNDATIONS OF BRIDGES AND BUILDINGS

By H. S. Jacoby and R. P. Davis. 3 ed. McGraw-Hill Book Co., New York and London, 1941. 535 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $5.00.

Completely revised and reset, this text covers the many recent developments in the field of foundation engineering. The more important phenomena in the field of soil mechanics are covered; there is new material on piling, cofferdams and caissons, grouting, and the obstruction of water flow by bridge piers; and a new chapter has been added on land foundations in open excavation including water control.

IMPERIAL INSTITUTE, ANNUAL REPORT, 1940,

London, South Kensington 60 pp., illus., tables, 10 x 6 in., paper, (obtainable from British Library of Information, 620 Fifth Ave., New York, not for sale, limited distribution only).

The many activities of the Institute are indicated by the brief reports of various committees which appear in this publication. In addition to the scientific research and exhibits thus described, the pamphlet contains the personnel of the governing groups and staff of the Institute, lists of publications and a list of co-operating organizations.

INDUSTRIAL FABRICS, a Handbook for Engineers, Purchasing Agents and Salesmen

By G. B. Haven. 3 ed. Wellington Sears Co., 65 Worth St., New York, 1941. 789 pp., illus., diagrs., charts, tables, 8 x 5 in., fabrikoid, $2.00.

All phases of the cotton fabric industry are covered in this handbook for engineers, purchasing agents and textile students. In addition to the considerable amount of information on the raw material, manufacturing processes and properties of fabrics, much space is devoted to specifications and test methods. There are many illustrations and tables, and the bibilography has been expanded.

INDUSTRIAL RELATIONS DIGESTS

VII. SELECTION AND TRAINING OF FOREMEN, 8 pp.

VIII. UPGRADING OF PRODUCTION WORKERS, 7 pp.

Princeton University, New Jersey, Industrial Relations Section, May, 1941. 10 x 7 in., paper, $.20 each.

The above titles represent two further subjects covered in a series of digests of current practice prepared for use in companies facing rapid expansion owing to defense orders. These digests are based on material received currently from a large number of representative companies.

INTERIOR ELECTRIC WIRING AND ESTIMATING

By A. Uhl, A. L. Nelson and C. H. Dunlap. 3 ed. American Technical Society. Chicago, 1941. 354 pp., illus., diagrs., charts, tables, 8½ x 5½ in., cloth, $2.50.

The methods, equipment and materials for all kinds of interior wiring, from small jobs to apartment and factory buildings, are described in detail. The final chapter covers estimating procedure for electrical work, including both materials and labor costs. Eight blueprints giving the architectural drawings for a small house accompany the book. New material has been added and the whole book has been revised in accordance with the 1940 National Electrical Code.

(An) INTRODUCTION TO PHYSICAL GEOLOGY

By W. J. Miller, 4th ed. D. Van Nostrand Co., New York, 1941. 465 pp., illus., diagrs., charts, maps, tables, 9½ x 6 in., cloth, $3.25.

Intended as an elementary text, no formal knowledge of chemistry or physics is necessary for an understanding of the contents of this book. It covers the composition, structure, unusual attributes and processes of formation and alteration of the earth's crust. The considerable revision of the new edition is particularly evident in the statistical material in the brief discussion of economic geology.

MANUAL OF ENGINEERING DRAWING for Students and Draftsmen

By T. E. French. 6 ed. Rev. and enl., McGraw-Hill Book Co., New York and London, 1941. 622 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $3.00.

The new edition of this comprehensive, standard textbook has undergone considerable revision. The page size has been enlarged to allow an increase in the size and number of illustrations; many problems have been changed and added; and in addition to revision of existing chapters new ones have been included on aircraft drawing, jig and fixture drawing and welding drawing. The material conforms to the standards of the American Standards Association, and there is a useful bibliography of allied subjects.

OUTLINE OF AIR TRANSPORT PRACTICE

By A. E. Blomquist. Pitman Publishing Corp., New York and Chicago, 1941. 402 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $4.50.

The activities of the various departments within an airline organization are outlined, with discussion of the necessary correlation between departments. The general principles of management, operation and sales that are fundamental to any type of transportation are here applied to air transport. Descriptions and analyses of practice are limited to scheduled operations in the United States. There is a bibliography.

PARTIAL DIFFERENTIAL EQUATIONS

By F. H. Miller. John Wiley & Sons, New York, 1941. 259 pp., tables, diagrs., 9½ x 6 in., cloth, $3.00.

The first two chapters of this elementary text are devoted to a review of ordinary differential equation methods, while Chapter III is designed to show the various ways in which partial differential equations come into being. The remaining chapters, with the exception of VI, which briefly discusses Fourier series, deal with methods of solving different classes of partial differential equations and with geometric and physical problems solvable by the processes explained.

PRACTICAL AIR CONDITIONING

By A. J. Rummel and L. O. Vogelsang. John Wiley & Sons, New York, 1941. 282 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, $2.75.

Material originally used for lecture courses for dealers, salesmen, operators and service men has been expanded to form this elementary text book. It covers essential fundamentals and definitions; the properties of air; requirements for human comfort; all types of equipment, including automatic controls; proper methods of operation and complete maintenance and servicing methods and schedules.

PRACTICAL SHELL DEVELOPING FOR STEEL SHIPBUILDERS

By A. F. Tulin. 2 ed. Simmons-Boardman Publishing Corp., New York, 1941. 158 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $3.00.

This manual for loftsmen, shipfitters, hull draftsmen and others who deal with steel ship construction explains the development and laying-out of the shell of a vessel. Consideration is mainly given to the points of mold-loft procedure beyond the minor fundamentals, which are assumed as familiar.

PRINCIPLES OF INTERCHANGEABLE MANUFACTURING

By E. Buckingham. 2 ed. Industrial Press, New York, 1941. 258 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $3.00.

This treatise on the basic principles involved in successful interchangeable manufacturing practice has been reprinted from the earlier edition with minor changes in two chapters. It covers design, tolerances, drawings, manufacturing equipment, gaging and inspection.

(The) RADIO ENGINEERING HANDBOOK

By K. Henney. 3 ed. McGraw-Hill Book Co., New York and London, 1941. 945 pp., diagrs., charts, tables, 7 x 4½ in., lea., $5.00.

The chief revision in this comprehensive working manual of the radio sciences has been made in the sections on television, high-frequency technique, loud-speakers and acoustics, detection and modulation, facsimile, and aircraft radio. As in former editions, considerable fundamental data is provided for the designer and operator, with the emphasis on practice rather than on theory. There are many references to supplementary material both in the form of footnotes and section bibliographies.

RADIO-FREQUENCY MEASUREMENTS by BRIDGE and RESONANCE METHODS

By L. Hartshorn. John Wiley & Sons, New York, 1941. 265 pp., diagrs., charts, tables, 9 x 5½ in., cloth, $4.50.

A systematic account of the basic principles and general working ideas of radio-frequency measurements by bridge and resonance methods is presented for the practicing technician. The various types of apparatus are discussed fully, and special attention is given to screening, earth connections, the physical nature of the quantities measured, and sources of error.

REGULATION OF PIPE LINES AS COMMON CARRIERS

By W. Beard. Columbia University Press, New York, 1941. 184 pp., tables, maps, 9 x 5½ in., cloth, $2.00.

A systematic, comprehensive study of federal and state regulation of pipe lines as common carriers. The coördination of pipe lines with other forms of transportation is dealt with, and the author closes the book with a summary of the existing information and certain conclusions which may be drawn therefrom.

RELAXATION METHODS IN ENGINEERING SCIENCE, a Treatise on Approximate Computation

By R. V. Southwell. Clarendon Press, Oxford, England; Oxford University Press, *New York, 1940. 252 pp., diagrs., charts, tables, 9½ x 6 in., cloth, $5.00.*

In this book, a new approach to engineering and physical computations is described, a method which is termed "systematic relaxation of constraints." The greater part of this treatise relates to problems confronted in the theory of elasticity: stress-calculations for frameworks and continuous beams, estimation of critical loads, etc. However, the method is shown to have wider application, and such problems as the adjustment of errors in surveying and the determination of currents and potentials in electrical networks also receive detailed consideration.

REPORTS ON PROGRESS IN PHYSICS, Vol. 7, 1940,

Edited by J. H. Awbery; published by The Physical Society, 1 Lowther Gardens, Exhibition Road, London, S.W.7, 1941. 362 pp., illus., diagrs., charts, tables, 10 x 7 in., cloth, $4.75.

Continuing the series of reports issued by The Physical Society, the present volume deals with advances in physical science up to the end of 1940. In accordance with the trend of the last few volumes, this issue contains for the most part comprehensive articles upon relatively specific types in a variety of physical fields. The only large topic receiving a general review is "sound". Each article is the work of a specialist, and large bibliographies are included in most cases.

RUBBER AND ITS USE

By H. L. Fisher. Chemical Publishing Co., Brooklyn, N.Y., 1941. 128 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, $2.25.

The constitution, properties and history of naturally occurring rubber are discussed, with information upon where it comes from, how it is obtained and how it is manufactured into various commercial articles. Recent developments in synthetic rubber are also covered. There is a list of reference works for supplemental reading containing brief descriptive notes.

SAE HANDBOOK, 1941 Edition.

Society of Automotive Engineers, New York. 830 pp., illus., diagrs., charts, tables, 8½ x 5½ in., cloth, $5.00 to non-members, $2.50 to members.

All the current standards and recommended practices of the Society of Automotive Engineers concerning automobile and aircraft materials and parts, tests and codes, production equipment, nomenclature and definitions are contained in this annually revised handbook. The numerous changes include new and revised standards, corrections and cancellations. There is also a partial list of American standards of interest to the automotive industry.

TRANSFORMERS

By E. E. Wild. Blackie & Son, London and Glasgow; Chemical Publishing Co., Brooklyn, N.Y., 1940. 132 pp., diagrs., charts, tables, 9 x 6 in., fabrikoid, $2.50.

One of a series of small volumes dealing with particular sections of electrical engineering. This book presents a concise account of the theory, design and operation of transformer types. The book contains a considerable number of worked and unworked examples.

TELEMETERING AND SUPERVISORY CONTROL

A report "Telemetering, Supervisory Control, and Associated Circuits," has just been published by the American Institute of Electrical Engineers.

Corrected to December 1940, this report summarizes a wealth of information concerning the electric telemetering and supervisory-control systems currently in use or commercially available in the United States, and includes a detailed discussion of the interconnecting circuits suitable for such purposes.

Telemetering and supervisory control equipment, although electrical developments and widely used in the electric power industry, are finding their greatest potential field of application in non-electrical industries. In water, oil, gas, and other industries this equipment is playing a vital and economically important role in such operations as the remote metering, indication, or control of the levels, pressures, temperatures, flows, etc., of liquids, gases, etc. Supervisory equipment is particularly adaptable to the remote control and monitoring of any device that may be electrically operated. In addition to control features, remote indications of the positions or conditions of practically any device—such as switch positions, governor settings, gate or valve openings, bearing or winding temperatures, synchronization, etc., may be obtained. Arrangements for the telemetering of various quantities may be incorporated in control systems.

In recognition of this ever-widening field of application for telemetering equipment, the report has been prepared in such form and terminology as to make it readily useful to engineers in any branch of industry likely to be concerned with problems of remote measurement and control. Extensive tabulations giving comparative data are designed to enable a prospective or existing user of telemetering or supervisory-control equipment quickly to determine the type of apparatus best suited to his requirements.

All known commercial sources of telemetering and supervisory-control apparatus in the United States have been canvassed, and every effort made to present a complete picture of the instruments and systems available for the purpose. Material for this special publication was prepared by a joint sub-committee of the AIEE committee on automatic stations and the AIEE committee on instruments and measurements. The work is based upon a report compiled by an AIEE subcommittee in 1932, although the coverage has been extended and of course the information has been brought down to date.

The special publication "Telemetering, Supervisory Control, and Associated Circuits" is a 28-page 8½ x 11-inch pamphlet attractively printed on durable paper. Copies may be secured from AIEE headquarters, 33 West 39th Street, New York, N.Y.; price is 40 cents per copy to members (80 cents to non members) subject to a 20 per cent discount for quantities of 10 or more mailed at one time to one address. Remittances, payable in New York exchange, should accompany orders.

BIBLIOGRAPHY OF RELAY LITERATURE PUBLISHED

A "Bibliography of Relay Literature, 1927-1939," has just been published by the American Institute of Electrical Engineers. This special publication was sponsored by the AIEE committee on protective devices and was prepared by a working group of the relay subcommittee. This subcommittee reviewed available indexes and from these compiled this list of significant articles dealing with protective relaying and also with closely related subjects, including all such material published in AIEE *Transactions* or *Electrical Engineering* from January 1927 to December, 1939, and most of that in the principal technical publications of the world from January, 1932 to December 1939.

The 450 odd annotated reference items are divided into the following subject sections, and in each section entries are consecutively numbered and listed alphabetically by years: Line Protection (Distance, Pilot Wire and Carrier; Current, Ground Faults, General), Bus Protection, Apparatus Protection, Distribution and Network Protection, Service Restoration, General and Miscellaneous Relaying, Testing and Analyzing, System Stability, Methods of Calculation, and Instrument Transformers and Other Auxiliary Devices.

The "Bibliography of Relay Literature, 1927-1939" is a 16-page, 8½ by 11-inch pamphlet, attractively printed on substantial paper; it is available at AIEE headquarters, 33 West 39th Street, New York, N.Y., at 25 cents per copy to members of the Institute (50 cents per copy to non-members); price is subject to 20 per cent discount in either instance for quantities of 10 or more to one address at one time. Remittances, payable in New York exchange, should accompany orders.

PRELIMINARY NOTICE

of Applications for Admission and for Transfer

July 25th, 1941

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 at the next meeting.

L. Austin Wright, General Secretary.

*The professional requirements are as follows:—

A 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 or 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 attainment 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

DUNCAN—JOHN MARTIN, of 153 Graham St. So., Hamilton, Ont. Born at Brampton, Ont., Oct. 18th, 1909; Educ.: B.A.Sc., Univ. of Toronto, 1935; 1935-37, gen. work, producing tubes for receiving sets, and 1937-38, supervisor of two units producing various types of tubes—respons. for mech. operation of equipment, etc., Radio Valve Co. of Canada; 1939-40, supervised filling of cylinders for the transportation of dissolved acetylene, also gen. work in oxygen plant at Montreal, and at present, plant manager, oxygen producing plant, Canadian Liquid Air Co. Ltd., Hamilton, Ont.

References: A. R. Hannaford, N. H. A. Eager, F. W. Paulin, A. W. Sinnamon, W. L. McFaul.

ESTABROOK—JAMES PIERCE, of Riverbend, Que. Born at Wallaceburg, Ont., July 31st, 1916; Educ.: B.Sc. (Chem.), Queen's Univ., 1939; 1939 to date, junior chemist, Price Bros. & Co. Ltd., Riverbend, Que.

References: N. F. McCaghey, S. J. Fisher, J. Frisch, K. A. Brebner, A. Jackson.

ESTABROOKS—DONALD STEEVES, of Riverbend, Que. Born at Woodstock, N.B., July 21st, 1912; Educ.: B.Eng. (C.E.), N.S. Tech. Coll., 1938; 1932-35, oiler, SS. Fort St. George; 1935-38 (summers), deputy land surveyer, asst. office engr. and instr'man., on Geol. Surveys of Canada, instr'man. on highway constrn.; 1938-39, inspr. on constrn. for C. A. Fowler, M.E.I.C.; 1939-40, i/c of magnetometer party doing geophysical exploration work in oil fields, Socony-Vaccum Oil Co., Venezuela; At present, records engr., Riverbend paper mill, for Price Bros. & Co. Ltd.

References: S. J. Fisher, N. F. McCaghey, K. A. Brebner, G. F. Layne, H. W. McKiel.

HOUDE—J. OSCAR, of 2020 St. Urbain St., Montreal, Que. Born at Quebec City, Nov. 26th, 1906; Completed I.C.S. Civil Engrg. Course; 1924 to date, with the Shawinigan Engineering Company on various developments, work including surveying, dfting., estimating, design of constrn. plant layout, quantity and cost analyses, and from 1935 to date, inventory and valuation fixed capital assets, estimating, cost accounting, quantity surveying, cost analysis and engrg. quantity report on La Tuque Power Development.

References: J. A. McCrory, A. L. Patterson, R. E. Heartz, H. K. Wyman, C. Luscombe, G. Rinfret, C. R. Lindsey, E. Cote.

MALKIN—ALFRED, of 5550 McLynn Ave., Montreal, Que. Born at Wolverhampton, England, June 6th, 1899; Educ.: 3 years night classes in practical electricity, Montreal Technical Schools; 1919-25, elect'l. dfting. & design, power Switchboard, Northern Electric Co.; 1925-32, dfting. & elect'l. layout design as applied to bldg. constrn., Ross & MacDonald; 1932-36, dfting. etc., various engrg. offices; 1936-37, dfting. & elect'l. layout design, Canadian Industries Ltd.; 1937-38, similar work, for John Stadler, M.E.I.C.; 1938-39, elec. engr., Ross & MacDonald; 1939-40, elec. engr. i/c of elect'l. systems, Canadian Broadcasting Corpn.; 1940 to date, elec. engr. i/c of design & constrn., incl. signal systems, fire alarm and telephone, Canadian Car Munitions Ltd., on loan from the C.B.C.

References: W. J. Armstrong, D. W. Heywood, N. N. Wright, E. A. Ryan, F. A. Combe, H. J. Ward, G. H. Kirby, R. M. Morton, D. Anderson, E. A. Pinto.

O'LEARY—EDMUND CECIL, of Halifax, N.S. Born at Halifax, May 28th, 1911; Educ.: B.A.Sc. (C.E.), N.S. Tech. Coll., 1936; 1934 (summer), on constrn. of transit sheds at Halifax; With Standard Paving Maritime Limited as follows: Summer 1935 and 1936-37, i/c constrn. job office, 1937-39, i/c various phases highway constrn. & paving, since 1938 prelim. investigations preparatory to tendering on highway projects, and from 1939 to date, field supt. i/c of constrn.

References: F. W. W. Doane, H. W. L. Doane, C. St. J. Wilson, S. Ball.

PARRY—THOMAS M., of Calgary, Alta. Born at Ashton-under-Lyne, Lancs., England, June 25th, 1902; Educ.: B.Sc. (E.E.), Univ. of Alta., 1929; 1920-28, automotive mechanic, full & part time; 1926 (summer), gen. mech. work, Power Corpn. of Canada; 1929, test course, Can. Westinghouse Co., Hamilton; 1929-30, asst. trans. engr. & constrn. dept., Bell Telephone Co. of Canada, London, Ont.; 1931 to date, technical dept., Western Canada High School—1931-37, instructor in automotive mechanics & dfting., 1937-41, head of motor dept. & instructor, and (Sept. 1941) technical vice-principal.

References: J. H. Ross, J. M. Ireton, H. J. MacLeod, W. E. Cornish, J. S. Neil, T. D. Stanley.

WARNOCK—SAMUEL, of 28 Noble Ave., Winnipeg, Man. Born at Coleraine, Co. Derry, Ireland, Feb. 10th, 1910; Educ.: B.A.Sc. (E.E.), Univ. of B.C., 1935; R.P.E. of B.C.; With the West Kootenay Power & Light Co. Ltd., Trail, B.C., as follows: 1935-37, gen. elec. work & power mtce., 1937-38, power operating, 1938-40, asst. i/c of mtce. & operating of substations; 1941 to date, A/C Inspector, No. 15 Technical Detachment, R.C.A.F., Winnipeg, Man.

References: L. A. Campbell, A. E. Wright, A. Peebles, J. N. Finlayson, H. F. G. Letson.

WILLIAMS—RALPH EMERSON, of 415 Stradbrooke St., Winnipeg, Man. Born at Toronto, Ont., Sept. 13th, 1891; Educ.: B.A.Sc., Univ. of Toronto, 1924; 1914-19, overseas; 1920-21, asst. engr., Dept. Public Works, Santa Domingo; 1921-22, engr. of tests, Pittsburgh Testing Lab.; 1922-23, city engr., Gainesville, Fla.; 1924-26, res. engr., Cleveland Met. Park Board; 1926-31, res. engr., N.Y. Central R.R. and Cleveland Union Terminals Co.; 1932-38, president & gen. mgr., Lawrences Bread Ltd., and 1938-40, Geo. Weston Bread & Cakes Ltd.; 1940 to date, asst. engr., Defence Industries Limited, Winnipeg, Man.

References: E. M. MacQuarrie, H. A. Babcock, W. L. Dobbin, L. A. Wright.

FOR TRANSFER FROM JUNIOR

KENT—WILLIAM LESLIE, of Lang Bay, B.C. Born at Content, Alta., Oct. 19th, 1907; Educ.: B.Sc. (C.E.), Univ. of Alta., 1931; 1931-34 (intermittently), asst. to district surveyor & engr., surveys dept., Prov. of Alberta; 1935 (July-Sept.), constrn. engr. on constrn. of flume for Nixon Creek (Cariboo) Golds Ltd.; 1937-39, office engr., estimating & constrn. studies, and Feb. to May 1940, i/c of lab. bldg. constrn. at Powell River, B.C., for Stuart Cameron & Co. Ltd., Contractors; June 1940 to date, with same company, job engr. i/c of office and field engrs. on constrn. of Lois River Dam. (St. 1929, Jr. 1937).

References: W. Jamieson, H. R. Webb, C. J. Jeffreys, J. Robertson, R. C. McPherson, N. Beaton, R. Bell-Irving.

PASK—ARTHUR HENRY, of Windsor, Ont. Born at Zeneta, Sask., July 2nd, 1911; Educ.: B.Sc. (E.E.), Univ. of Man., 1935; R.P.E. of Ont.; 1936-37, design & dfting of diesel plants & pump installns., Canadian Fairbanks Morse Ltd., Montreal; 1937, redesign of machy. & production supervision, Eagle Pencil Co., Drummondville; 1937 to date, project engr., Alkali Divn., Canadian Industries Ltd., Windsor, Ont., Design & Dfting.of plant extensions & changes—later in charge of complete projects of plant extensions & changes incl. cost estimates, design, dfting. & constrn. (St. 1935, Jr. 1937).

References: H. L. Johnston, J. F. Bridge, C. F. Davison, G. E. Medlar, E. M. Krebser.

PATERSON—WALTER HOWARD, of Berranca Bermeja, Colombia, S.A., Born at Owen Sound, Ont., May 23rd, 1909; Educ.: B.Sc., Queen's Univ., 1935; Summers—1930, rodman for Grey County engr., 1931, operator, H.E.P.C. Ontario, 1933, supt., municipal quarry, Owen Sound, 1934, foreman, gradings operations, McArthur Constrn. Co.; 1934-36, asst. city engr., Owen Sound; 1936, asst. to supt., grading contract, McArthur Constrn. Co.; 1937, sales engr., General Supply Co.,

(Continued on page 417)

Employment Service Bureau

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party. Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted upon request after a lapse of one month. All correspondence should be addressed to THE EMPLOYMENT SERVICE BUREAU, THE ENGINEERING INSTITUTE OF CANADA, 2050 Mansfield Street, Montreal.

SITUATIONS VACANT

GRADUATE ENGINEER with at least two years practical experience in a tool room to act as an instructor in the Apprentice School of a large industrial concern. Apply Box No. 2344-V.

MECHANICAL DESIGNING DRAUGHTSMAN with experience for permanent position with firm engaged in war work. Apply Box No. 2375-V.

ARCHITECTURAL DRAUGHTSMEN required immediately by large industrial concern for their Montreal office. Apply Box No. 2376-V.

FIELD ENGINEER, aggressive, capable, preferably one with a university degree in chemical engineering and who has some knowledge of boiler plant operation to sell and service boiler feed water treatment chemicals. Candidate must possess personality conducive to good salesmanship having good educational and family background. Remuneration will be $1,500.00 a year and travelling expenses when away from Headquarters. Write fully education, experience and present occupation, giving references. Personal interview will be arranged only by written application to Box No. 2394-V.

JUNIOR CHEMICAL AND METALLURGICAL ENGINEER for plant installation and operation work. Apply Box No. 2400-V.

STRUCTURAL OR GENERAL DRAUGHTSMAN for plant extension work. Apply Box No. 2401-V.

JUNIOR MECHANICAL GRADUATE with about one to five years experience for work in South America. Apply Box No. 2402-V.

MUNICIPAL ENGINEER, conversant with road construction, paving, construction and maintenance of sewers and water services, for a town in Ontario. Salary from $2,400 to $3,000 per year according to experience and qualifications. Send applications with full particulars to Box No. 2403-V.

CIVIL SERVICE OF CANADA

Engineering Division of the Penitentiary Branch of the Department of Justice at a salary of $2,220 per annum. Although only a temporary appointment can be made at present to this position, this examination will qualify for a permanent appointment. In the case of permanent appointment the initial salary of $2,220 may be increased upon recommendation for meritorious service and increased usefulness at the rate of $120 per annum until a maximum of $2,700 has been reached.

Duties: To assist in designing and to prepare plans and estimates of mechanical equipment, power plant, heating and ventilation systems and electric wiring installations; and to perform other related work as required.

Qualifications Required: Education equivalent to high school graduation; either graduation in mechanical engineering from a school of applied science of recognized standing with three years of experience in mechanical engineering work, one year of which shall have been in a position of professional responsibility; or, five years of mechanical engineering experience, one year of which shall have been in a position of professional responsibility; knowledge of building construction and power plant design.

While no definite age limit has been set for this competition, age may be a determining factor in making a selection. Appointment, however, will be subject to the provisions of Order-in-Council P.C. 4759 of June 27, 1941.

Nature of examination: A rating on education and experience will be given from the sworn statements, supporting documents and other evidence submitted by applicants on and with their application forms. Candidates are requested to furnish full particulars concerning their technical training and experience especially as they bear on the qualifications for and the duties of this position. An oral examination may be given if necessary in the opinion of the Commission. No examination fee is required.

An eligible list valid for a period of one year may be established.

Time Limit: Application forms properly filled in must be filed with the Civil Service Commission, Ottawa, NOT LATER THAN August 30, 1941.

Application forms are obtainable at all City Post Offices, the Post Offices in the larger towns, the offices of the Employment Service of Canada, or from the Civil Service Commission, Ottawa, Canada.

SITUATIONS WANTED

ELECTRICAL ENGINEER, B.SC. in electrical engineering, age 43, married, available on two weeks notice. Fifteen years experience in electrical work. Including electrical installations of all kinds in hydro-electric plants and sub-stations. Maintenance and operation of hydro-electric plants. Electrical maintenance and installations in pulp and paper mill. Considerable experience on relays and meters. At present employed, but desires change. Apply Box No. 636-W.

GRADUATE ELECTRICAL ENGINEER, University of Toronto, five years experience drafting and design in connection with electrical instruments and small motors. Also experienced in design of small jigs and fixtures and general machine design. Desires permanent position. Apply to Box No. 1486-W.

GRADUATE CIVIL ENGINEER, M.E.I.C., 15 years engineering on this continent and five years overseas. Experienced in design and construction of dams, hydro-electric and industrial plants. Field engineer for construction on dams and transmission lines, considerable experience in concrete work. Desires position preferably as field engineer or construction superintendent. Apply Box No. 1527-W.

ELECTRICAL ENGINEER, Age 32 with the following experience—Eight years field work in general construction, supervision, estimating and ordering materials. At present employed in general construction but wants to enter the electrical field. Apply Box No. 1992-W.

MECHANICAL ENGINEER, JR.E.I.C., and member of the American Society for Metals. Since graduation (Toronto '33) has specialized in the metallurgy, processing, and heat treatment of steel, aluminum and aluminum alloys. Also five years successful sales experience and is thoroughly familiar with materials specifications of all types. Now thirty years of age, available at once, and can furnish the best of references. Desires permanent position. Apply Box No. 2365-W.

PRELIMINARY NOTICE (*Continued from page 416*)

Toronto; 1937 to date, engr. with the Tropical Oil Co., as follows: 1937-38, location, constrn. & mtce., 1938-40, asst. to supt. of constrn., and 1940 to date, field engr. geological dept. (Jr. 1936).

References: F. C. McArthur, T. D. Kennedy, D. S. Ellis, J. H. Addison.

RAMSAY—WILLIAM WALLACE, of Winnipeg, Man. Born at Stonewall, Man., July 23rd, 1907; Educ.: B.Sc. (C.E.), Univ. of Man., 1933; R.P.E. of Man.; 1927-30, Dept. of Good Roads, Man.; 1936-37, underground surveyor, Flin Flon Gold Mines; 1937, res. engr., Century Mining Corpn.; 1938-41, P.F.R.A. water development, Dom. Govt., Dept. of Agriculture—1938, engr. dftsman., 1939-40, jr. engr., and since May 1941, asst. engr. (Jr. 1937).

References: C. H. Attwood, B. B. Hogarth, D. M. Stephens, G. H. Herriot, W. F. Riddell.

FOR TRANSFER FROM STUDENT

BUCHANAN—ARNOLD AMHERST, of Allandale, Ont. Born at Montreal, Oct. 27th, 1913; Educ.: B.Eng., McGill Univ., 1939; 1939-40, estimator, Jenkins Bros. Ltd.; 1940 to date, Engineer Officer (rank of F.O.), with R.C.A.F. at Camp Borden, Ont. (St. 1938).

References: C. M. McKergow, A. R. Roberts, R. DeL. French, E. Brown.

MACKIE—GEORGE ARTHUR, of 50 Queen St., Saint John, N.B. Born at Montreal, Nov. 7th, 1913; Educ.: B. Sc. (E.E.), Univ. of N.B., 1935; Summers (1931-35) and 1935-36, elect'l. estimating, wiring repairs, etc., for George Mackie, elect'l. contractor; 1936-37, inspr., National Harbours Board, Saint John, N.B.; 1937-39, instr'man., highway divn., Dept. of Public Works of N.B.; 1940, timekpr. & instr'man., Dept. of National Defence, Saint John; 1940 to date, Lieut., 1st Brighton Fortress (E. & M.) Coy., R.C.E. (A.F.), Saint John, N.B. (St. 1935).

References: D. Ross, C. G. Grant, G. Y. Dow, A. Gray, A. F. Baird, D. R. Smith.

PURVES—WILLIAM FRANKLIN, of Stanford, Conn. Born at Lindsay, Ont., January 5th, 1911; Educ.: B.Eng. (Elec.), McGill Univ., 1935; 1935, topographer, Noranda Power Corpn.; 1935-36, drfsman., surveys divn., Canadian Airways Ltd., Montreal; 1936, inspr. & test engr., Donald-Hunt Ltd., Montreal; 1936-38, development & research engr. on "personalized products" and electrical appliances, Schick Laboratories, Montreal; 1938-39, elect'l engr., asst. to chief engr. of Schick Dry Shaver Inc., Stamford, Conn., and 1939 to date, asst. to chief engr. as elect'l. engr. i/c of product, research & development. (St. 1935).

References: H. W. B. Swabey, A. E. Simpson, C. V. Christie, R. DeL. French, J. F. Plow, E. Brown.

GOLD OUTPUT INCREASING IN NORTHWEST TERRITORIES

New gold is being produced in increasing quantities in the Northwest Territories, reports the Department of Mines and Resources. Preliminary figures place the output for the first half of 1941 at 31,001 ounces as compared with 24,799 ounces in the first six months of 1940, an increase of 6,202 ounces.

Four mines are now producing—the Con, Negus, and Rycon in the Yellowknife area, and the Slave Lake Gold Mines property on Outpost Island.

In response to the war-time demand for gold, the capacity of the mill at the Con mine is being increased from 100 to 350 tons daily. Development work is going ahead at other properties, which are expected to enter production shortly. Ptarmigan Mines Limited is installing a 100-ton per day mill, Thompson Lundmark Gold Mines Limited is putting in a 150-ton mill, and a 25-ton mill is being installed at the Giant Yellowknife Gold Mines Limited property.

Industrial News

Industrial development — new products — changes in personnel — special events — trade literature

AUTOMATIC CONTROLS AND RECORDING INSTRUMENTS

Catalogue No. 7, 48 pp. issued by Minneapolis-Honeywell Regulator Co. Ltd., Toronto, Ont., provides in condensed form, catalogue data, specifications, and illustrations of the Minneapolis-Honeywell line of controls and instruments with a section devoted to the Company's "Brown Industrial Instruments."

STOKERS

Detroit Stoker Co. of Canada Ltd., Windsor, Ont., have issued a catalogue, No. 840, of 32 pages and cover under the title "Detroit RotoStoker" which is thoroughly illustrated with sectional drawings, unit photographs, installation views and blue print reproductions, and describes the principle of the "RotoStoker" and emphasizes its main features. Operating charts, comments from users and details of installed capacities are also included.

FANS, BLOWERS AND EXHAUSTERS

A 6-page folder, Form CB-2629, entitled "When Heat Gets 'Em Down Comfort Cooling with Fresh Air Builds 'Em Up!" published by Canadian General Electric Co. Ltd., gives an illustrated description featuring the application to modern industry of various types of Canadian Sirocco fans, blowers, exhausters and ventilators, distributed by Canadian General Electric Co. Ltd.

FEED WATER CHEMISTRY

The fundamental reactions involved in water softening are given in a 12-page booklet No. 3006 recently issued by Cochrane Corp., Philadelphia, Pa. A section deals with the "Ionic Analysis" and with "Equivalents per Million," which methods of interpreting water analysis are coming into more general use, according to the Company. Formulae and molecular and equivalent weights of substances frequently appearing in the chemistry of water softening are also included.

METALLIZING

"The History, Purpose and Practice of Metallizing (Metal Spraying)" is the title of a 52-page book recently issued by the Metallizing Co. of America Inc., Chicago, Ill. As its title indicates, this book is a comprehensive treatment of the subject of metal spraying and after reviewing the history, purpose and practice, and indicating in concise forms with illustrations the equipment required to carry on the work of metallizing, the book offers well illustrated descriptions of the application of this process to a wide variety of industrial works.

LABORATORY FILTER

Sparkler Manufacturing Co., Chicago, Ill., have issued a folder describing and illustrating the Sparkler horizontal plate laboratory filter which, the manufacturers state, is a compact, practical unit that can do any laboratory filtering job without extensive preparations or experiments. Available in iron, aluminum, bronze, Monel and stainless steel, the Sparkler unit is designed to handle viscous materials as well as aqueous solutions with any type of filter aid.

MONEL STORAGE HEATERS

An 8-page bulletin No. 40M, entitled "Whitlock-Darling Type K Monel Storage Heaters" has been issued by Darling Brothers Ltd., Montreal, Que. These heaters are of the steam actuated type and consist of a Monel storage shell in which is installed a removable, copper tube, heating section. The bulletin contains sectional drawings of construction and installation details and a table of "Hot Water Fixture Capacities for Various Types of Buildings," as well as specifications and detailed descriptions of the horizontal and vertical heaters.

SINGLE-PHASE WATTHOUR METERS

Bulletin No. 49, issued by Ferranti Electrical Ltd., Toronto, Ont., contains 64 pages of detailed instructions for the use of the following types of single-phase alternating current watthour meters: FR, FRA, FRS, FCc, FDb, FD and C, and the type "C" polyphase watthour meters. The booklet includes full details regarding testing and servicing of new and used meters with illustrated instructions covering adjustments. The Ferranti meter test board is also illustrated and fully described and a considerable amount of other useful reference information is included.

SMALL GASOLINE ENGINES AND PUMPS

D. R. Clarke Engine Co. Ltd., Toronto, Ont., have published an 8-page booklet entitled "Clarke Engine Products," which features the following products: 1¼ h.p. utility gasoline engine, weighing 19 lbs.; centrifugal, primeless, self-draining water pump, weighing 30 lbs., with a 4000 to 5000 gals. per hr. capacity; air compressor and paint spray unit weighing 37 lbs.; 1¼ marine utility inboard type engine, weighing 25 lbs.; and electric generating units from 6 to 110 volts up to 400 watts.

STEAM SAMPLE DEGASIFIER

Publication No. 3020 of the Cochrane Corporation, Philadelphia, Pa., entitled "Cochrane Steam Sample Degasifier," describes this device for condensing a steam sample, separating non-condensible gases for analysis, and degasifying the condensed sample for conductivity tests for determination of carryover.

TRANSMISSION MOTORIZING UNIT FOR MACHINE TOOLS

Dominion Auto-Drive, Ltd., Walkerville, Ont., gives, in a 2-page leaflet, general details and specifications of the "Auto-Drive," and individual transmission motorized unit for machine tools, intended primarily to modernize valuable machinery and eliminate overhead line shafts.

WELDING MACHINES & SUPPLIES

G. D. Peters & Co. of Canada Ltd., Montreal, Que., have issued a comprehensive 128-page catalogue, No. 80, which contains detailed descriptions and illustrations covering complete equipment for the modern arc and gas welding shop.

W. W. Brumby

APPOINTED ASSISTANT PLANT ENGINEER

The English Electric Company of Canada Limited have announced the appointment of W. W. Brumby as Assistant Plant Engineer. Mr. Brumby is a graduate from Technical College and Auckland University in New Zealand, also the City and Guilds of London Institute. He was for several years with the National Electric and Engineering Company of New Zealand, and a number of years with the Auckland Electric Power Board at Auckland. In 1929 he joined the staff of Canadian General Electric Company Limited.

His first job at St. Catharines will be the laying out of the new test department in the company's current plant extension.

APPOINTED TRANSFORMER ENGINEER

M. B. Mallett, who has been appointed Transformer Engineer in the Engineering Dept. of The English Electric Company of Canada Ltd., received a degree in electrical engineering from the Rensselaer Polytechnic Institute in 1924, and, following the completion of the General Electric Test Course at their Pittsfield works, he was with the Pittsfield Transformer Engineering Dept. until joining the "English Electric" staff in March of this year.

His particular specialty will be larger size power transformers, and it is interesting to note that he designed the first 55,000 kv.a. 287 kv. power transformer units for the Boulder Dam development.

M. B. Mallett

THE ENGINEERING JOURNAL

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NOTES ON THE ANALYSIS AND DESIGN OF RECTANGULAR REINFORCED CONCRETE SLABS SUPPORTED ON FOUR SIDES

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SUMMARY—In the first part of the paper the mathematical analysis of rectangular plates is considered and values of bending moments and shearing forces for various conditions of edge restraint are given. Considerable use has been made of the results obtained by Westergaard, Inglis, Lévy, Timoshenko, and others, and these are compared with the results given by some of the more widely used empirical formulas. In the second part of the paper the above analysis is used to determine moment coefficients for reinforced concrete slabs supported on four edges and reinforced in two directions. Consideration is given to the moments resulting from various arrangements of loads upon a group of panels; and approximate coefficients of maximum moments are derived. These coefficients are then modified to make allowance for plastic flow. It is shown that these modified coefficients are closely represented by linear equations in terms of the ratio of length to breadth of slab. In addition, the intensity of loading on the supporting beams is considered and it is shown that for practical purposes this may be assumed to be uniformly distributed. The recommended design coefficients are included in Part 3 of the National Building Code.

The National Building Code is a model building code, for use by Canadian municipalities, prepared under the joint sponsorship of the National Research Council and the Department of Finance of Canada.

PART I—MATHEMATICAL INVESTIGATIONS OF STRESSES IN RECTANGULAR PLATES

(a) INTRODUCTION

The majority of reinforced concrete slabs, apart from flat slabs, are designed in the same way as beams. It is assumed that they are supported along two opposite edges only, and the effects of curvature at right angles to the direction of the span are not considered. In practice, however, many slabs are supported along four edges and it is obvious that in such circumstances a slab will assume a saucer-shaped deformation and that any load placed on it will be transferred to all of the supporting beams. From the early days of reinforced concrete construction attempts have been made to estimate the manner in which the load will be divided in the two principal directions of bending and many empirical formulas have been proposed. The problem is one in which mathematicians have long been interested and in the first part of this paper it is proposed to present briefly some of the more important results obtained by mathematical analysis. (For a comprehensive treatise on this subject the reader is referred to the recently published book by Timoshenko on the "Theory of Plates and Shells."*)

Problems connected with the bending and vibration of thin plates subject to transverse loads have been considered by mathematicians since the time when Euler investigated the modes of vibration of a bell in 1766. The general equation is due to Lagrange (1811) and the solution for a rectangular plate freely supported at its edges, as generally presented, is due to Poisson (1828) and Kirchoff (1850). A complete solution of the more complex problem of a rectangular plate clamped at its edges was published by Love in 1928; approximate solutions of considerable accuracy were made by Hencky in 1913 and by Inglis in 1925.

In an outstanding paper by Westergaard and Slater[2] the various mathematical results were discussed and simple empirical formulas proposed to represent them.

Reference should also be made to the "elastic web method" due to Marcus (1925); this is an approximate method of solution in which the plate is represented by a net of elastic wires loaded at their points of intersection. (A description in English of the Marcus method has been given by Wise[1].)

The mathematical approach to the problem has been made possible by dividing plates into three main types: thin plates such as membranes in which the deflections may be large but bending stresses are small; thin plates in which the deflections are small and bending stresses are large; and thick plates in which deflections are small but in which the deformation due to shear cannot, in general, be neglected. The first case is analogous to the bending of thin rods, the second to the approximate theory of the bending of beams, and the third to the more rigorous analysis of beams by the method of St-Venant. For engineering purposes beams and slabs are considered to belong to the second class, i.e., deflections are considered small and the influence of shear upon bending stress is neglected. In the case of plates or slabs Love[1] describes the results as "the approximate solution for a thin plate in which deflections are assumed to be small." Westergaard[2] refers to such a plate as "a moderately thick plate."

Prescott[3] emphasizes that the limits of application of the usual theory of bending of plates are more serious than are the limitations of the analogous theories for beams. In each case it is assumed that there is a neutral plane which is not stretched or shortened and the slope is small at all points. It is not possible, however, to bend a thin isotropic plate without deforming some part of the middle surface whereas the neutral axis of a beam may remain unstretched whatever the curvature. With the above rather important reservation, the assumptions involved in applying the usual theory of plates to reinforced concrete slabs are the same as those implied in applying the theory of simple bending to reinforced concrete beams. It is not necessary to discuss these here except perhaps to point out that their validity is being increasingly questioned. There are many who maintain that stress analysis, based upon the assumption of elastic conditions, does not give an accurate indication of the ultimate load carrying capacity of reinforced concrete beams or columns (see, for example, the paper by Hajnal-Konyi and ensuing discussion in *Concrete and Construction Engineering*, January to October, 1937). The objections to elastic analysis of beams apply also in the case of slabs, but to a greater extent, since "plate action" depends upon the existence of torsional moments, without which the slab will tend to behave as a membrane, or as if it were com-

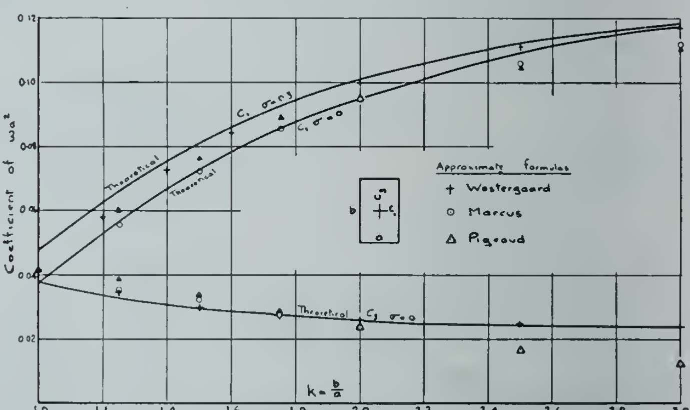

Fig. 1—Rectangular plate freely supported at its edges. Coefficients of maximum bending moments.

*Timoshenko's most valuable monograph had not been published when the manuscript of this paper was written.

posed of a number of independent strips. Gehler[4] states that this is the case when the concrete in a slab has cracked, a theory which is said to have received support from the results of numerous tests carried out for the German Reinforced Concrete Committee from 1915 to 1926 at Stuttgart and from 1927 to 1930 at Dresden. Assuming, however, that the design of beams is based upon the theory of simple bending, it appears reasonable that the design of slabs should be based upon the approximate theory for thin plates. Some modification of the results may be made to make allowance for the redistribution of bending moments due to plastic flow of the concrete.

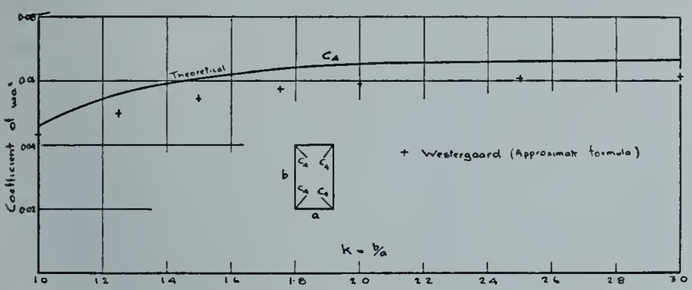

Fig. 2—Rectangular plate freely supported at its edges. Coefficients of maximum torsional moments.

(b) GENERAL EQUATIONS FOR THIN PLATES

Notation

- a Length of side parallel to OX (usually the short side)
- b Length of side parallel to OY (usually the long side)
- $k = \frac{b}{a}$
- w Load per square unit
- W Total load $= wab$
- V_a Shear per unit length along side a
- V_b Shear per unit length along side b
- $m = \frac{a}{b}$
- M_x Bending moment per unit length in a direction perpendicular to OX
- M_y Bending moment per unit length in a direction perpendicular to OY
- M_{xy} Torsional moment
- σ Poisson's ratio
- $E' = \frac{E}{1-\sigma^2}$
- t Thickness
- z Deflection
- q Ratio of live load to dead load

The relation between load and deflection is given by the following equation due to Lagrange.

$$w = \frac{Et^3}{12\,(1-\sigma^2)} \triangle^4 z$$

$$= \frac{E't^3}{12} \triangle^4 z \quad \text{- - - - - - - - - - - - -} \quad (1)$$

where $\triangle^2$ is the operator $\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}$

[This is analogous to the equation for simple bending

$$w = El \;\frac{d^4y}{dx^4}\Big]$$

From equation (1) the following equations for bending moments may be deduced:

$$M_x = -E't\left(\frac{\partial^2 z}{\partial x^2} + \sigma\frac{\partial^2 z}{\partial y^2}\right) \quad \text{- - - - - - - - - -} \quad (2)$$

$$M_y = -E't\left(\frac{\partial^2 z}{\partial y^2} + \sigma\frac{\partial^2 z}{\partial x^2}\right) \quad \text{- - - - - - - - - -} \quad (3)$$

In addition, any element will be subjected to torsional moments represented by:

$$M_{xy} = \frac{E\,t}{1+\sigma}\frac{\partial^2 z}{\partial x \partial y} \quad \text{- - - - - - - - - - - -} \quad (4)$$

The shearing forces along the boundaries of the plate will be given by:

$$V_a = -E'\frac{\partial}{\partial y}\triangle^2 z \quad \text{- - - - - - - - - - - -} \quad (5)$$

$$V_b = -E'\frac{\partial}{\partial x}\triangle^2 z \quad \text{- - - - - - - - - - - -} \quad (6)$$

(c) BOUNDARY CONDITIONS

The equations given above apply to any thin plate but only in the simplest cases can they be solved when the correct boundary conditions are substituted. The boundary conditions comprise three geometrical conditions corresponding to the three co-ordinate axes, together with three stress conditions corresponding to bending moment, torsional moment and shear. It can be shown, however, that it is not possible arbitrarily to specify all three stress conditions. For example, in the case of a rectangular plate freely supported on all edges, if the bending moments and the deflection at the edges are assumed to be zero then it can be shown that there must be either torsional moments applied at the edges, or concentrated downward reactions applied at the corners. Much discussion has centred around this problem; for a general consideration of it reference should be made to Love (Fourth Ed. p. 458) and interesting comments on the particular case of a rectangular plate have been made by Pigeaud[5].

Rectangular Plate Freely Supported at its Edges

(a) BENDING MOMENTS

The deflection of a rectangular plate carrying a uniform load and freely supported at its edges is given by the equation:

$$z = \frac{16\;a^4b^4w}{\pi^6\;E\;I}\sum_{m=1,3,etc.}^{\infty}\;\sum_{n=1,3,etc.}^{\infty}\frac{\sin\frac{m\pi x}{a}\;\sin\frac{n\pi y}{b}}{(m^2a^2+n^2b^2)^2} \quad (7)$$

from which the bending moments M_x and M_y may be determined using equations (2) and (3). Considering first

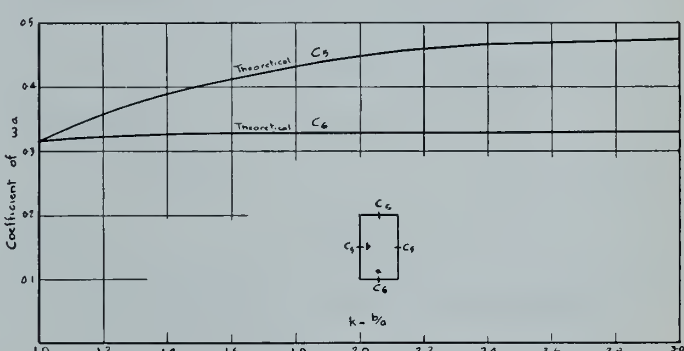

Fig. 3—Rectangular plate freely supported at its edges. Coefficients of shearing forces at the edges of the plate.

the moments in the shorter span. With the notation adopted and assuming "b" to be greater than "a" this will be M_y and can be written in the form

$$M_y = C_1\,wa^2 \quad \text{- - - - - - - - - - - - - -} \quad (8)$$

Figure 1 shows the relation between C_1 and $k = \frac{b}{a}$ for values of k varying from one to three. Two theoretical curves are shown corresponding to values of Poisson's ratio (σ) of 0.3 and zero. Most experiments on reinforced concrete slabs have tended to give results nearer to the lower curve than the upper, and consequently most practical design methods are based upon the assumption that σ is equal to zero.

This also has the advantage of simplifying the theoretical computations which are apt to be long and tedious.

Results obtained from a number of approximate formulas are also shown in Fig. 1. Very many such formulas have been proposed and used, those shown being amongst the most widely accepted. The approximate equation by Marcus appears in the German Regulations for Reinforced Concrete.

The formulas are as follows:

(a) Westergaard,

$$C_1 = \frac{k^3}{8(2+k^3)} \quad \text{- - - - - - - - - - - -} \quad (9)$$

(b) Marcus,

$$C_1 = \left(1 - \frac{5\,k^2}{6\,(1+k^4)}\right) \frac{k^4}{8\,(1+k^4)} \quad \text{- - - - - - -} \quad (10)$$

(c) Pigeaud,

$$C_1 = \frac{k^4}{8\,(k^4+k^2+1)} \quad \text{- - - - - - - - - - -} \quad (11)$$

Coefficients of the maximum moment in the longer span are also shown in Fig. 1. This moment may be written:

$$M_x = C_2\, w\, b^2 \quad \text{- - - - - - - - - - - - -} \quad (12)$$

but from practical considerations it is more convenient to express it in the form:

$$M_x = C_3\, w\, a^2 \quad \text{- - - - - - - - - - - - - -} \quad (13)$$

in which case:

$$C_3 = k^2 C_2 \quad \text{- - - - - - - - - - - - - - -} \quad (14)$$

It has been pointed out by Westergaard and others that the maximum moment in the long span does not occur at the centre except when the plate is nearly square. This makes it difficult to determine the maximum values. The figures plotted in Fig. 1 are due to Westergaard and are based on the assumption that σ is equal to zero. For comparison with the curve, points determined from the following formulas are shown:

(a) Westergaard,

$$C_3 = \frac{k^2+1}{48\,k^2} \quad \text{- - - - - - - - - - - - - -} \quad (15)$$

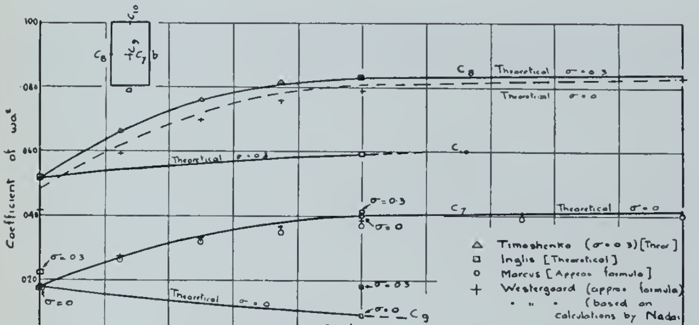

Fig. 4—Rectangular plate fixed at its edges. Coefficients of maximum positive and negative bending moments.

(b) Marcus,

$$C_3 = \left(1 - \frac{5\,k^2}{6\,(1+k^4)}\right) \frac{k^2}{8\,(1+k^4)} \quad \text{- - - - -} \quad (16)$$

(c) Pigeaud,

$$C_3 = \frac{k^2}{8\,(k^4+k^2+1)} \quad \text{- - - - - - - - - -} \quad (17)$$

Torsional moments are unimportant in isotropic plates but must be considered in reinforced concrete slabs. The maximum torsional moment occurs at the corner and is directed perpendicular to the line bisecting the angle between the edges, i.e., at 45 deg. to XY. Figure 2 shows the relation between this moment and k where M_{xy} is expressed in the form:

$$M_{xy} = C_4\, w\, a^2 \quad \text{- - - - - - - - - - - - -} \quad (18)$$

Poisson's ratio is assumed to be zero. Figure 2 also shows points obtained from Westergaard's formula:

$$C_4 = \frac{k^3}{8\,(2k^3+1)} \quad \text{- - - - - - - - - - - -} \quad (19)$$

(b) SHEARING FORCES AT THE EDGE OF THE PLATE

Shearing forces are usually unimportant in reinforced concrete slabs, but since they are equal to the reactions exerted by the beams their distribution is of interest in determining the maximum bending moments in the latter.

An examination of equations (5) and (6) shows that the shearing forces must be zero at the corners increasing to a maximum at mid-span of the supporting beams. Investigation of $\frac{\partial V_a}{\partial y}$ and $\frac{\partial V_b}{\partial y}$ shows that the shear curve has an infinite slope at the corners. Thus the load distribution is similar in general shape to a semi-ellipse. The semi-minor axis of this pseudo-ellipse (i.e., the maximum load on each span) may be determined by approximate methods. Accurate values, however, may be found from equations (5) and (6) and it appears to be unnecessary to use approximations. In Fig. 3 the maximum shear per unit of length for a simply supported span is shown in terms of the load on the shorter span:

$$V_b = C_5\, w\, a \quad \text{- - - - - - - - - - - - - -} \quad (20)$$

$$V_a = C_6\, w\, a \quad \text{- - - - - - - - - - - - - -} \quad (21)$$

It will be noticed that the maximum shear occurs on the longer edge and that C_6 and the loading on the shorter edge is nearly constant throughout the range considered.

Rectangular Plate Fixed at its Edges

(a) BENDING MOMENTS

A valuable addition to the literature on rectangular plates was made by Inglis who in 1925 published an elegant solution of the problem of a rectangular plate clamped at its edges [(7)]. In this method the condition of complete edge restraint was approached by successive approximations but since complete restraint was never reached the method cannot strictly be called an exact solution. Even with a first approximation, however, the errors were shown to be small; with a second approximation they may be considered negligible. Inglis investigated the square plate, and the rectangular plate in which k is equal to two.

A more extensive range of values has been given by Timoshenko [(8)]. Both Inglis and Timoshenko assumed Poisson's ratio to be 0.3. Figure 4 shows curves of the maximum positive and negative moments. The latter occurs at the middle of the longer edge. The moments are expressed by the equations:

For $x=a/2,\ y=b/2,\ M_y = C_7\, w\, a^2$ - - - - - (22)

For $x=0,\ y=b/2,\ M_y = -C_8\, w\, a^2$ - - - - - (23)

Where values of M_x and M_y at any particular point are known for $\sigma = 0.3$ the values corresponding to $\sigma = 0$ may be determined from the equation:

$$M'_x = \frac{M_x - \sigma M_y}{1-\sigma^2} \quad \text{- - - - - - - - - - -} \quad (24)$$

From the values of M_x and M_y given by Inglis it can be shown that C_8 is not appreciably altered by the value chosen for σ. C_7 is reduced somewhat if $\sigma = 0$, particularly in the case of a square plate. Two points calculated from Inglis' figures are shown in Fig. 4, and for comparison with them a curve of values given by Westergaard is indicated by a dotted line. The latter are based on results given by Nadai. Hencky, by an approximate method cited by Love (Fourth Ed. p. 494), obtained values in fair agreement with those of Timoshenko and Inglis. In Fig. 4 coefficients derived from the following approximate formulas are shown:

Westergaard

$$C_7 = \frac{k^4}{8\,(3k^4+4)} \quad \text{- - - - - - - - - - - -} \quad (25)$$

$$C_8 = \frac{k^4}{12\,(k^4+1)} \quad \text{- - - - - - - - - - - - - (26)}$$

Marcus

$$C_7 = \left(1-\frac{5}{18}\,\frac{k^2}{(1+k^4)}\right)\,\frac{k^4}{24\,(1+k^4)} \quad \text{- - - - (27)}$$

Two other curves are shown in Fig. 4. These refer to the moments in the direction of the longer span and are and expressed in terms of $w\,a^2$ using coefficients C_9 and C_{10}.

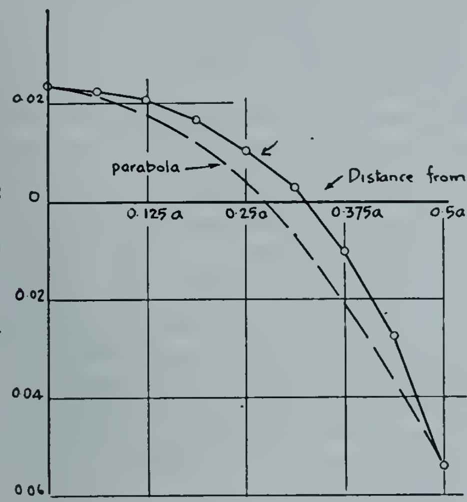

Fig. 5(a)—Square plate fixed at its edges. Distribution of bending moments along centre lines.

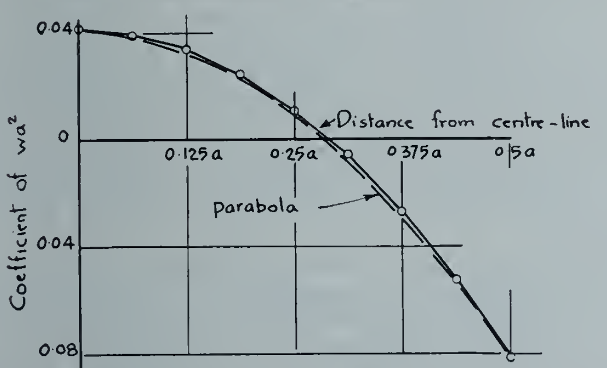

Fig. 5(b)—Rectangular plate (K=2) fixed at its edges. Distribution of bending moments along the centre line of the short span.

For $x=a/2,\ y=b/2 \qquad M_x=C_9\,w\,a^2$ - - - - (28)

For $x=a/2,\ y=0 \qquad M_x=-C_{10}\,w\,a^2$ - - - (29)

It should be noted that in all cases the coefficients change very slowly for values of k greater than two.

From figures given by Inglis it is possible to examine the distribution of moment along the centre line of the plate. For the long span, as in the case of the simply supported plate, the maximum positive moment does not occur at the centre except for nearly square plates. When k is equal to two the moment at the quarter point is 13.5 per cent greater than the mid-span moment. In the case of the short span the curve showing the distribution of moment has the general shape of a parabola though, as is shown in Fig. 5, there is an appreciable difference from a true parabola when the plate is square.

(b) SHEARING FORCES AT THE EDGES OF THE PLATE

Pigeaud implies that shearing forces for a plate with fixed edges are similar to those for a simply supported plate (Résistance des Matériaux, p. 918). Inglis, however, has determined the distribution and the results do not support this view. Figures 6a and 6b show the distribution of pressure along the edges of a square plate and a rectangular plate respectively. In the case of a square plate and for the short side of a rectangular plate the load curve is more nearly parabolic than elliptical in general shape. Graphical integration of the load curve in the case of a square plate shows the maximum bending moment in the beam to be $0.168\ W'a$, W' being the total load on the beam $(W'=\frac{wa^2}{4})$. This compares with $0.1435\ W'a$ assuming an elliptical distribution of load and $0.1667\ W'a$ assuming a triangular distribution with a maximum value of $0.5\ wa$. In the case of the rectangular plate ($k=2$), the maximum moment determined by graphical integration is $0.225\ wa^3$. Using Pigeaud's coefficient of the maximum load and assuming an elliptical distribution, the maximum moment is $0.204\ wa^3$ and assuming a trapezoidal distribution of load with a maximum of $0.5\ wa$ the maximum moment is $0.229\ wa^3$.

Rectangular Plate Fixed at Some Edges and Freely Supported at the Others

If it is assumed that any edge of a rectangular plate may be either freely supported or fixed, and if k is always greater than unity, there are nine possible conditions of restraint for symmetrical loading. These are shown diagrammatically in Fig. 7 and for brevity will be referred to by the numbers given in the figure. Cases 1 and 6 have already been considered. Cases where the restraints are unsymmetrical on opposite sides are not easily treated mathematically. The case where two parallel sides are fixed and two are freely supported (3a and 3b) was considered by Lévy[9], and Westergaard has computed bending moments by a method based upon Lévy's analysis. These results are presented in Figs. 8 and 9. It is assumed that σ is equal to zero and curves are given for the coefficients in the following equations:

Case 3a (Long sides fixed)

For $x=a/2,\ y=b/2 \quad M_y=C_{11}\,w\,a^2$ - - - - (30)

For $x=0,\ y=b/2 \quad M_y=-C_{12}\,w\,a^2$ - - - - (31)

For $x=a/2 \quad M_{x\,(max.)}=C_{13}\,w\,a^2$ - - - (32)

As in the case of the freely supported slab the maximum moment in the long span does not occur at mid-span. Values of coefficients calculated from approximate formulas by Marcus and Westergaard are also shown. The formulas are as follows:

Marcus

$$C_{11} = \left(1-\frac{25}{18}\,\frac{k^2}{(1+5k^4)}\right)\,\frac{5k^4}{24\,(1+5k^4)} \quad \text{- - - (33)}$$

$$C_{13} = \left(1-\frac{5}{6}\,\frac{k^2}{(1+5k^4)}\right)\,\frac{k^2}{8\,(1+5k^4)} \quad \text{- - - (34)}$$

Westergaard

$$C_{11} = \frac{k^4}{24\,(k^4+0.4)} \quad \text{- - - - - - - - - - - (35)}$$

$$C_{12} = \frac{k^4}{12\,(k^4+0.2)} \quad \text{- - - - - - - - - - - (36)}$$

$$C_{13} = \frac{k^2+0.3}{80k^2} \quad \text{- - - - - - - - - - - - (37)}$$

Case 3b (Short sides fixed)

For $x=a/2,\ y=b/2 \quad M_y=C_{14}\,w\,a^2$ - - - - (38)

For $x=a/2 \quad M_{x(max.)}=C_{15}\,w\,a^2$

For $x=a/2,\ y=0 \quad M_x=-C_{16}\,w\,a^2$- - - - (39)

Part II—Derivation of Design Rules for a Group of Approximately Equal Rectangular Slabs Carrying Uniform Loads

INTRODUCTION

When a rectangular slab forms part of a structure, and there are other slabs of approximately the same size continuous at one or more of its edges, an infinite number of combinations of conditions of restraint may occur. In order to arrive at practical rules for design it is necessary to establish a comparatively small number of arbitrary conditions which may be considered to represent practical conditions without serious errors. In the case of one-way slabs the following moment coefficients are widely used:

Positive moment at or near mid span,	
End spans....................	.100
Interior spans...................	.083
Negative moment at first interior support,	
Two spans....................	.125
More than two spans...........	.100
Negative moment at other interior supports............................	.083

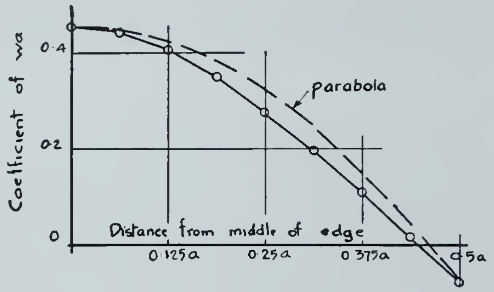

Fig. 6(a)—Square plate fixed at its edges. Distribution of pressure along the edges.

The above coefficients are given in C.E.S.A. Specification A23-1929, Concrete and Reinforced Concrete, and apply to slabs "built to act integrally with beams and girders or other slightly restraining supports." The A.C.I. building regulations for reinforced concrete give similar coefficients except that for slabs having a span of less than 10 feet the coefficient of negative moment at the first interior support may be assumed to be 0.100 in the case of two spans and 0.083 for more than two spans. An attempt will be made to derive practical formulas analogous to the above for use with two-way slabs.

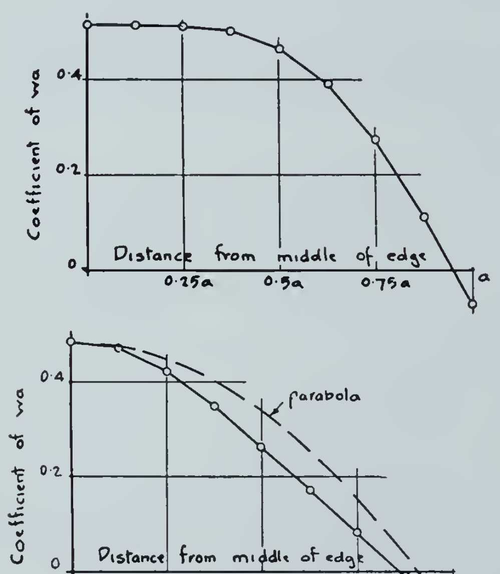

Fig. 6(b)—Rectangular plate (k=2) fixed at its edges. Distribution of pressure along the edges.

Maximum Positive Moment in the Shorter Span

A comparison of the values of C_{11} and C_7 (Figs. 4 and 8) will show that the positive moment at mid-span is not influenced very greatly by the degree of restraint at the short edge of the slab, provided that k is not greater than about 1.5. If slabs are constructed monolithically with the supporting beam, it appears to be reasonable to assume that a fairly high degree of restraint will be present in all cases. This will be particularly true in the case of an interior panel where the short edges will be restrained both by the beams to which they are attached and by the slabs forming against the panels. It is proposed, therefore, to assume that the restraint on the short edges will always correspond to 75 per cent fixity when considering the values of positive moments. This assumption may introduce small errors on the wrong side in the case of a single row of panels and small errors on the right side in the case of a full panel located in an interior row but it appears that, in either case, the errors will be very small. The simplification made possible by this assumption is very great—the positive moment in a slab will not depend upon the location of the slab with respect to parallel rows, i.e., the moment in a corner panel will be assumed to be the same as that in an exterior panel not at a corner.

It is necessary next to consider the conditions of restraint that may exist on the long side of the slab. These, of course, will have considerably more influence upon the values of the positive moments. At an exterior edge it appears reasonable to assume that the degree of restraint will never be less than that corresponding to 25 per cent fixity. This is probably a very conservative figure. At an edge having another slab connected to it any condition of restraint may occur as a result of different combinations of loading. Considering only one row of panels the maximum positive moment at mid-span will occur when the span under consideration and alternate spans on either side carry live load. Löser[10] has shown that the maximum positive moment may conveniently be determined by superimposing the following loading conditions:

(1) Dead load plus half live load on all spans.

(2) Half the live load applied alternately upwards and downwards on successive spans.

For the first loading, moment coefficients will correspond to fixed-end conditions for an infinite number of spans and approximate values may be chosen for any specified number of spans. For the second case, the moments will be those for simply supported conditions. Thus, any long edge of the slab may therefore be considered as simply supported, 25 per cent fixed, or completely fixed, depending upon the loading.

The problem therefore is to find moment coefficients for all the possible cases of restraint. There are six cases and these are shown diagrammatically in Fig. 10 as cases (a) to (f). (Two other cases (g) and (h) are also shown in Fig. 10; these will be referred to when considering negative moments). Moment coefficients can be determined by approximation from the theoretical values already given. These moment coefficients will be designated as C_a^+, C_b^+, etc. for cases (a), (b), etc. Values of these constants have been computed using the following approximate equations:

$$C_a^+ = 0.25\, C_1 + 0.75\, C_{14} \qquad (40)$$

$$C_b^+ = 0.25\, C_{11} + 0.75\, C_7 \qquad (41)$$

C_c^+ No mathematical expression has been given for this. It is believed, however, that very close results can be obtained in the following manner making use of two approximate equations given by Marcus.*

$$C_c^+ = 0.75\, C_M' + 0.25\, C_M'' \qquad (42)$$

$$\text{where } C_M' = \left\{1 - \frac{15}{32}\,\frac{k^2}{(k^4+2)}\right\} \frac{k^4}{k^4+2}\,\frac{9}{128}$$

$$\text{and } C_M'' = \left\{1 - \frac{75}{32}\,\frac{k^2}{(2+5k^4)}\right\} \frac{5k^4}{2+5k^4}\,\frac{9}{128}$$

$$C_d^+ = .75\, C_a^+ + .25\, C_c^+ \qquad (43)$$

$$C_e^+ = .75\, C_a^+ + .25\, C_b^+ \qquad (44)$$

$$C_f^+ = .75\, C_c^+ + .25\, C_b^+ \qquad (45)$$

Applying Löser's method to two spans, for both spans loaded the moment coefficient will be C_f^+, and if half the live load is acting downwards on one span and upwards on the other the moment coefficient will be C_d^+. If q be the

*Reference could also have been made to Timoshenko "Theory of Plates and Shells," pages 211-212.

ratio of live load to dead load, the coefficient of maximum positive moment, C_{17}, will be given by

$$(1+q)\, w\, C_{17} = C_f^+\, (1 + 0.5q)\, w + C_d^+\, (0.5q)\, w$$

$$C_{17} = \frac{C_f^+\, (1 + 0.5q) + 0.5q\, C_d^+}{1+q} \quad - - - \quad (46)$$

Löser's method cannot be applied directly to determine the maximum positive moment in the end panel of a row containing more than two panels. When all panels are loaded the slope of the slab will not be zero at the first interior support and thus the positive moment will be somewhat greater than it was in the case of two spans only. In the case of a continuous beam the coefficient of the maximum positive moment in the first span is .0702 for two spans and .80 for five spans. A reasonable increase in the

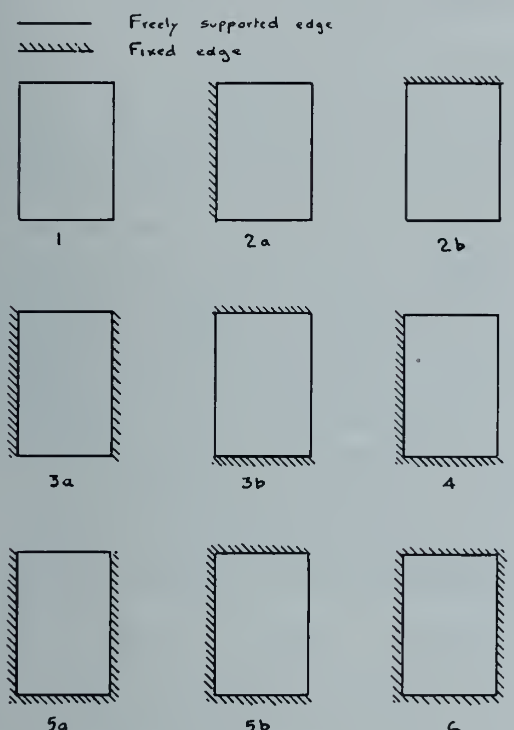

Fig. 7—Rectangular plate. Condition of edge restraint.

case of a slab would appear to be about 10 per cent. If this assumption is made the coefficient of maximum positive moment in the end span of a series of more than two spans will be given by

$$C_{18} = \frac{1.1\, C_f^+\, (1+0.5q) + 0.5q\, C_d^+}{1+q} \quad - - - - - - \quad (47)$$

The maximum positive moment in interior spans can be determined when considering a span forming one of an infinite series. Since the actual number of panels in a row is likely to be comparatively small, errors will be introduced by applying results derived for an infinite number of spans. These errors will only be appreciable in spans near the end of a row where the positive moment will be somewhat less than that given for an infinite series. The errors are, however, on the right side and are not considered to be significant. Applying Löser's method to determine the coefficients of maximum positive moment gives the following equation:

$$C_{19} = \frac{C_b^+\, (1 + 0.5q) + 0.5q\, C_a^+}{1+q} \quad - - - - - - - \quad (48)$$

Maximum Positive Moment in Direction of Longer Span

By the use of equations similar to equations (42) to (48) coefficients of maximum positive moments in the direction of the longer span have been computed. The long edges have been assumed to be 75 per cent fixed in each case.

The results show that positive moments in the long span are but little affected by variations in the restraint of the short edges. This being the case it does not appear to be necessary to consider the effect of differing arrangements of live load upon a group of panels. For practical purposes it will be assumed that the coefficient C_a^+ (long span) will apply in all cases. This coefficient will be designated as C_{20} since the symbol C_a^+ has been used to indicate a particular condition of restraint.

Maximum Negative Moments in the Direction of the Shorter Span

A comparison of C_8 and C_{12} in Figs. 4 and 8 respectively shows that negative moments at the longer support are influenced to an appreciable extent by the degree of restraint provided for the shorter edges of the slab, particularly when k is greater than about 1.7. In considering negative moments in the direction of the shorter span, i.e., at right angles to the longer span, it therefore appears to be necessary to consider not only the effects of varying the restraint along the long edges but also the effect of varying the restraint along the short edges. As in the case of positive moments, it will be assumed that at a continuous edge 75 per cent restraint will be present and at a non-continuous edge 25 per cent. It will also be assumed that maximum negative moments occur when all spans in the row under consideration are loaded. In approximately equal spans the errors involved in this assumption are very small. Making the above assumptions there will be four cases to be considered.

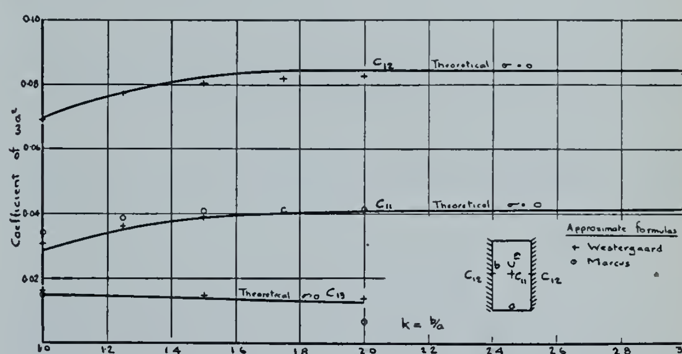

Fig. 8—Rectangular plate having its long edges fixed and its short edges freely supported. Coefficients of maximum positive and negative bending moments.

(1) The first interior support in an exterior row.
(2) Interior supports other than the first in an exterior row.
(3) The first interior support in an interior row.
(4) Supports other than the first interior support in an interior row.

The case of a single row of panels, being comparatively unimportant, has not been considered.

These degrees of restraint correspond to the conditions indicated in Fig. 10 for cases (g), (h), (f), and (b), respectively.

The moment coefficients corresponding to these cases may be determined in the following manner:

Case (b) $C_b^- = 0.75\, C_8 + 0.25\, C_{12}$ - - - - - - - - (49)
Case (f) $C_f^- = 1.375\, C_b^-$ - - - - - - - - - - - - (50)
Case (g) $C_g^- = 1.375\, C_h^-$ - - - - - - - - - - - - (51)
Case (h) $C_h^- = 0.75\, C_M''' + 0.25\, C_{12}$ - - - - - - - (52)

where C_M''' is determined by the Marcus approximation

$$C_M''' = \frac{k^4}{6\,(1+2k^4)}$$

It was stated above that conditions of restraint in an end panel could be represented by cases (f) or (g). These cases, however, only apply strictly to two panels since when there are more than two continuous spans it is necessary to make corrections owing to the fact that the slope of the slab will not be zero at the first interior support. In the case of a continuous beam the coefficient of the moment at the first interior support is about 20 per cent less for five spans than for two. A comparison of the values of C_{17} and C_{18} indicates that, for positive moments, there are only small differences between the values obtained for two spans and for the end span of a row of more than two spans. In the case of negative moments it does not appear to be worth while considering the two cases separately. Since it is somewhat doubtful if the uncommon case of only two panels should be made the governing factor in determining moment coefficients for end spans in general, it is proposed to reduce the appropriate coefficients, viz., C_h^- and C_f^-, by

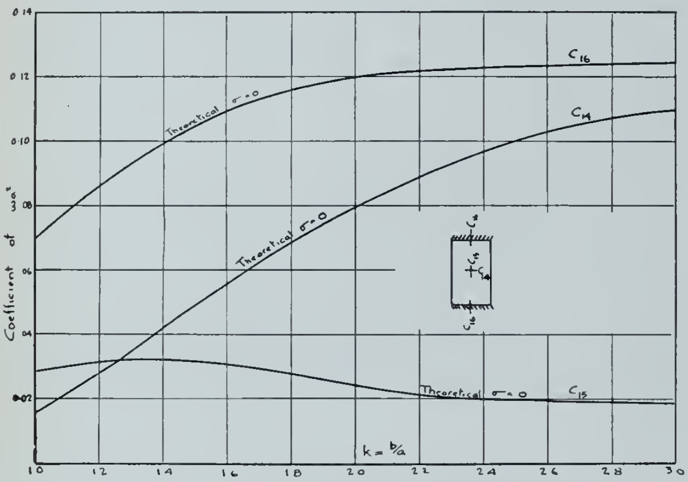

Fig. 9—Rectangular plate having its long edges fixed and its short edges freely supported. Coefficients of maximum positive and negative bending moments.

15 per cent and to assume that the figures so obtained will apply to the first interior support no matter how many panels may be in the row.

Maximum Negative Moments in the Direction of the Longer Span

By a method similar to that used for determining coefficients of negative moments in the shorter span the coefficients of moments in the direction of the longer span have been calculated.

Moment Coefficients for Use in Design

The moment coefficients derived in the preceding paragraphs could be used without further transformation as a basis for the design of slabs. It will be found that the coefficients of negative moments are in general considerably greater than the coefficients for positive moments. There appears to be good reason for believing that this difference will be reduced by the effect of plastic flow or creep. Thus, experiments on continuous frames have shown that, as a consequence of plastic flow, a redistribution of moment occurs. This takes the form of a decrease of moment at the supports together with an increase at mid-span. The German and British regulations take account of this by permitting a reduction of 15 per cent in the maximum negative moment provided this amount is added to the maximum positive moment. In the case of continuous slabs Westergaard[11] has pointed out that the effect of plastic flow will be as follows: The distribution of negative moment along the supports will tend to become more uniform with a consequent reduction of the maximum moment; the negative moment will decrease and the positive moment at mid-span will tend to increase; the positive moment in the short span will tend to decrease and the positive moment in the long span to increase. These conclusions may be accepted as correct but it is difficult to assess the relative importance of the various effects without a considerable amount of experimental evidence.

Most tests have been carried out in a comparatively short time so that in interpreting the results it is difficult to estimate the effects of plastic flow at all accurately. Conditions during a brief time loading test are not the same as those occurring when the load is sustained for a long period of time. Tests in which loading is sustained for a year or more do not appear to have been carried out on two-way slabs and in the absence of such data, design formulas must be based upon assumptions that may or may not be correct.

The following method appears to be reasonable in principle and it is believed that it will always lead to structures with an adequate factor of safety.

It will be assumed that the transference of moment from the supports to mid-span resulting from plastic flow will be such as to lessen the numerical difference between the maximum negative moments and the maximum positive moments to one-half of its calculated value. This will result in the following positive moment coefficient:

Positive moment coefficient assumed in design = calculated positive moment coefficient
+0.25 (calculated negative moment coefficient − calculated positive moment coefficient)
= 0.75 (calculated positive moment coefficient) + 0.25 (calculated negative moment coefficient) - - - - (53)

In cases where the negative moment along the two supporting edges differs, the greater value will be assumed in using equation (53).

In the case of the negative moments it will be assumed that there will be a further reduction due to transference of moment from the middle of the sides to the ends. A reduction of 15 per cent of the calculated moment is proposed for this. The following negative moment will result:

Negative moment coefficient assumed in design = 0.85 (calculated negative moment coefficient)
− 0.25 (calculated negative moment coefficient − calculated positive moment coefficient)
= 0.60 (calculated negative moment coefficient) + 0.25 (calculated positive moment coefficient) - - - - (54)

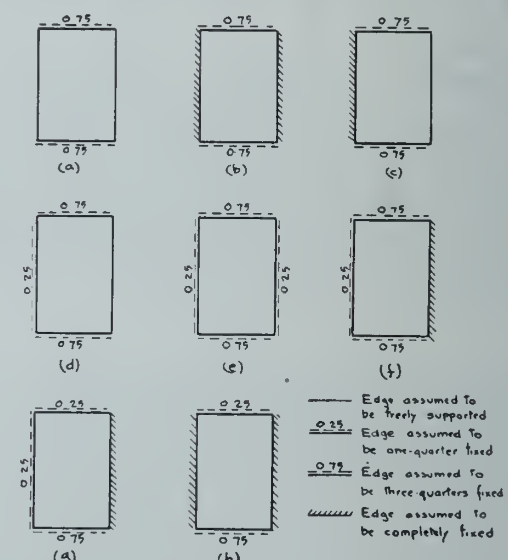

Fig. 10—Rectangular slab. Conditions of restraint.

The coefficient of moments derived in the preceding section (C_{17}—C_{26}) have been modified by the use of equations (53) and (54) and the resulting coefficients are given in Table I and are shown graphically in Figs. 11 and 12.

In Figs. 11 and 12 the coefficients have been plotted against the reciprocal of k, (m), and it will be seen that they can be conveniently represented for practical purposes by linear equations. In some cases the proposed lines follow the calculated coefficients quite closely but in other cases the agreement is not so close. In general, the proposed lines are in close agreement with the derived coefficients for square and nearly square slabs but some consideration

TABLE I

Summary of Calculated Values of Moment Coefficients

Coefficient	Span	k = Long Span / Short Span						
		1.0	1.25	1.5	1.75	2	2.5	3
Positive Moments—								
Two spans, $q=4$	Short	.035	.050	.061	.069	.075	.082	.085
End span of more than two, $q=4$	Short	.031	.045	.055	.064	.070	.077	.080
End span of two or more	Long	.033	.035	.037	.037	.037	.037	.037
Interior span, $q=4$	Short	.029	.041	.051	.059	.064	.069	.073
Interior span	Long	.030	.030	.031	.032	.031	.031	.030
Negative Moments—								
First interior support—								
Exterior row	Short	.046	.058	.066	.071	.074	.077	.079
Interior row	Short	.043	.055	.064	.070	.073	.077	.079
First interior support—								
Exterior row	Long	.046	.053	.059	.061	.063		
Interior row	Long	.044	.049	.052	.054	.054		
Supports other than first interior support—								
Exterior row	Short	.039	.050	.057	.061	.064	.066	.067
Interior row	Short	.037	.047	.055	.060	.063	.065	.067
Supports other than first interior support—								
Exterior row	Long	.040	.046	.051	.053	.054		
Interior row	Long	.038	.043	.046	.047	.047		

has been given to the conventional coefficients for one-way slabs and in most instances moment coefficients in the short span approach the usual coefficients for one-way slabs when k is approximately equal to three ($m=0.33$). From a practical standpoint it has not been considered worth while distinguishing between positive moments in two spans and in the end span of more than two spans of a row of more than two spans, and also between negative moments in exterior and interior rows. It is believed that coefficients obtained from the proposed formulas will have an adequate margin of safety, that they will be found simple to use, and that in the case of square or nearly square panels they are as small as can be justified on the assumption of elastic behaviour.

In addition to the coefficients given in Figs. 11 and 12 it is necessary to propose values for positive moments in an isolated span and for negative moments at exterior edges in general. For an isolated panel the moment coefficients could, of course, be derived from Figs. 1 or 4, providing that some estimate of the degree of restraint at the edges would be made. Such a method, however, might lead to moment coefficients appreciably less than those prescribed for the end panel of a row of two or more.

TABLE II

Coefficients of Maximum Bending Moments in Rectangular Slabs Reinforced in Two Directions

	Coefficient of $w'a^2$	
	Short Span	Long Span
Positive Moments		
(a) Near the centre of single spans	$0.13-0.09m$	0.04
(b) Near the centre of the end span of two or more spans	$0.115-0.08m$	0.035
(c) Near the centre of interior spans	$0.095-0.065m$	0.03
Negative Moments		
(a) At the exterior supports of a slab	$0.05-0.03m$	0.02
(b) At the interior support of two spans and at the first interior support of more than two spans	$0.13-0.085m$	$0.085-0.04m$
(c) At interior supports other than the first	$0.103-0.066m$	$0.077-0.04m$

Symbols have the following meanings:

w' = load per square unit

a = shorter span

$m = \frac{\text{shorter span}}{\text{longer span}}$

In order to avoid this apparent anomaly, the prescribed moment coefficient for positive moment in the short span of an isolated span has been taken as 1.13 times the values prescribed for the end span of a row. This gives a coefficient of $0.13-.09m$. It has been assumed that the coefficient of moment in the long span remains constant at 0.4 irrespective of the value of m. For negative moment at an exterior edge a coefficient of 0.02 is proposed for a square panel, increasing for short spans up to 0.04 for k equal to 3. This upper limit corresponds approximately to the value of 1/24 commonly used when designing one-way slabs. The value for square slabs corresponds to about 38 per cent fixity and it will be remembered that when deriving coefficients at interior supports the fixity at an exterior edge was assumed to be 25 per cent. Thus, the proposed coefficient should contain an adequate margin of safety.

The proposed design coefficients are collected together in Table II.

Intensity of Loading on Supporting Beams

It was shown in the preceding portion of this paper, that the distribution of shear at the edge of a rectangular plate is such as to produce a distribution of pressure along the supports which may be represented approximately by an ellipse if the edges are freely supported, and by a parabola if they are clamped. It was further shown that in the latter case the maximum bending moment in the beam may be closely estimated by assuming a trapezoidal distribution of load. Table III summarizes the coefficients of moment previously derived:

TABLE III

Maximum Bending Moments in the Supporting Beams

Assumed Distribution of Load	Maximum Bending Moment in Side OB	
	$k=1$	$k=2$
Elliptical—freely supported	$.036wb^3$	$.025wb^3$
Trapezoidal—clamped	$.042wb^3$	$.029wb^3$

If no redistribution of moment due to flow occurred, the maximum moment in the beam would presumably be within the above limits for various conditions of restraint. The effects of transference of moment in the slab and deflection in the beam will be to equalize the pressure along all the supporting edges. The German regulations recognize this and state that "the supporting pressures exerted by uniformly loaded rectangular two-way slabs that are supported by beams or walls may be assumed to be uniformly distributed." Making this assumption, the unit load on the beams will be $\frac{wa}{2}\frac{(k)}{(1+k)}$ and the maximum bending moment will be $\frac{wb}{16\,(1+k)}$ and $\frac{wa}{16}\frac{(k)}{(1+k)}$ in the long and the short sides respectively. The maximum moment in the long side will then be $.031\ wb^3$ and $.021\ wb^3$ for $k=1$ and $k=2$ respectively. A comparison of these figures with those given in Table III leads to the conclusion that the assumption of uniform pressure is a convenient way of making allowance for deflection and plastic flow. This method has the further advantage of making it possible to design the supporting

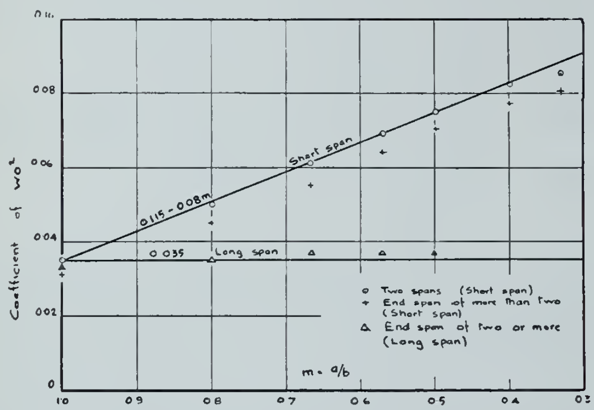

Fig. 11(a)—Continuous rectangular slabs. Coefficients of maximum positive moments in the end span of two or more spans.

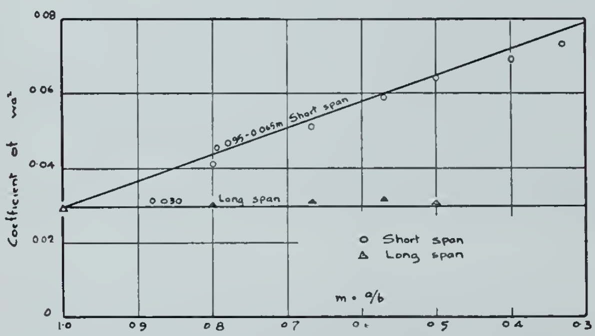

Fig. 11(b)—Continuous rectangular slabs, Coefficients of maximum positive moments in interior spans.

beams as continuous beams making use of the moment coefficients commonly used for uniform loadings. The only disadvantage is that there will be a discontinuity in the loading to be assumed, if a slab, in which k is equal to three for example, is designed as a one-way slab rather than a two-way slab. This may be avoided with a slight loss of economy by assuming that the loading expressed as a coefficient of wa varies uniformly from 0.25 to 0.5 as k varies from one to three. The coefficient will thus be given by the formula:

$$C_{27} = \frac{1+k}{8}$$

$$= \frac{m+1}{8m} \qquad (55)$$

It is suggested therefore that the following rule could be safely adopted:

The pressure exerted by uniformly loaded rectangular two-way slabs on the supporting beams or walls may be assumed to be uniformly distributed and equal in intensity to $\frac{1+k}{8}(wa)$ or $\frac{m+1}{8m}(wa)$.

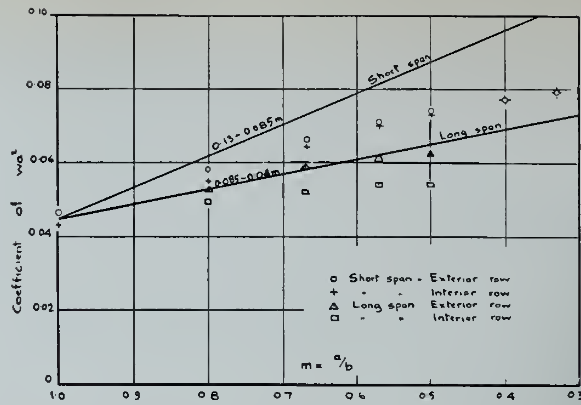

Fig. 12(b)—Continuous rectangular slabs. Coefficients of maximum negative moments at interior supports other than the first.

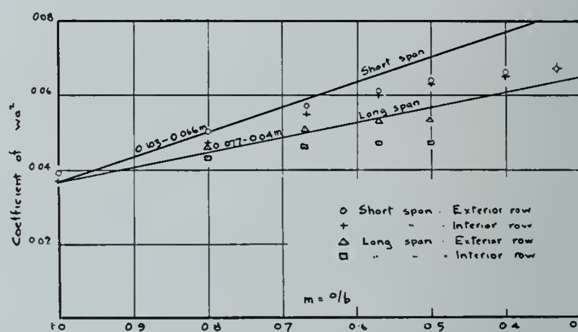

Fig. 12(a)—Continuous rectangular slabs. Coefficients of maximum negative moments at the first interior support.

Acknowledgement

The author wishes to acknowledge his indebtedness to Dean C. R. Young, M.E.I.C., chairman of the Sub-committee on Reinforced Concrete Construction of the National Building Code for reading the manuscript of this paper and for many helpful suggestions.

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THE HELEN MINE AND BENEFICIATING PLANT

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Paper presented before the Toronto Branch of the Engineering Institute of Canada, on February 20th, 1941

SUMMARY—The history of iron mining in Canada as well as early mining at the Helen Mine serves as an introduction to the description of the mining and sintering operation of the new Helen Mine. The operation of the Magpie Mine is referred to as having a direct effect on the present Helen operation. A description is given of one of the largest and highest speed belt conveyor systems in Canada located at Michipicoten Harbour where vessels are loaded with the mine's product.

Iron mining in Canada goes back to early in the eighteenth century. The first mining took place at Three Rivers and at Radnor Forges in Quebec. Iron at these points was mined almost continuously for one hundred and fifty years.

The earliest iron mining in Ontario is recorded at Normandale in Norfolk County in 1813. Records show New Brunswick and Nova Scotia mining iron in 1848 and 1849, respectively, although it probably started much earlier.

The total recorded iron mined in Canada since 1886, is 7,110,000 tons. Of this, Ontario produced 5,128,000 tons and Nova Scotia 1,279,817. These two provinces were the only ones to figure prominently in iron production. 1913 was the last year Nova Scotia recorded any shipments. It will thus be seen that Ontario has made the main contribution to Canada's iron mining industry in producing 72% of the total.

The Algoma Steel Corporation, since 1899 has been the mainstay of Ontario's production and up to the close of navigation for 1940, has been responsible for nearly 4,500,000 tons or 88 per cent of Ontario's total.

The Helen Mine was discovered in 1898 during the gold rush near Wawa Lake. It was immediately acquired by Mr. Clergue who was at that time building power and paper plants at Sault Ste. Marie. The construction of the steel works at the Sault followed as a direct result of the discovery of the Helen. This is another example, many times repeated in Canadian history, where mineral discoveries have resulted in the establishment of thriving towns and cities. Without the steel plant with its 4,500 employees, the Sault would still, in all probability, be a small village.

The original discovery consisted of a hill of solid hematite ore, rising above the shore of a small lake. The hill was about 100 feet high and at its base, 1,000 feet in length by 700 feet in width.

The property was located eleven and a half miles from Michipicoten Harbour, on the north shore of Lake Superior. Loading docks at the harbour were immediately constructed and a railway built to connect with the mine. This was the start of the Algoma Central Railway Company.

Mining was commenced in 1899 and the first ore was shipped in 1900. The mine was operated until 1918 when the hematite became exhausted at a depth, below the lake level, of 800 feet.

In 1910 it became evident that the life of the Helen was definitely limited and an extensive search was commenced for new iron deposits. A discovery of what appeared to be a magnetite deposit was made about 14 miles north of the Helen and this property was acquired by the Steel Corporation. Diamond drilling soon revealed that the new deposit was not magnetite but siderite, an iron carbonate containing about 35 per cent iron. There were several places where this kind of ore was being used direct in blast furnaces, where cheap fuel was available and the furnaces were near the mine. But for the Algoma Steel to use this class of ore direct, was out of the question. Therefore, experiments were started to improve the grade of the ore before shipping.

It was found that by roasting, the siderite gave off CO and CO_2 gases and was converted to an oxide. In this process the ore was reduced in weight by one third. Thus by treating three tons of ore containing 35 per cent iron, two tons resulted, grading 50 per cent iron. In addition to raising the iron content, it was necessary to burn out most of the 2 per cent sulphur which the Helen ore contained.

The experiments were slow and expensive but a succesful process was gradually evolved; a commercial plant was then erected at the property, now known as the Magpie Mine.

The roasting was done in rotary kilns, similar to those used in the manufacture of cement. They were six in number, each 125 feet long and 8 feet in diameter, lined with firebrick. They sloped to the discharge end at ½ inch to the foot and made one revolution in two minutes. Powdered coal was blown in at the discharge end and 2,800 pounds of siderite and 300 pounds of pulverized coal were required to produce one ton of finished iron. It took four hours for the ore to travel through the kiln and each kiln had a capacity of 110 tons of finished ore per day. The maximum temperature was 1,100 deg. C. The raw ore was crushed to about 3½ inches and the finished material retained pretty much the same structure as the raw ore.

The sulphur in the finished ore was high, averaging about 0.2 per cent, but this did not interfere with marketing the ore, due to its other good characteristics which were no moisture, good structure, 3 per cent manganese, low phosphorus and sufficient lime to make the ore self-fluxing.

Over 1,000,000 tons of finished ore were produced at the Magpie. In 1921, however, ore prices dropped, and due to the cost of treatment, the Magpie could no longer compete with other iron producers so that operations ceased.

Fig. 1—Helen open pit at top of hill and aerial tram loading plant and bin.

It has been proved, however, that an excellent blast furnace product could be made out of siderite.

In 1910 and 1911 it was found that the ore body in the Helen hematite mine diminished in size as greater depths were reached. It was noticed that on three sides, east, west and south, as the hematite ended, the material along the contacts was siderite. Diamond drill holes were put down from underground and a large body of siderite was located, both below the hematite and to the east. It was estimated that this siderite would extend eastward to the edge of a steep hill, 400 feet in height, a distance of 800 feet. It seems almost unbelievable that it was not recognized, that in this hill itself, fully exposed on its western slope, and in many places on the crest, existed the main siderite deposit, now the new Helen Mine. Figure 1 shows this exposure as it existed at that time.

In the latter part of 1911 the first exploration of the ore in this hill commenced and in 1912 and 1913 it was trenched and diamond drilled. An ore body nearly 200 feet in width, 3,000 feet in length and at least 2,200 feet in depth was indicated, estimated to contain one hundred million tons.

No further work was done in the development of this deposit until 1917, when a tunnel was driven into the ore, 300 feet below the top of the hill. In 1918 this work was suspended.

With the experience at the Magpie Mine in view, it was not considered that this ore could be mined and treated in competition with Lake Superior open pit ores.

In 1937, the Ontario Government passed an act giving a bounty of two cents a unit on iron ore produced in the province. This act immediately produced results. Sir James Dunn, now president of the Algoma Steel Corporation, decided to place this huge, but low grade, ore deposit in production. Even with the bounty, it required courage to make this decision. The required expenditure was large and the field a new one. There were no plants treating this class of ore and it was recognized at the outset that the costly and inefficient process used at the Magpie would not be practicable.

The deposit, however, had many things in its favour. It was already connected by the Algoma Central Railway to Michipicoten Harbour, a distance of twelve miles, and to the Sault, 180 miles to the south. The power lines of the Great Lakes Power Company were only a few miles distant.

The upper 400 feet of the ore body could be mined cheaply, largely by open pit; the size of the deposit itself, together with the fact that it stood almost vertical, indicated low mining costs.

The ore body was carefully sampled on a large scale and tests were commenced at various plants to determine the best equipment to use. Mr. C. D. Kaeding was given charge of the entire project and he and his staff, together with the Steel Company's engineers, carried out the tests.

Two main systems of sintering were in use, one an intermittent process and the other continuous. Both systems worked satisfactorily and a decision was finally made to use the continuous or Dwight-Lloyd machine.

At the mine, a tunnel, eight feet by twelve feet, 400 feet long was driven into the ore body 270 feet below the crest of the hill. At the end of this tunnel a raise was put up, coming out on the western slope of the hill 150 feet above the tunnel. At this elevation the quarry floor was established. This would give a maximum quarry face 120 feet high.

At the foot of this raise and close to the south side of the ore body, a crusher chamber was cut and a Traylor Bulldog jaw crusher, 48 inches by 60 inches, was installed. This crusher is fed by a large Ross feeder. The grizzly at the mouth of the raise has 34 inch openings.

Fig. 2—Helen open pit showing ore from face being loaded into trailers.

Drilling in the pit is done with a Bucyrus-Armstrong blast hole drill. Nine-inch holes are drilled, spaced about 25 feet apart. The burden on the holes is also about 25 feet. The holes are drilled 6 feet below grade. One of the most important parts of the whole operation is the loading of the holes. Before loading, the face is carefully surveyed and a knowledge is obtained of the amount of work each hole is expected to do. The whole face, 200 feet in width is shot at one time. From 25 to 35 cases of powder are used in each hole. It is most important that the bottom part of the face breaks out well. Therefore from four to five cases of 60 per cent Forcite are used in this bottom section. This is followed by seven cases of 40 per cent Forcite. Above this, there are three feet of stemming, then two cases of 40 per cent Forcite. This alternate stemming and two cases of Forcite continues about half way up the hole, above which the Forcite is replaced by 60 per cent ammonia powder. The holes are loaded to within 17 to 20 feet of the collar. The powder all comes in 12½ pound bags. The holes are fired by Prima Cord blasting fuse. This fuse is run all the way down each hole and the fuse from all holes, are connected to a trunk line on the surface. It is not necessary to use any detonating caps on this fuse in the holes. One detonator on the fuse on surface fires the whole charge. By

Fig. 3—Side view of sintering plant.

using this fuse the hole is detonated instantaneously from top to bottom as the fuse has a speed of over 20,000 feet a second. From 60,000 to 75,000 tons are broken with each blast, about three weeks production. Two to three rock drills are kept on secondary blasting work to reduce the larger pieces to 34-inch size. As a whole, the fragmentation is very good from the primary blasting. It has, however, taken considerable study and experiment by the mine staff to reach this end.

The broken ore is loaded from the face by a 2½ yard Marion electric shovel into 11-yard Athey quarry trailers, as shown in Fig. 2. These trailers are hauled by a D-7 Caterpillar tractor and taken to the mouth of the raise. The trailers are dumped by oil pressure, directly from the cab of the tractor and the whole operation is quick and efficient.

The ore is passed down the raise to the primary crusher below. It is crushed to 4½-inch size, and conveyed along the tunnel and conveyor gallery to a loading plant equipped with a 500-ton steel ore bin. (See Fig. 1.).

The topography in the vicinity of the mine is very rugged and no site for the sintering plant was available near by. This plant was, therefore, built on a gravel plain, 2½ miles distant. From the 500-ton loading bin mentioned above, the ore is conveyed to the sintering plant by an aerial tramway, having a capacity of 120 tons an hour. The ore on reaching the plant site is discharged into a 1,000-ton steel terminal bin. In all cases ore is referred to in gross tons of 2,240 pounds.

The tests on Helen siderite had been as complete as possible, considering the relatively small scale on which they were made. The new plant (shown in Fig. 3) was designed largely on the experience gained in the experimental work and the investigation of plants working on other types of iron ore. The standard set by the Company for the finished ore involved bringing the iron content to 51.50 per cent and reducing the sulphur to 0.05 per cent.

The sinter had to have good physical structure and be as free as possible from fines.

The ore from the terminal bin is drawn by a Ross feeder on to a conveyor belt. This belt delivers the ore to a surge bin at the top of the crushing and screening plant. Four feeder belts take the ore from the surge bin to the double deck Tyler screens (4 by 8 ft.) where three products are made, plus 1⅛ in., minus 1⅛ in. and plus ¼ in. and minus ¼ in. The latter size is the required product for the sintering machines. The first size is delivered to a 5½-ft. Symons cone crusher, set at ¾ in. and driven by a 150 hp. slip ring motor. The second size is delivered to a set of Traylor heavy duty rolls (72 by 18 in.) driven by two-150 hp. slip ring motors. The third or finished size, minus ¼ in., goes direct to the fine ore charge bins. The undersize from the crusher and rolls is returned to the main belt feeding the ore from the terminal bin to the surge bin. This puts the crude ore in closed circuit with the crushing plant. The circulating load is about 200 per cent and the crushing capacity in terms of all minus ¼ in. product, is 200 tons per hour.

Fig. 4—Front view of sintering plant.

The charge bins are eight in number, each 16 feet in diameter and 40 feet high. Four of these are for the crushed raw ore, two for coke and two for fine sinter.

Coke is used for fuel in the sintering operation and must be crushed and dried. It is necessary to crush the coke at least as fine as the ore in order to obtain a uniform mix. As the sinter comes off the machines, part of it has not been fully sintered and part breaks into pieces 1 in. or less in size. All sinter under one inch is screened out. This material is further screened, all over ½ in. in size goes to one sinter bin and is shipped with the rest of the finished ore. That part under ½ in. goes to the second sinter bin and is later mixed with the raw ore going to the machines.

In all sintering tests it was very evident that this fine sinter, mixed with the raw ore, was important for successful operation. The fine sinter is made up of porous pieces which are not affected by further heat. It, therefore, tends to keep the whole charge uniformly open. Of the whole charge, 20 per cent should be returned fines. Without these fines, the air circulation is not uniform and channelling results.

The returned fines and raw ore are drawn by belt conveyors from their respective bins and fed, in the calculated proportion, to a cross belt. This mixture is then conveyed to three hoppers, one above each sintering machine.

Originally the coke was also added to the cross belt but due to the variation in the sulphur content of the ore, this practice was discontinued.

For average ore containing 2½ to 3 per cent sulphur, about 3 per cent coke was added. However, sulphur itself is a fuel and when the sulphur content rises above this amount it is necessary to cut down the amount of coke. The coke, therefore, is now conveyed directly to coke hoppers, also located above the sintering machines, and in this way the coke feed can be closely controlled.

The charge, both ore and coke, is fed from the hoppers into a pug mill, one mill for each machine, where water is added to aid in nodulizing the charge. From the pug mills, the ore is fed through a swinging spout on to the sintering machines. These sintering machines are of the Dwight-Lloyd type 60 by 77 ft., each served by a 105 in. fan, directly connected to a 500 hp. slip ring motor. There is a dust collector for each machine and a conduit to a 125 ft. stack. The machines are located in parallel on a floor 37½ ft. above the ground level. Figure 4 is a front view of the sintering plant.

The raw ore is fed on to the machines in a bed 15 in. in depth. It then passes under the igniters which are of the oil burning, semi-reverberatory type. As the ore is conveyed down the machines, the fire is gradually drawn down through the charge, by the volume of air sucked through the fans. Vacuum boxes are located under the grates of the machine along its whole length. The ore travels at a rate of four feet per minute and each machine has a capacity of 800 tons of sinter per day.

The sinter cakes drop off the front end of the machine on to heavy grizzly bars set 10 in. apart. Below these bars there is another grizzly with 1 in. spaces. The oversize from both of these grizzlies goes by gravity to the loading bins, from which the ore is loaded directly into railway cars. This loading is controlled by air operated gates. The undersize from the 1 in. grizzly goes to the sinter bins mentioned earlier in this paper. Figure 4 shows the front of the sintering plant with the loading bins.

The ore in these bins is usually quite hot and is sprayed with water. Water sprays are also directed at the inside of the railway cars. This spraying avoids the warping of the steel plates in the bin and railway cars. To prevent dust there should be about 0.7 per cent moisture in the ore as it is shipped.

The Algoma Central Railway handle the ore from the sintering plant to Michipicoten Harbour, a distance of eight miles. Twin hopper, centre-dump gondola cars, 58-tons capacity, are used. (See Fig. 4.)

Fig. 5—Algoma Central Railway trestle with receiving hopper below at Michipicoten harbour.

At the harbour itself, a new plant for loading vessels had to be constructed by the railway company. The old ore dock used twenty years earlier for the old Helen Mine, had been dismantled.

As the Helen Mine was the only customer in sight, it was obvious that the cost of a steel and concrete pocket dock would be prohibitive. Boats, however, demand quick loading and several types of loading facilities were investigated.

It was finally decided to use a belt conveyor system, and it was necessary to load vessels at a rate comparable to the American pocket docks. This meant a single belt with a capacity of at least 1,500 gross tons per hour.

The plan decided on, included loading vessels at the face of an existing coal dock. The coal bridge would be run to the south end of the dock, thus allowing free use of the entire frontage for loading iron ore.

A reinforced concrete tunnel was constructed just north of the coal dock floor and at the same elevation. This tunnel, 250 feet in length, is 10 feet wide by 7 feet in height. Hatches, three feet square, were made in the top of the tunnel at 10 foot intervals, making 24 in all. A basin to hold 14,000 gross tons of ore was created over the tunnel by building up the sides with gravel and facing the top of this fill with railway ties, the effect being to create a large hopper, the bottom of which would be the top of the tunnel.

The railway track came to this loading area at an elevation of 45 ft. above the top of the tunnel and a steel trestle was built out over the entire length of the tunnel. A space between the rails was left open to allow the ore to be dumped from the bottom of the cars. (See Fig. 5).

A 48 in. belt conveyor was installed in the tunnel. This belt is loaded by means of a single loading hopper which travels from hatch to hatch. As this hopper comes under a hatch, it engages the hatch gate which is then opened to any

Fig. 6—Algoma Central Railway gantry transferring ore from dock belt to ship.

desired area by the operator. The loading hopper and the gate are electrically operated. Baffles in the loading hopper allow a uniform feed and flow on to the belt in the direction of belt travel, thus preventing any undue belt wear at this point.

The ore is conveyed on the tunnel belt to a transfer point 37 ft. beyond the tunnel mouth. It is then transferred to a cross belt, also 48 in. in width, which carries it a distance of 150 ft. to the face of the coal dock. This transfer belt is on an incline of 8 degrees. The ore is weighed on this cross belt by a set of Fairbanks conveyor scales.

The ore from the cross belt is then transferred to another 48 in. belt which travels along the face of the dock for a distance of 470 feet as shown in Fig. 6.

A travelling gantry moves on tracks up and down the face of the dock and the ore is transferred by means of a tripper on to the gantry. The tripper travels with the gantry and both are electrically operated.

The gantry, itself, simply consists of an incline belt conveyor mounted on a movable structure. The ore is conveyed to a chute directly over the centre of the ship's hatch, through which it is fed into the vessels's hold. When the required amount is fed into any individual hatch, the gantry, together with the tripper, then moves to the next hatch. During this move the ore feed is shut off at the tunnel. The average time consumed in moving from one hatch to another is about two minutes.

The whole belt system is controlled from the operator's cabin on the gantry. The belts operate with time relay switches. The gantry belt starts first, followed in 15 seconds by the dock belt, which in turn is followed, at the same time intervals, by the cross belt and the tunnel belt. The belts are stopped in the reverse order.

The belts are all the same size but travel at different rates of speed. The slowest speed is used in the tunnel and each succeeding belt runs a little faster with the highest speed obtained with the gantry belt. The tunnel belt travels 580 ft. per minute and the gantry belt 610 ft. per minute.

This system eliminates the possibility of an excess of ore piling up at any point along the system. The tunnel belt can be instantly stopped by the loading operator in the tunnel, should occasion arise, but no other belt can be stopped unless the one immediately behind it has ceased operation. As 12 cubic feet of ore per second is handled on the belts, the reason for such precautions becomes obvious. The tunnel, cross and gantry belts are each driven by 75 hp. motors. The belt along the face of the dock is driven by two 75 hp. motors. The gantry is moved along its track by a 15 hp. motor and the boom carrying the belt over the vessel's hatch is raised and lowered by a 7½ hp. motor. The loading hopper in the tunnel is operated by a 3 hp. motor. The air in the tunnel is kept clear by an exhaust fan driven by a 25 hp. motor.

All of the belts are flood-lighted as loading is done both by day and night.

At the close of navigation for 1940, 471,000 tons had been loaded through these facilities. The whole system has operated very smoothly and efficiently. It has been demonstrated that the belts, when in operation, can handle 2,400 gross tons per hour or 19 cubic feet per second. Including all delays, an average boat can be loaded in five hours and during the season of navigation, 200 days, this installation can handle from one to one and a half million gross tons of ore.

The Helen or Algoma sinter as it is called, is a highly desirable iron ore and goes into the markets of both Canada and the United States. It has good structure and has sufficient lime to make it self fluxing. Sulphur is practically eliminated. Phosphorus is low and the sinter contains 3 per cent manganese.

How well the sinter came up to the standards set before the plant was constructed, is shown by the average analysis of the whole 1940 production:

Fe 52.90%; P 0.024%; SiO_2 7.7%; Mn 2.99%;
Alumina 1.86%; CaO 3.45%; MgO 7.78%; S 0.040%.

This result reflects great credit on Mr. Kaeding and his associates who designed the plant and on Mr. Kidder and his staff who carry on the operation and who successfully overcame the many difficulties that arise in developing any new process of this kind.

TREATMENT OF BOILER FEEDWATER BY CARBONACEOUS ZEOLITE SOFTENER

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SUMMARY—This paper describes the introduction into Canada of carbonaceous zeolite water softening which works on the combination of hydrogen and sodium cycle. It also gives the results of the first year's operation.

In 1939, the Goodyear Tire and Rubber Company of Canada, New Toronto, installed a new high pressure boiler and turbine. Great care was given to the selection of the water softener equipment. The high speed turbine required entirely clean steam, free from carry-over. The boiler manufacturer permitted only 1,300 ppm.* total solids in the boiler water for a guaranteed carry-over of not more than 1 ppm. This involved excessive blow-down unless the total solid content of the raw water could be reduced to a fairly low value. Furthermore the decision to use a closed tubular feedwater heater and desuperheaters permitted only a very low hardness in the feedwater. The water softener had to produce makeup water of such quality that the boiler would be entirely free from scale, corrosion and embrittlement. Of course, it was desired to operate the equipment at the lowest possible cost and with the maximum amount of safety.

In this plant the water softener has to supply makeup water for a boiler with 90,000 lb. per hr. continuous output, at a pressure of 665 lb. per sq. in. and a temperature of 650 deg. F. The maximum makeup water requirement is 50,000 lb. per hr. The water, drawn from Lake Ontario and pumped first into a large concrete cistern in the plant, is of a fairly uniform quality, except that in springtime, freshets bring a comparatively high amount of suspended matter. An average analysis is given in Table I.

TABLE I

Average Analysis of Raw Lake Ontario Water

		*ppm.**	*epm.***
Hydroxide	(O H).	0.0	0.00
Carbonate	(CO_3).	0.0	0.00
Bicarbonate	(H CO_3).	119.0	1.95
Sulphate	(SO_4).	23.0	0.48
Chloride	(Cl).	16.0	0.44
Silica	(SiO_2).	5.2	0.17
Calcium	(Ca).	31.8	1.54
Magnesium	(Mg).	5.6	0.48
Sodium	(Na) calc.	26.4	0.85
Alkalinity to M.O.	(Ca CO_3).	100.0	. . . .
Total Solids.		175.0	. . . .
Total hardness as Ca CO_3.		100.0	. . . .
Calcium hardness	(Ca CO_3).	79.0	. . . .
Magnesium hardness	(Ca CO_3).	21.0	. . . .
pH.		7.6	. . . .

To soften this water only the hot-lime-soda and the carbonaceous zeolite softener were given consideration. The straight zeolite softener, working only on the sodium cycle, was not considered because this merely exchanges the calcium and magnesium ion for sodium, without reducing the total solids content of the water. It was estimated that with the hot-lime-soda softener the hardness in the effluent would be 17 ppm. as Ca CO_3 and the total solids about 145 ppm. Furthermore 0.80 lb. quicklime and 0.45 lb. soda ash would be necessary for 1,000 gallons*** of raw water.

The carbonaceous zeolite softener was stated to give 2-3 ppm. hardness as Ca CO_3 in the effluent and a total solid of 100 ppm., while using 0.88 lb. sulphuric acid and 2.05 lb. sodium chloride per 1,000 gals. of raw water.

*ppm. = parts per million. **epm. = equivalent per million.
***All gallons mentioned are U.S. gallons. To change to 10^6 lb. multiply by 120.

The condition required to be maintained in the boiler water was set at 1,300 ppm. total solids, 86 ppm. trisodium phosphate, 160 ppm. sodium hydroxide and proportionately 706 ppm. sodium sulphate. From the above mentioned data the carbonaceous zeolite softener seemed to be the most economical and was finally chosen. The possibility of keeping the tubular heaters indefinitely free of scale was another reason for this selection.

OPERATING PRINCIPLES AND DESCRIPTION OF THE CARBONACEOUS ZEOLITE SOFTENER

The softener consists of two elements, one working on the sodium cycle with common salt regeneration, and the other working on the hydrogen cycle with sulphuric acid regeneration. The chemical equations of these cycles are the following:—

Sodium cycle

I. SOFTENING

1.) $\begin{matrix}(Ca)\\(Mg)\end{matrix}\ (HCO_3)_2 + (Na_2Z) \rightarrow \begin{matrix}(Ca)\\(Mg)\end{matrix}\ Z + 2\ Na\ H\ CO_3$

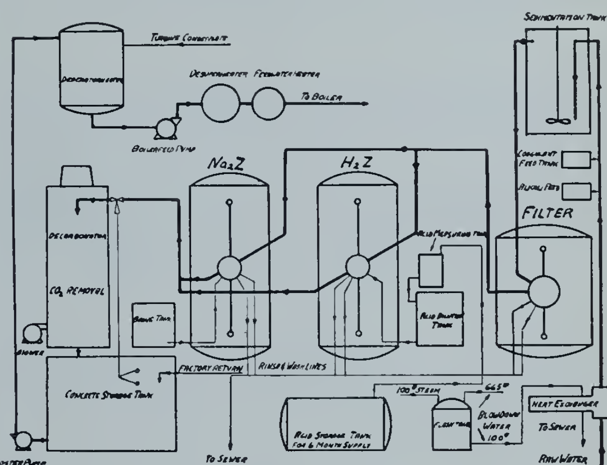

Fig. 1.

1a.) $(Na_2)\ (HCO_3)_2 + (Na_2Z) \rightarrow (Na_2)\ Z + Na_2\ (HCO_3)_2$
No reaction.

2.) $\begin{matrix}(Ca)\\(Mg)\end{matrix}\ (SO_4) + (Na_2Z) \rightarrow \begin{matrix}(Ca)\\(Mg)\end{matrix}\ Z + Na_2\ SO_4$

2a.) $(Na_2)\ (SO_4) + (Na_2Z) \rightarrow (Na_2)\ Z + Na_2\ SO_4$
No reaction.

3.) $\begin{matrix}(Ca)_2\\(Mg)_2\end{matrix}\ (Cl) + (Na_2)Z \rightarrow \begin{matrix}(Ca)\\(Mg)\end{matrix}\ Z + 2\ Na\ Cl$

3a.) $2\ Na\ Cl + (Na_2)Z \rightarrow Na_2\ Z + 2\ Na\ Cl$
No reaction.

II. REGENERATION

4.) $\begin{matrix}(Ca)\\(Mg)\end{matrix}\ Z + 2\,Na\,Cl \rightarrow Na_2\ Z + \begin{matrix}(Ca)\\(Mg)\end{matrix}Cl$

Hydrogen Cycle

I. SOFTENING

5.) $\begin{matrix}(Ca)\\(Mg)\\(Na_2)\end{matrix}\ (HCO_3)_2 + H_2\ Z \rightarrow \begin{matrix}(Ca)\\(Mg)\\(Na_2)\end{matrix}\ Z + 2\ H_2\ CO_3$

6.) $\begin{matrix}(Ca)\\(Mg)\\(Na_2)\end{matrix}\ (SO_4) + H_2Z \rightarrow \begin{matrix}(Ca)\\(Mg)\\(Na_2)\end{matrix} + H_2\ SO_4$

7.) $\begin{matrix}(Ca)\\(Mg)\,Cl_2\\(Na_2)\end{matrix} + H_2Z \rightarrow \begin{matrix}(Ca)\\(Mg)\\(Na_2)\end{matrix} Z + 2\,HCl$

II. Regeneration

8.) $\begin{matrix}(Ca)\\(Mg)\,Z\\(Na_2)\end{matrix} + H_2\,SO_4 \rightarrow H_2\,Z + \begin{matrix}(Ca)\\(Mg)\,SO_4\\(Na_2)\end{matrix}$

The sodium cycle converts all the Ca and Mg salts into the corresponding Na salts following equations 1, 2 and 3. The hydrogen cycle, following equation 5, converts all the bicarbonates into carbonic acid which easily breaks down to water and carbon dioxide following the equation $H_2\,CO_3 = H_2\,O + CO_2$. The sulphates and chlorides will be changed to sulphuric acid and hydrochloric acid respectively following equations 6 and 7.

The effluent of both cycles is mixed, giving the following chemical reactions:—

From 1, 1a and 5:

9.) $2\,Na\,HCO_3 + 2\,H_2\,CO_3 = Na_2\,CO_3 + H_2\,CO_3 + 2\,H_2O + 2\,CO_2 = Na_2\,CO_3 + H_2O + CO_2 = 2\,H_2O + 2\,CO_2.$

From 2, 2a, 6 and 9:

10.) $Na_2\,SO_4 + H_2\,SO_4 + Na_2\,CO_3 = Na_2\,SO_4 + Na_2\,SO_4 + H_2\,CO_3 = 2\,Na_2\,SO_4 + H_2\,O + CO_2.$

From 3, 3a, 7 and 9:

11.) $2Na\,Cl + 2HCl + Na_2\,CO_3 = 2Na\,Cl + H_2\,CO_3 = 2Na\,Cl + H_2\,O + CO_2.$

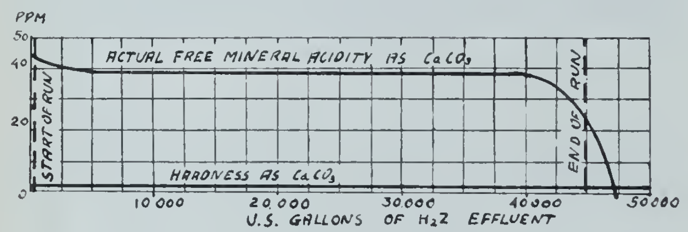

Fig. 2.

All the CO_2 can be easily removed by a mechanical blower. The net result in the effluent from 9, 10 and 11 is: $Na_2\,CO_3 + Na_2\,SO_4 + Na\,Cl$.

The $Na_2\,CO_3$ from 9 is used to neutralize the $H_2\,SO_4$ and HCl in 8 and 9, so that by changing the amount of $Na_2\,CO_3$ any desired $Na_2\,CO_3$ can be obtained in the effluent; if necessary, the effluent can be rendered neutral.

The arrangement of the apparatus and the working principle of the softener is shown diagrammatically in Fig. 1.

It is believed that a zeolite bed does not work effectively with water of higher turbidity than 10 ppm. Although the Lake Ontario water very seldom contains so much turbidity, precautions have been taken to prevent plugging of the zeolite beds from this cause.

The Lake Ontario water, which is stored in the large cistern in the yard of the plant, passes through a heat exchanger which utilizes the heat of the blow-down water. Then it enters the sedimentation tank, which is located overhead to provide the necessary continuous head above the softener and to make overloading of the softening beds impossible. In front of the sedimentation tank are located two cast iron chemical feed tanks. In case of excessive turbidity aluminum sulphate can be fed from one of the cast iron tanks for good flocculation. It was estimated that about 2 grains per gal. feeding would be necessary. Should the pH value become too low, soda ash or some other alkaline could be fed from the second tank to maintain a pH value of 6.5 to 6.8 for best coagulation.

After the water has been properly agitated and coagulated in the sedimentation tank, it passes to an anthrafilt pressure filter. This filter is backwashed at every regeneration of the softener or when the pressure drop becomes excessive. This drop in pressure has never occurred while the sedimentation tank is working properly.

The softener itself consists of two vertical shells placed close together. The water coming from the filter is divided into two parts. One part goes to one of the shells, the hydrogen softener, which is regenerated by sulphuric acid. This shell and all the effluent piping, including some of the valves, are rubber lined. Nearby are the concentrated acid measuring tank and the dilution tank. Both are lead lined. The rest of the water passes to the second shell, the sodium softener, which is regenerated by common salt. Near this a brine preparation tank is provided.

In the shells are the softening beds. The carbonaceous zeolite is a finely screened bituminous coal treated with strong acids, made entirely acid-resisting. The exchange capacity on the sodium cycle has been found to be 6,000 grains per cu. ft. hardness removal, and on the hydrogen cycle about 14,000 grains per cu. ft. cation removal.

The effluent of both softeners is mixed in a simple tee and is discharged through a pilot water-operated diaphragm valve into a wooden spray type decarbonator, where the air-counterflow mechanically expels the carbon dioxide which is formed in the hydrogen softener.

From the decarbonator the soft, slightly alkaline water discharges by gravity into a hotwell where it is mixed with the condensate return of the factory. The water level in the hotwell is kept constant by a float box which actuates a solenoid valve which in turn closes and opens the pilot water line of the main valve ahead of the decarbonator and this starts and stops the softener.

The water is then lifted by a booster pump to a deaerator of the atomizer type from which it is drawn by boiler feed pump.

The addition of sodium hexametaphosphate and sodium sulphite takes care of the least traces of residual hardness and oxygen. This reagent is fed by a variable stroke feed pump straight into the steam drum.

Operation Results

Figures 2, 3 and 4 illustrate a normal run of the softener. The $H_2\,Z$ softener, as indicated in Fig. 2, starts the run at 45 ppm. mineral acidity which is equal to the theoretical which could be formed by having the chloride and sulphate content according to the average water analysis. This drops after about 5,000 gals. of water pass through the softener, and during the bulk of the run remains about 88 per cent of the theoretical mineral acidity. At the end of the run, when the softener becomes exhausted, the acidity starts to drop and finally it goes over to alkalinity. The hardness of the effluent still remains low. The reason for this is that the bed has a tendency to be regenerated by the sodium ion of the raw water, and this sodium ion placed on the bed counteracts the hydrogen ion exchange to a certain degree in forming the mineral acidity. The same sodium ion collected on the bed during the run in exchange of the hydrogen ion makes it possible for the bed, even after the hydrogen ion is all exchanged, to remove all the Ca and Mg of the water and simply work as a $Na_2\,Z$ softener until entirely exhausted In practice, the softener is taken out of service and regenerated as soon as the acidity drops, as this would upset the alkalinity balance of the whole set-up.

The $Na_2\,Z$ softener, as indicated in Fig. 3, starts the run as soon as the hardness is sufficiently low. The curve of the alkalinity to methyl orange indicates that the regeneration of the bed with the Na ion of the raw water also exists in this cycle. The drop of alkalinity at the end shows that the bed, having exhausted the Na of the regeneration fluid, takes up the Na of the raw water. The relatively high Cl content at the start of the run is noticeable, but this is not considered serious when extended over the whole of the run.

It is of interest to note that the hardness removal is decidedly better on the H_2Z than on the Na_2Z cycle.

Figure 4 shows the results. It is evident that the higher alkalinity and the congruent higher acidity of the two cycles are of advantage in forming an even alkalinity of the blended effluent.

According to experience, Lake Ontario water does not change very much regarding dissolved solids. The water only becomes turbid in spring and at that time the pretreatment already described may be necessary. The

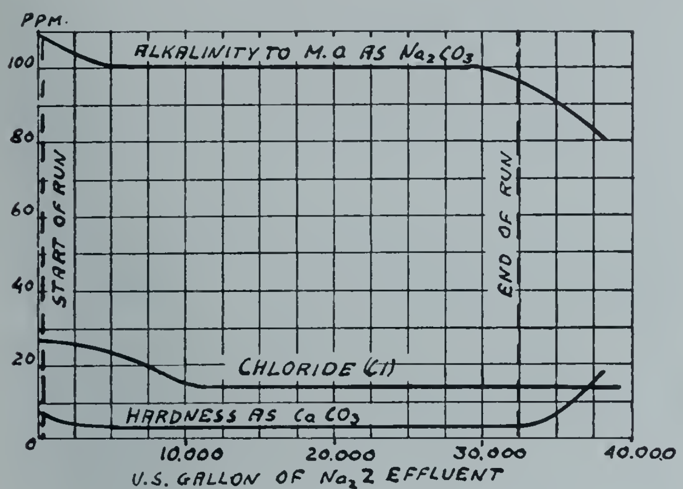

Fig. 3.

stability of the water makes it possible to use almost the same blending proportion throughout the year. If necessary the proportions can easily be computed by the formula:

$$\text{Percentage of } H_2Z \text{ effluent} = 100\ \frac{\text{Alk. inf.—Alk. blended}}{\text{Alk. inf.—Acidity}}$$

Alk. inf. = Alkalinity to methyl orange in influent water

Alk. blended = Alkalinity to methyl orange in blended water

Acidity = Free mineral acidity actually measured on the H_2Z cycle.

In practice the titration of the effluent for methyl orange alkalinity directs the blending.

In the present case it is a practice for the boiler water alkalinity and concentration to be regulated by the amount of blow-down. The blending of the make-up water makes it possible for the ratio between sodium carbonate alkalinity and sodium sulphate to be maintained according to the A.S.M.E. ratio without feeding sodium sulphate. The danger of caustic embrittlement is low, owing to the welded design of the boiler drums and the character of the raw water.

According to the figures, one softener run produces about 45,000 gals. on the H_2Z and 32,000 gals. on the Na_2Z cycle. The daily consumption varies between 80,000 and 92,000 gals. This means that the softener should be regenerated approximately every 20 hours. This operation takes two hours and is made by well-trained shift-engineers. The first step is the back-washing of the softener. During the run there is a downward flow, but during the backwashing the flow direction is reversed, the upward flow then loosens all the particles of the bed and removes the collected dirt. The rate of flow at backwashing is 4 gals. per sq. ft. per min., which is determined by the danger of raising the bed and washing the zeolite out of the tank. The duration of the backwashing is 5 to 10 minutes.

After backwashing, the softener is regenerated by introducing the acid (or salt, as the case may be) to the beds. The concentrated sulphuric acid is diluted to 10 per cent by weight in a lead-lined dilution tank. It then passes to the bed through an eductor where a further dilution to one per cent takes place. The brine is prepared in a similar manner in a tank and is an approximately saturated solution = (26 per cent). It is drawn from this tank through a sand filter to the bed through an eductor where a further dilution to 4 per cent takes place. The regeneration is made at a flow of 2 gals. per sq. ft. per min. and takes 45 minutes on the H_2Z cycle and 28 minutes on the Na_2Z cycle. During that time the bed is completely immersed in the regenerating liquid.

After regeneration is finished, the calcium, magnesium and sodium, the excessive acid, as well as all the sulphates, the excessive brine and all the chlorides are rinsed out of the beds at a flow of 5 gals. per sq. ft. per min. The rinsing takes 25-30 minutes on the H_2Z cycle and 45-50 minutes on the Na_2Z cycle.

The softener is completely regenerated in two hours. During this time the make-up water is taken from a concrete storage tank which has ample storage capacity for 3½ hours' supply. The filter which is near the softener is usually backwashed at the same time. The softener is then put into operation again. At present it works at a flow of 5 gals. per sq. ft. per min.

The softening capacity is apparently greater if the beds are working intermittently. Therefore, the softener runs at a rate of about 6,000 gals. per hour for ten minutes, then the high water level in the storage well stops it and the following low water level starts it up again. Over the week-end the standing time is increased and also the softening capacity.

During the run the softener does not need any special attention. The shift-engineer makes only one complete check on the water during the shift. The end of the run is indicated by large hands on the meters and by an alarm light.

The softener performs three functions during the run. As illustrated in the above figures, it reduces the hardness from 100 to 3 ppm. in terms of Ca CO_3. This assures an entirely scale-free boiler feedwater which also does not produce any deposits in the high temperature tubular heaters at 330 deg. F. It also reduces the alkalinity of the raw water from 100 to 17 ppm. in terms of Na_2CO_3. This assures a very low CO_2 content in the steam, which is of great importance in case of dry steam to prevent the condensate being too low in pH value. The softener also reduces the total solid content of the treated water from 180 to 100 ppm. which makes a low blow-down possible effects considerable saving.

The pH value of the raw water is 7.6. That of the H_2Z softener is around 3.0, and the Na_2Z softener is around 8.0. The blended effluent after the decarbonator is usually 7.0-7.2. The softened water and condensate mixture have a

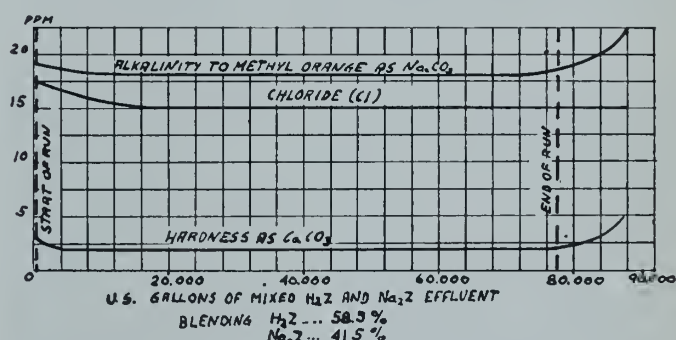

Fig. 4.

pH of 6.8-6.9. Then the water enters the deaerator heater which has an excellent pH raising effect, having an average feedwater of pH = 8.2 to 8.3 at a methyl orange alkalinity of 10-12 ppm. as Na_2CO_3 and an O_2 content of less than .03 cc. per litre.

It should be mentioned that there is no removal of silica in this water conditioning. The silica content of the raw water is low, and all analyses of the deposits taken at frequent boiler inspections show no appreciable silica accumulation. The reason for this is that the very low calcium content of the softened water combines more readily with

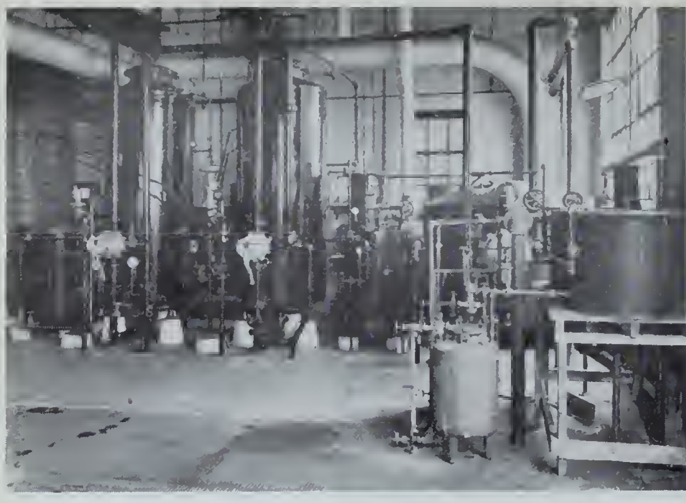

Fig. 5—A view of the carbonaceous zeolite water softening equipment at the Goodyear plant, New Toronto.

the continuously maintained 50 ppm. of PO_4 in the boiler salines than with the silica. The small silica content in the deposits is largely combined with magnesium or iron which are substances generally used to remove silica in flocculent form.

The water softening helps keep the boiler and all parts connected with the feed water in the best condition. This was checked quite frequently in the first year, and it can be stated that the boiler and all the heaters were found to be in first class condition. No corrosion, no scale and no tube losses occurred. Further, there was no shutdown or hindrance on account of failure of the water softening.

The only difficulties encountered were of mechanical character, and were mainly on the H_2Z softener. The softener itself and also a part of the valves are rubber lined. This seems to give full protection by saving wear of the parts. The automatic valves, made of copper alloys, suffered from the acid water, and will be replaced by better acid-resisting materials.

It was found that the feed water had higher hardness than the softened water and condensate. The reason was that the storage tank was of concrete and particles dissolved due to the high temperature of the condensate. It is proposed to apply rubber lining to the concrete storage tank, which would be of great benefit and unique in this line.

Cost of Treatment

During the run from which the above figures have been taken, 34,000 gals. Na_2Z and 46,000 gals. H_2Z softened effluent were supplied to the boiler. For this amount of water the regeneration needed 70 lb. of concentrated sulphuric acid H_2SO_4 and 120 lb. of sodium chloride Na Cl. At the same time the raw water hardness was 6.8 grain per gal. as $CaCO_3$. The price of Na Cl is $0.55 per 100 lb. and of the H_2SO_4 $0.92 per 100 lb. f.o.b. plant. The cost of these reagents was therefore 70 x 0.92 = 64.5c. and 120 x 0.55 = 66c. or a total of 130.5c. for 80,000 gals. The wash-water requirement was 7,350 gals. per regeneration. The plant costs are 2.65c. per 1,000 gals. Thus the cost of wash-water was 7.35 x 2.65 = 19.5c. per regeneration. Therefore, the total cost was 130.5 + 19.5 = 150c. per 80,000 gals. or 1.87c. per 1,000 gals. This is an average monthly figure.

The true comparison of costs requires that all the other costs involved should be taken into consideration, and also the loss in the blow-down water.

On the average the softener described reduces the total solids to 110 ppm., which requires a blow-down of 9 per cent of make-up for 1,300 ppm. total solids.

This blowdown makes the softening costs finally up to 2.08c. per 1,000 gals.

In the present case there is no need, as above explained, for sodium sulphate feeding.

For the final treatment the plant uses sodium hexametaphosphate Na PO_3 to carry an excess of 50 ppm. PO_4 in the boiler salines. At a phosphate price of 18.6c. per lb. this actually means 0.85c. per 1,000 gals. including the loss in blowdown, making a total of 2.08 + 0.85 = 2.93c. per 1,000 gals.

The chemical costs of a hot-lime-soda softener of the usual design for 17 ppm. hardness in the effluent and at a price of 0.6c. per lb. for quicklime and 2c. per lb. for soda-ash, may be estimated at 1.38 per 1,000 gals.

The hot-lime-soda softener requires sodium sulphate feeding, at the rate of 0.53 lb. per 1,000 gals. @ 2.75c. per lb. = 1.46c. per 1,000 gals. The phosphate required for the final treatment may be estimated at 0.154 lb. per 1,000 gals. @ 18.6c. per lb. = 2.86c. per 1,000 gals., making the total of chemical costs amount to 1.38 + 1.46 + 2.86 = 5.70c. The blowdown can be estimated at 14.5 per cent and that gives a final amount of 6.52c. per 1,000 gals.

It should be noted that the costs of the zeolite treatment are taken from the actual monthly average costs, and they are above the amount theoretically required, but below the costs guaranteed by the manufacturer.

This proves the economy of the system adopted, but it must be remembered that each case needs special consideration. In the present case the first costs of the two systems were close to each other. With greater hardness at the same flowrate, the cost would change in favour of the hot-lime-soda softener. The operation costs in case of turbid water also increase considerably. (This item has been neglected here because the plant needs treatment for turbidity only for two months per year). The above figures indicate that the lime treatment is very cheap for temporary hardness removal. The present tendency in the case of larger units is to use a cold lime softener in an improved form, combined with zeolite or sodium and hydrogen zeolite.

Recently there has been a further remarkable improvement in zeolite water softeners. By adding a further unit regenerated with caustic soda or soda ash an effluent can be obtained which is almost equivalent to distilled water.

It can be stated that in this case the carbonaceous zeolite water softener equipment fulfilled the expectations in all chemical and economical lines.

The decision on the choice of equipment was made by Mr. C. R. Smith, Mechanical Engineer, New Toronto, and Mr. J. C. Hergert, Steam Engineer of the Goodyear Plant, Akron, Ohio. The water softener was built by the Canadian Allis Chalmers, the Canadian representative of the Cochrane Corporation, Philadelphia, Pa. The water conditioning is under the supervision of Hall Laboratories, Pittsburgh, Pa.

CO-ORDINATION OF INDUSTRY WITH ENGINEERING COLLEGES*

WALTHER MATHESIUS
Vice-President, United States Steel Corporation of Delaware, U.S.A.

An address delivered at the Sixth Annual Meeting of the Allegheny Section of the Society for the Promotion of Engineering Education, Pittsburgh, Penn., on October 26th, 1940

The opportunity to appear before this group of distinguished educators is an honour for which I am grateful, and I appreciate this chance to present to you some of my views on engineering education and its relation to industry. It has been my good fortune and pleasure over the years to meet some of you individually and in groups such as this and I have always gained from these gatherings a better appreciation of your aims and a stronger desire to assist in the pursuit of our common objective as far as my ability permits me to do so. I trust you will not object when I ask you to receive my statements as representing only an individual viewpoint, rather than that of industry, and to accept my remarks as the observations of one who during his years of service in the operating phases of the steel business has always tried to keep alive his curiosity and interest in the world at large and particularly in the relationships which do and should exist between his field and engineering colleges.

This interest, if I may suggest, is not merely academic with me, since the training of younger and better executives is an urgent requirement of modern industrial enterprise; and besides I have two sons to whom a solution of this problem is of prime importance. Renewed discussion becomes timely due to the growing needs of industry for qualified graduate engineers, and due to the constantly increasing load of manifold responsibilities facing them in the service of industry.

As I view the title of my assignment: "Co-ordination of Industry with Engineering Colleges," I am frank to admit that my definition of co-ordination may not necessarily be the most precise. As I conceive it, it presupposes the existence of one or more problems of common concern and this, in turn, leads to the finding that such co-ordination logically implies mutual aims and interests. Certainly, industry owes much of its progress to the technological advances which have resulted from the skill of your engineering graduates to apply in practice the scientific facts and the knowledge which you taught them, and industry is happy to acknowledge this debt. Since engineering colleges, on the other hand, exist largely because of the demand for their graduate students by industry, they should currently be conversant with industry's requirements and be prepared to meet them.

It is not my intention to discuss any specific technical or engineering course, or its adequacy for fulfilling the expectations of a particular industrial field, but rather to consider college education in a broader sense which assumes a scope substantially wider than the exact curriculum or science itself. My viewpoint is concerned with the need for more adequate training of students at engineering colleges in the basic fundamentals of knowledge and logic, so that in later years they may advance creditably from a strictly engineering activity to administrative and executive positions with a maximum of advantage and continued benefit from the teachings of their college years. I find, in my own practical experience, that the effect of premature specialization in studies for a particular field often clings to the individual in business life and tends, in numerous cases, severely to limit his scope of usefulness and his advance to positions of greater importance in industry. Because engineering courses deal with exact sciences and problems, it might be assumed that the very nature of his early training in these subjects would tend to imbue the individual with unfailing logic and result in the training of men with marked analytical powers. It has been my experience, nevertheless, that quite frequently the contrary trend exists. While these technical graduates can solve specifically assigned and difficult engineering problems, their trained engineering mind tends to focus narrowly upon their task in its designing, construction or production phases and it fails to grasp the importance of essential economic, sociological and other fundamental relationships. Yet, it is frequently more important, in industry, that the needs for an improvement and its consequences, if made, be carefully and intelligently analyzed in their commercial, social and economic aspects rather than that the mechanics of the proposal be designed to the highest degree of perfection and precision. The latter task is as a rule quite capably handled by our graduate engineers, but apparently the former requirement is not so readily recognized by them. That this is due to a lack of inherent ability on the part of those engaged in the engineering profession is not conceivable since the fundamentals involved are certainly no more difficult to comprehend than the intricacies of many specific engineering problems.

It is obvious that engineers must be effective technologists, but it is also necessary that this profession, in order that it may render creditable services to the interests of the nation, be able to recognize and analyze correctly the many varied and complex economic, commercial or human problems which beset the majority of industrial developments today. The serious threats to their very existence, experienced by many branches of industry during the lean years of the recent past, have demonstrated forcibly and convincingly that it is not enough to drive for cost reductions and improved production methods, but that systematic attention must of necessity be given to public and industrial relations, to personnel administration and to research in these directions as well as in strictly engineering matters. Since all of these subjects must be considered as rightfully belonging within the sphere of technological influence, it is with good logic that the steel industry is now taking a more earnest interest in the activities of our colleges and in its mutual relationship and responsibilities with them, of which I should like to outline briefly, what appear to me as two important phases.

Firstly, I submit that one of the primary objectives of our engineering schools is the training of the growing generations to meet the future requirements of operation and management in industrial enterprise. Industry is, in a sense, an important customer for one of the college's principal products—a healthy crop of competent young engineers emerging annually from the undergraduate courses. Obviously it is desirable that there should be agreement between the colleges as producers and the industries as the consumers concerning the specifications for this output, just as they form a proper basis for dealing in the more commercial commodities of everyday business. My contention is that industry's co-operation could go far in aiding the college faculty as well as its students, if it would frankly state its conception of the essential qualifications for engineering graduates, and better still, if it would develop this conception by means of a thorough and continuous analysis of experience with its college trained personnel. While I

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am in no way authorized and perhaps only partly qualified to speak on behalf of the steel industry, I should like to present to you—as a personal good-will token—my own idea of a specification for engineers of college grade. It is my conviction that the essential objective of a higher education in engineering should certainly not be the graduation of specialists, but rather the building of good citizens, equipped with fundamental knowledge, and trained in logic. Completing his college studies should not become the end of, but rather the foundation for the young engineer's education for life, so that he will step out into the world able and eager to broaden his scope or, if he should desire later on to do so, to concentrate on a narrower field, in which he might then become a specialist and expert by choice and experience and not because of educational limitations.

I should like to urge my colleagues in the steel industry and my friends on the college faculties that they add their own statements of experience and recommendation to mine, in support or in rebuttal; and I suggest that these statements be submitted for the consideration of those who must plan and direct the curricula for our future engineers and managers. I am confident that co-operation of this kind will be welcome and helpful to industry, the colleges and the students.

It is obvious that under an educational programme such as I have attempted to describe, our technical colleges could not be expected to supply from its graduating classes to industry engineers so completely and so thoroughly prepared as to fit them at once for responsible positions which usually require not only experience and skill but a substantial amount of further study whereby to develop proficiency in one or more specific fields. This is of course primarily a task which the young engineer must undertake on his own responsibility and for which he will be well prepared if he has learned during his college years, as he should have, the faculty of study. However, in fairness to him as well as in its own interests, industry must assume the obligation to provide adequate opportunity for such further development and study. I regret having to admit that in my opinion the steel industry has as yet made little progress beyond the bare realization of this fact. Too often are the college graduates who join our forces assigned to narrowly confined specific jobs from which they find it difficult to extricate themselves except by resigning and looking for a better chance elsewhere. Too generally is this post-graduate training of engineers in industry left to chance and far too few are the instances where systematic training programmes and intelligent personnel management are actively and effectively applied.

It seems, firstly, that help is required to convince industrial managers that there is need for action on their part, not only as a matter of fair dealing, but definitely in the interest of assuring to their own enterprises intelligent and effective operators and managers for the future. And, secondly, I believe that industry, confused by apparent conflicts of interests and belabored by various pressure groups, needs fair and competent advice concerning the soundness of the principles and the propriety of methods in its personnel management procedures.

I venture the suggestion that you, the members of our college faculties, should be eminently qualified by reason of your impartial standing and your experience in education, to give such counsel to industry. Keeping in touch with the graduates of your schools, collecting, analyzing and reporting on their experiences, their progress and their recommendations for better ways of learning and doing more, you can, I believe, make a major contribution to the welfare of our industrial life, which should improve effectiveness in management and production and promote harmony in industry's ranks on the basis of just rewards to those sharing in its tasks with their hands, their heads and their savings.

And now I should like to point your attention to a second field of relationship between the technical colleges and industry. They can and will find more and more common ground upon which to work as partners for the sole purpose of gaining knowledge and of applying it to the conversion of natural resources into goods and services.

The logical contribution of the universities to this phase of co-operative endeavour comes of course from their facilities and talent for fundamental research—from their opportunities for post-graduate training and for specialized technological courses. The industry's share in this picture, as I see it, appears on the background of a broad long range policy, which directs the conduct of the business in the interest of the common good and subordinates to this requirement the desire for immediate and selfish gains. This policy does not lose sight, however, of the necessity for profits, whereby to assure continuance of the enterprise and to provide for improvements as well as for support to still further search for greater knowledge.

Undoubtedly there are industrial concerns which because of their scope or their position in a given field should undertake fundamental research work in their own laboratories and with their own staff, and some of these have done so creditably and with notable results. This does not, however, in my opinion, alter the fact that the greater share of the responsibility for searching out basic truth impartially and scientifically must always be assumed by our learned institutions.

But even under this arrangement, industry cannot permit itself to become a silent partner and to relinquish the active pursuit of this never-ending search to the universities. Industry must always provide through its own facilities and personnel, for the essential continuity to link fundamental research to applied technology and this in turn to practical operations and results. Theory and practice are thus joining hands more securely in the steel industry, which is learning to appreciate the value of scientific approach to production problems and the necessity for adopting, in place of the old trial and error routes, modern means for the impartial and precise determination of the relationship between cause and effect. In the steel industry, as elsewhere, not only management, but particularly the rank and file is at times apt to discount the experiences of the past and take the present for granted, as rightfully theirs. However, even among those who toil with their hands the recognition is dawning today that the future of their livelihood is linked definitely to that of the industry and that the welfare of the latter cannot be made permanent by dictates of law or by restrictive agreements on output, employment and development. They are making a major contribution to harmony and effective performance in the steel industry by conceding and supporting the value of scientific knowledge in partnership with training and experience. For overall success this co-ordination is essential as much as courageous, competent and conscientious management leadership. Together, they give us, in my opinion, a far better assurance for the future of our economy than could be realized under any other social order, no matter how glowing its promises might be for the pot of gold at the end of the rainbow.

These mutual interests and mutual responsibilities place definite obligations at the doors of industry and colleges and neither have been remiss in their attempts to fulfill their commitments. Nevertheless, I do not believe that the greatest degree of success in co-ordination can be realized for the common good until a strenuous effort is made by both sides to understand fully these mutual relationships in the service of educational as well as technologic advancement and to agree on the manner in which these objectives will be obtained. It is my personal opinion that industry can go somewhat further than it has up to the present time in developing ways and means for effective co-operation with engineering colleges. I suggest that in addition to the various avenues now utilized to this end, representatives of industry might more frequently visit the educational centers to acquaint themselves at first hand with the problems which you face and also to convey to the students as well as the college faculty their conceptions of the needs and prospects in industry. For example, I believe that many executives and others in responsible industrial positions would be willing to give of their time as far as they can, to meet with the students and the faculties for informal talks on specific engineering subjects as well as on the broader aspects of industry's requirements from educational colleges. I suggest further that, in addition to this type of contact, arrangements be made for similarly informal meetings concerned with other phases of world affairs and our national life. This would, in my opinion, be a rational means of directing the student's attention to other essential elements of present-day civilization, which may be remotely beyond the scope of his engineering courses, but which he should learn to understand so as to broaden his grasp of humanity and his appreciation for the wonders of our universe.

And in conclusion, might not the desired co-ordination be more readily consummated through efforts made conversely also by the members of the college faculties, to call more frequently at industrial centers and in the workshops, there to take the initiative of inquiry and of discussions on the problems of both sides with men in industry and in public life ? From such excursions into the whirl of productive and competitive activity you would bring home not only facts and figures, but often evidence of lacking knowledge, of bias and confusion, challenging your powers of impartial observation and scientific analysis. You would find there encouragement for your efforts in research, in teaching, in your written or spoken contributions to the scientific literature and technical wisdom.

Leaving this suggestion for your consideration may I express the hope that continued frank discussion may stimulate thought and action, aiming for continued development rather than for sudden changes to serve a passing need or to meet a present emergency. Only through sustained interest and effort can the coordination of industry with engineering colleges become complete and lasting, and that is for both an essential requirement of preparedness for distinguished service to our country and to mankind. Your S.P.E.E. can and will have an important share in this endeavour.

DISCUSSION

Robert F. Mehl*

I find it very pleasant,—very pleasant indeed,—to discuss this paper by Dr. Mathesius. Six years ago, when we reorganized our curriculum in metallurgical engineering, we discussed the problem with many prominent industrialists, of whom Dr. Mathesius was one of the most helpful. His experience both in metallurgical education and in industry has been such that his advice has always been welcome and his opinions always well-formed and reasonable.

I doubt that there is anyone in engineering education more concerned with co-ordination with industry than the professor of metallurgical engineering. Such cooperation in metallurgy is somewhat more difficult than in other branches of engineering, arising, I believe, from the fact that the profession of metallurgical engineering is not so well defined as, for example, that of chemical engineering or that of electrical engineering. The metallurgical engineer must scatter his attention over so very many different processes and products, and he must be familiar with so many types of engineering and science that it is not easy to formulate *simple* programs of metallurgical education.

The profession of metallurgy itself is in a period of rapid change. The industrial metallurgist may be a man who started in life as a mill boy or he may be one who has attended a university and obtained a doctorate; he is called upon at once to operate mills, to exercise his judgment upon some highly specialized technical and scientific problems, and even to handle labor problems. He is to-day varied in type, and he must handle a wide variety of problems. But in the past decade or so industry has been calling for huge numbers of well-trained metallurgical engineers, and placing them in positions which previously were filled by men of no training but of much practical experience. In such a changing and complex scene, it is inevitable that the problem of metallurgical education should not be an easy one; surely in such a position, it is of the greatest importance that the industrialist and the educator co-operate in such a way as to contribute the maximum good to the profession.

I very much like, therefore, Dr. Mathesius' suggestion of mutual discussions among educators and industrialists. I organized a discussion group on metallurgical education in the American Institute of Mining and Metallurgical Engineers two years ago. It was only moderately successful. I think it showed chiefly that the problem is one which requires careful thought and not one to be solved off-hand. My chief difficulty was that the industrialist was not so much concerned in discussing the content of metallurgical curricula, which he was quite willing to leave to the educator, as he was in discussing the miserable English graduates of technical schools display, which though certainly important was somewhat beside the point. By and large, however, these men agreed with Dr. Mathesius that it is the first function of the educator to present to his students the *fundamentals* of science and engineering, leaving the very, very many details of industrial processes to be learned by later experience in the industry. Not all industrialists feel this, for many think graduates should be more thoroughly acquainted with practical engineering as they graduate. We have found some difficulty in pointing out that the processes in industry are so very numerous that there simply isn't time enough in school to train men even in the important ones, and in pointing out to them also that in a very few years the details of many of these will have changed. Here, I think, is a situation which cries for the type of discussion which Dr. Mathesius recommends so strongly. It has been our experience that when educators and industrialists *fully* discuss these problems, they invariably agree that engineering training should and must be restricted almost exclusively to fundamentals.

I think that misunderstanding occasionally arises by individuals confusing the several duties of the professor. In a school such as ours, the professor has three chief duties: first, to train engineers in a four-year curriculum in such a way that they will be of maximum service to industry second, to train graduate students so as to make them competent to assist industry in research and development; and third and last, to carry on research. These several duties have, as you can see, different objectives and should not be confused. It is not difficult to organize a department in which all three duties may be adequately met. I think it would be easy to agree that the primary duty of the university professor in research is to do research in fundamentals. While industries do some fundamental research, isn't it clear that the university professor should contribute not primarily to practical research and development but to fundamental research and development ? As an example (so that these words should not be wholly empty) the industrially important processes of the carburizing of steels is one which depends on the rate of absorption of carbon *by* steel and on the rate of diffusion of carbon *in* steel. This industrial process has never been adequately handled from an engineering point of view, chiefly because the factors which influence rates of diffusion of carbon in steels have not been studied. The university can then set for itself the task of

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studying these fundamental rates, from which in time engineering knowledge may ensue and the industry benefit.

If we admit, then, that the professor should do this type of research, let it be *thoroughly understood* that his activities in this direction do *in no way* preclude his success in training the undergraduate for practical work. As to the responsibilities of the professor in cooperation with industry, should he enjoy such sympathetic understanding from industry, let him then see to it that he welcomes every contact he can make with industry, and let him recognize that his fundamental research is justified only as it will in time be of service to industry.

I may conclude this discussion by suggesting a type of co-operation which I think would be of great value to the engineering school and *especially* to industry. It is obvious that the atmosphere of the engineering college is not that of industry. Every educator must make an effort to acquaint his students with the industrial scene by frequent inspection trips and by frequent lectures by outside engineers. This isn't enough. For years we have wanted to make some arrangements that would permit our undergraduate engineers to spend two or three summers working in mills, but we haven't yet been able to work out such a plan. Only a few students are able to make such arrangements themselves. If such a program could be formally organized, I think it would be as fine a contribution to metallurgical education as anything that has been done in many years. I should not wish this upon Dr. Mathesius as a task, but I should hope that the co-operation between industry and the engineering college for which we both devoutly wish will develop to a degree that a program of this sort may be recognized as desirable and be begun.

DISCUSSION OF COLUMNS SUBJECT TO UNIFORMLY DISTRIBUTED TRANSVERSE LOADS

Paper by Professor J. A. Van den Broek[1], published in *The Engineering Journal*, March, 1941

S. D. Lash, M.E.I.C.[2]

Professor Van den Broek's paper is a very welcome addition to the literature on the design of columns subject to transverse loads.

It is worth while pointing out perhaps, that the assumption that the elastic curve of the column may be closely represented by a sine or cosine curve is not new. It should, I believe, be credited to Professor Perry and dates from 1892[3]. A description of this method has been presented more recently in "The Analysis of Engineering Structures" by A. J. S. Pippard and J. F. Baker, from which the following has been taken using Professor Van den Broek's notation:

Assuming $y = -\triangle \sin\frac{\pi x}{l}$ - - - - - - - - - - - (1)

$M = -EI\frac{d^2y}{dx^2} = Qy + M'$, (where M' is the moment due to the lateral loads acting alone) (2)

$$-EI\ \frac{\pi^2}{l^2}\sin\frac{\pi x}{l} = Qy + M'$$

$$P_{cr}y = Qy + M' \text{ where } P_{cr} = \frac{EI\pi^2}{l^2}$$

$$y = \frac{M'}{P_{cr} - Q}$$

Substituting in (2), $M = \frac{P_{cr}}{P_{cr} - Q}\ M'$ - - - - - - - (3)

Let f_1 be the limiting stress, then $f_1 = \frac{Mc}{I} + \frac{Q}{A}$

$$= \frac{P_{cr}M'c}{(P_{cr} - Q)\ I} + \frac{Q}{A}$$

Substituting, $M' = \frac{kwl^2}{8}$

$$f_1 = \frac{1.23\ kwEc}{P_{cr} - Q} + \frac{Q}{A}$$

$Q = \frac{1}{2}\left[f_1A + P_{cr} - \sqrt{(f_1A - P_{cr})^2 + 4.92\ kwEcA}\right]$ - (4)

The above calculation makes use only of the fundamental relation between curvature and moment and appears considerably simpler than introducing work or energy methods. There does not appear to be any approximation involved, but rather curiously, equation (4) is the same as Professor Van den Broek's formula IV (a). (There is a typographical error in the paper as printed in the March *Journal:* the sign before the square root in formula IV (a) should be minus instead of plus). This result is somewhat surprising since formula IV (a) was arrived at by assuming the elastic curve to be a fourth degree parabola rather than a sine curve. However the difference between the two equations is slight.

It should perhaps be pointed out that the Perry column formula for axially loaded struts without transverse loads, is derived in a somewhat similar way, the imperfections in material, workmanship, etc., being represented by a hypothetical initial curvature of the strut or column, such curvative being represented by a sine or cosine curve.

I. F. Morrison, M.E.I.C.[4]

The treatment of the theory of combined compression and bending as applied to beam-columns by the author is indeed novel and interesting.

The basis on which the analysis rests depends on two fundamental assumptions, namely that the material is elastic and that its stress-strain relationship follows Hooke's law. Both are necessary for the validity of Formula I and the one does not imply the other, for there are materials which, though they possess linear stress-strain relationship, are not elastic and vice versa. In Formula I the integral term is the expression for the internal work done by the auxiliary load, F, in conjunction with the strain caused by the actual loading. Its validity rests on the assumption of Hooke's Law. The left-hand term is the external work done by the auxiliary load, and the validity of the process of equating the two terms rests on the assumption of elasticity of the material as well as of the system as a whole. Thus, it is not only the elastic limit which should be chosen as the controlling stress but also the proportional limit and these, except by assumption, may not have the same numerical value. The assumption that they are the same must, therefore, be added to those assumptions above. In its abstract form, the stress-strain curve for the material is often taken as straight, up to a certain value of the unit stress, which, for those materials, such as mild steel, which possess a well defined yield point, is taken as equal to the yield value and which otherwise must be arbitrarily assumed. It would seem better, therefore to change the meaning of f_1 in the

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[2] Acting Secretary, National Building Code Project, National Research Council, Ottawa.

[3] "Struts and Tie-Rods with Lateral Loads," by John Perry, *Philosophical Magazine*, Vol. 33 (1892), pp. 269-284.

[4] Professor of Applied Mechanics, University of Alberta, Edmonton, Alta.

paper to indicate the yield point instead of the elastic limit stress. Materials which do not follow Hooke's law acquire a well defined yield point after the first application of loading but suffer a permanent strain in the process.

The paper deals with a special case of transverse loading and does not deal with members not initially straight, nor does it deal with eccentrically applied axial loads. Both of these items are of considerable importance in practical design and the paper might well be extended to include them. It is easily shown that both "the initial imperfection," as Southwell calls it, and the application of a couple at each end are equivalent to a suitably chosen transverse loading and, therefore, may be so treated in the theory. However, although the end couples could be dealt with by a change in the load factor k, the initial imperfection required a variable transverse loading. This could be included in the theory by adding $\sum w_n \sin \frac{n\pi x}{l}$ for the kw term. Practically, the first term of the series would likely be found sufficient.

The term P_{cr} in Formula II is apt to be, at first sight, misleading, for it is the critical load for the column based on the assumption that I, the moment of inertia of the constant cross-section about an axis perpendicular to the plane of the loading, is a minimum. This is often not the case, so that the minimum critical load may be much less and may limit the carrying capacity of the number as a column. In addition, the member may be unstable as a beam under transverse loading due to insufficient torsional rigidity.

Southwell gives for the bending moment including the thrust-effect,

$$M = Q\ (A \sin nx + C \cos nx) - \frac{kw}{n^2}$$

in which kw is the intensity of loading and $n^2 = \frac{Q}{EI}$. A and C are constants of integration to be determined by the end conditions.

For a uniform load, i.e. constant kw and pinned ends $M_{max} = \frac{kw}{n^2}\ (\sec \tfrac{1}{2}\ nl - 1)$, and the maximum compressive stress due to combined thrust and bending is $f = \frac{Q}{A} + \frac{kw\ Ec}{Q}\ (\sec \tfrac{1}{2}\ nl - 1)$ - - - - - - - - - - - - (5)

This equation cannot be solved for Q and, although $(\sec \tfrac{1}{2}\ nl - 1)$ can be expanded into a series, this series is convergent only when $(\tfrac{1}{2}\ nl)^2 < \frac{\pi^2}{4}$. When $(\tfrac{1}{2}\ nl)^2 = \frac{\pi^2}{4}$, $Q = \frac{\pi^2\ E\ I}{l^2}$ so that at the critical load the series is no longer convergent and in fact it is so slowly convergent for values of Q near the critical load as to be of no practical value.

In order then to have a unit stress, f_1, produced due to the combined effect of a thrust, Q, and a uniform transverse load, kw, these values must be related by means of the equation (5).

If, as in Table I, one takes as an example l = 25 in. Q = 22,866 lb. for a 1 in. round rod, with $E = 30 \times 10^6$ p. s. i.[6] Then f amounts to 40,035 p. s. i. which is quite close.

The differential equation for the beam-column with a uniformly distributed load is: $E\ I \frac{dy^2}{dx^2} = -\ Q\left(y + \frac{kwlx}{2Q} - \frac{kwx^2}{2Q}\right)$.

This is easily solved and gives:

$$\triangle = + \frac{k\ w}{Qn^2}\ (\sec \tfrac{1}{2}\ nl - 1) - \frac{kwl^2}{8Q} \quad - - - - - - - \quad (6)$$

The numerical value for $\triangle$ from equation (a) is: $\triangle$ = .0458 in. and from equation (6) $\triangle$ = .0460 in.

By these results it is shown that the theory in the paper checks quite well with the classical theory.

C. M. Goodrich, M.E.I.C.[7]

Professor Van den Broek's column formula makes a strong appeal to the writer, partly because of the clean-cut basic analysis, partly because of its treatment of coincident transverse loading.

The ratio at the quarter point between the fourth degree parabola and the sine curve is .711 to .707, with equal centre deflections.

When $k = 0$, one sees a very characteristic straight line to an Euler curve at $L/r = 80$, approximately, as in Figs. 3 to 7 in the paper. In a paper by Mr. Pritchard in the *Transactions* of the American Society of Civil Engineers, Vol. 89, one finds on Page 1238 a table of tests of columns by the U.S. Bureau of Standards, and below it the note "Omitting these three from consideration the U.L.P. (useful limit point) of columns with $L/r = 85$ is smaller than for columns with $L/r = 50$ by less than one per cent." On Page 1246 a table of column tests of lap-welded tubing by the Watertown arsenal gives for spherical ends, $L/r = 47$, 31,700 lb. per sq. in.; $L/r = 72$, 33,300 lb. per sq. in.; for pin ends, $L/r = 47$, 32,300 lb. per sq. in.; $L/r = 72$, 30,300 lb. per sq. in.; for flat ends, $L/r = 50$, 29,500 lb. per sq. in.; $L/r = 75$, 30,500 lb. per sq. in.; $L/r = 100$, 28,700 lb. per sq. in.

In the same table the tests for built pin-ended columns of I-beams with covers and four angles 4 by 3 by 3/8 show the average for $L/r = 50$ as 30,000 lb. per sq. in., for $L/r = 75$ as 29,300 lb. per sq. in., for $L/r = 100$ as 30,700 lb. per sq. in.

It would be interesting to compare still further tables; the writer has merely taken the first such tables that came to hand. As far as they go they appear to confirm the character of the boundary line as given in the paper.

One hopes that the author will add still further light in this twilight zone of column analysis.

E. C. Hartmann[8]

Some of the readers of Professor Van den Broek's interesting and valuable paper will no doubt wish that the method of column design which he has outlined were available in a form suitable for use with conventional allowable working stresses instead of being limited to the case of ultimate loads or "limit" loads. Other readers will wish that the formulas were expressed in more general terms so that the effects of eccentricities, crookedness, and non-uniformly distributed side loads could be handled. For such readers, attention is called to the writer's discussion of a paper by Mr. D. H. Young, "Rational Design of Steel Columns." This discussion, which covers practically the same subject that Professor Van den Broek has covered, but from a somewhat different viewpoint, was first published in the August, 1935, *Proceedings* of the American Society of Civil Engineers and is also available in the 1936 *Transactions* of the same society.

In his discussion of Mr. Young's paper, the writer has derived a formula (Equation 108) for the allowable working stress in any beam-column. This formula, when rewritten in the nomenclature used in Professor Van den Broek's paper with an additional term n representing nominal factor of safety, is as follows:

$$f_w = \frac{f_1}{n} - \frac{Q}{nA}\ \frac{\left(\frac{f_1}{n} - \frac{Q}{nA}\right)}{\frac{P_{cr}}{nA}}$$

in which f_w = the allowable combined direct and bending stress in the extreme fibres of the beam-column, lb. per sq. in.

$\frac{f_1}{n}$ = the allowable extreme fibre stress on the member if it were a beam only, lb. per sq. in.

[6] The use of $E = 40 \times 10^6$ p. s. i. in Table II is obviously a typographical mistake.

[7] Consulting Engineer, The Canadian Bridge Company, Limited, Walkerville, Ont.

$\frac{Q}{n}$ = the working column load for which the member is being designed, lb.

$\frac{P_{cr}}{n}$ = Euler load divided by the same factor of safety used in arriving at $\frac{f_I}{n}$, lb.

A = cross sectional area of member, sq. in.

The formula above appears more complicated than it really is, because the factor of safety n would ordinarily appear only once as an explicit factor.

The writer's formula is best applied in design by cut and try methods. Given the column load and the beam load which a member must safely carry simultaneously, and the allowable stress for the material in bending, a trial member is selected and the proper quantities entered in the above formula to obtain the allowable combined stress. If the resulting allowable combined stress exceeds the combined stress calculated in the conventional manner neglecting the deflection of the member, the member is safe. If the resulting allowable combined stress is less than the calculated, the member does not have the desired factor of safety and stronger members should be investigated until a safe one is found. An example of the application of this method is given in the writer's discussion of Young's paper previously mentioned.

Multiplying through the above formula by n, the factor of safety, one obtains:

$$nf_w = f_I - Q\frac{(f_I - \frac{Q}{A})}{\frac{P_{cr}}{A}}$$

In this form the formula is suitable for use with ultimate loads instead of working loads, the term nf_w on the left representing the permissable combined stress on the extreme fibre of the beam-column when the member is just ready to fail. For a member of the type shown in Fig. 1 of Professor Van den Broek's paper, just ready to fail, the formula may be rewritten as follows:

$$\frac{Q}{A} + \frac{kwl^2c}{8I} = f_I - Q\frac{(f_I - \frac{Q}{A})}{\frac{P_{cr}}{A}}$$

This formula, solved by cut and try methods, gives results identical to those obtained from Professor Van den Broek's formula II. This is not surprising in view of the similarity of the two derivations. This similarity is evident from the fact that Equation 102 of the writer's discussion of Young's paper is identical with Professor Van den Broek's equation (c).

As Professor Van den Broek has ably pointed out, certain constants in the formulas to be used with beam-columns depend upon the configuration of the member in its deflected position. Professor Van den Broek's solutions cover two configurations, the sine curve and the fourth degree parabola; and the writer's formula is derived for the sine curve only. Such formulas are quite accurate when applied to beam-columns with axial end loads and uniformly distributed side loads, but they are not so accurate when applied to eccentrically applied end loads and concentrated side loads, because with these loading conditions the configuration of the column may depart considerably from the sine curve or the fourth degree parabola. The formulas will be found satisfactory, however, for almost all combined loading conditions met with in ordinary design.

The writer's formula, in somewhat modified form, is included in the 1938 and 1940 editions of "Structural Aluminum Handbook"[9] under the heading, "Combined Bending and Direct Compression," on page 57. Included in this section is an additional formula of the same general type derived by the writer's colleague, Mr. H. N. Hill, which permits the analysis of beam-columns to be extended to members which become unstable in the direction perpendicular to the plane of the applied bending moment. This phase of the problem has also been investigated by Dr. Bruce G. Johnson in a paper, "The Lateral Buckling of the I-Section Column with Eccentric End Loads in the Plane of the Web," presented before the National Applied Mechanics Meeting, American Society of Mechanical Engineers, Philadelphia, June 21, 1941.

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[9] Aluminum Company of America, Pittsburgh, Pa.

THE AUTHOR

The discussion of my paper on "Columns Subject to Uniformly Distributed Transverse Loads" is very much appreciated indeed. The major points made by the reviewers appear to fall into two classes. Mr. Goodrich and Professor Morrison would like to see the method of analysis illustrated in my paper applied to other column problems, while Mr. Lash and Mr. Hartmann question the newness of either method or formulae.

There is, indeed, "nothing new under the sun." Yet, it is the method of approach and the distinctiveness of the analysis stressed in the title and in the synopsis which I regard as the most significant part of the paper. Mr. Hartmann states: "This formula (his formula), solved by the cut and try methods, gives results identical to those obtained from Professor Van den Broek's Formula II." Mr. Lash states: ". . . but rather curiously, Equation (4) (Mr. Lash's equation) is the same as Professor Van den Broek's Formula IVa." I believe both gentlemen to be in error. Instead of their formulae being the same as either of mine, Mr. Hartmann's formula is identical to Mr. Lash's which is derived from Pippard and Baker, which in turn, was first developed by Perry.

Mr. Lash's formula seems to contain a slide rule error. His figure 4.92 is derived from $\frac{\pi^2}{2}$ and should therefore have been 4.9348. When Mr. Lash identifies his formula with my formula IVa he fails to note an important difference. His formula contains the term, P_{cr} whereas mine has the expression $9.836EI/l^2$. For practical results an accuracy of four or even three significant figures is not warranted. I will concede, then, that Mr. Lash's formula constitutes a third formula, that all three are but approximate formulae and that for practical results, one may choose any one of them. The following table illustrates the differences in the results obtained by the three formulae:

			Formula IIa	*Formula IVa*	*Mr. Lash's Formula*
For 1″ round bar	$\frac{l}{r} = 100$	$k = 10$	20272	20282	20339
	$\frac{l}{r} = 200$	$k = 10$	4576	4593	4609
For 12″ x 3″ x 25 lb. channel	$\frac{l}{r} = 60$	$k = 10$	253580	254300	254370
For 5¾″ x 9½″ x 40 lb. subway column	$\frac{l}{r} = 60$	$k = 10$	395470	396830	397220

I further concede that, instead of introducing energy methods, I might have limited myself to the use of the differential equation of curvature and obtained identical results. This, however, seems to be strictly a matter of taste and does not warrant further discussion.

If it is conceded that Lash's, Hartmann's and Pippard and Baker's formulae are approximations, the question as to the magnitude of the error remains. The presumption is that they check the results of their formulae with those obtained by means of the exact theory, or what Professor Morrison calls the classic theory. They follow the procedure which Professor Morrison applied to my formulae. In this then lies the essential distinction between my method of analysis and that of Lash's or Hartmann's. I could not call my method either exact or classic, but I feel I am entitled to call it thoroughly rational. Note that in my paper I did not go to any exact or classic theory to obtain a check for my formulae. Had I done so I would have defeated my principal purpose. The most important part of any theory lies in its assumptions or postulates. Therefore, I regard my figure 2, which presents proof of the near identity of the sine curve and the 4th degree parabola, as the most important part of my development. This near identity, in my opinion, makes my treatment complete in itself.

Regarding the application of the method of analysis, illustrated by my paper, to other column problems, which Professor Morrison and Mr. Goodrich request, let us consider the case of the eccentrically loaded column.

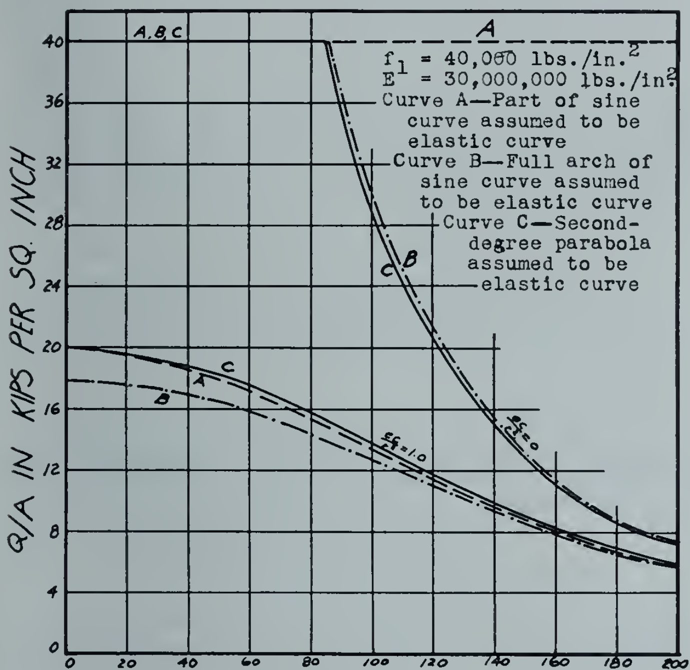

Fig. 9—Comparison of different column formulae for eccentric loading.

The elastic curve of an eccentrically loaded column is an intercept of a sine curve. In the second edition of my book, Elastic Energy Theory[10] which is to appear January 1, 1942, may be found the development of a strength formula for eccentrically loaded columns by the method here under discussion. The resulting formula is the familiar secant formula:

$$f_1=\frac{Q}{A}\left(1+\frac{ce}{r^2}\sec\frac{l}{2}\sqrt{\frac{Q}{EI}}\right) \qquad \text{Formula A}$$

[10] Elastic Energy Theory, by J. A. Van den Broek, John Wiley and Sons, 1942.

Since the elastic curve assumed is the correct elastic curve we arrive at the so-called exact formula.

For the limiting case, in which the eccentricity, e, approaches zero as a limit, the elastic curve of the eccentrically loaded column approaches the sine curve as a limit. For the limiting case, in which the eccentricity, e, approaches infinity as a limit, the elastic curve of the eccentrically loaded column approaches the arc of a circle as a limit.

The strength formula for eccentrically loaded columns, predicated on the assumption that the elastic curve is a complete arch of a sine curve, is:

$$\frac{Q}{A}=\frac{1}{2}\left[f_1+\frac{\pi^2E}{\left(\frac{l}{r}\right)^2}\left(1+\frac{\pi^2}{8}\frac{ec}{r^2}\right)-\sqrt{\left\{f_1+\frac{\pi^2E}{\left(\frac{l}{r}\right)^2}\left(1+\frac{\pi^2}{8}\frac{ec}{r^2}\right)\right\}^2-4f_1\frac{\pi^2E}{\left(\frac{l}{r}\right)^2}}\,\right] \qquad \text{Formula B}$$

Figure 9 shows Formulae A and B plotted for the values of $\frac{ec}{r^2}=0$ and $\frac{ec}{r^2}=1$. In my opinion, Fig. 9 is not necessary to demonstrate the inaccuracy of Formula B. Figure 2 of the original paper is enough to convince me that Formula B will give values which are seriously in error. In the analysis of the beam column the two limiting curves, the sine curve and the 4th degree parabola, are so nearly identical as to be almost indistinguishable as shown in Fig. 2. In this instance, however, the two limiting curves, the sine curve and the circle, show the greatest possible divergence.

While Formula B is obviously unsatisfactory, this does not mean that the method of analysis used in its derivation may not give quite satisfactory results. All we need to do is to choose a compromise curve, which, for values encountered in engineering practice, will give satisfactory results. The second degree parabola is such a compromise curve. This curve, when used in the manner illustrated in the original paper, results in a strength formula for an eccentrically loaded column which appears quite satisfactory. The resulting formula is:

$$\frac{Q}{A}=\frac{1}{2}\left[f_1+\frac{9.6E}{\left(\frac{l}{r}\right)^2}\left(1+\frac{ce}{r^2}\right)-\sqrt{\left\{f_1+\frac{9.6E}{\left(\frac{l}{r}\right)^2}\left(1+\frac{ce}{r^2}\right)\right\}^2-\frac{38.4f_1E}{\left(\frac{l}{r}\right)^2}}\,\right] \qquad \text{Formula C}$$

The mathematical development for this formula may be found in my book[10]. This book also shows curves for a greater range of values of $\frac{ec}{r^2}$, and shows that in all cases Formula C gives results very close to those of Formula A.

The advantage of Formula C over A lies in the fact that it permits of direct solution. Formula A, being a trigonometric formula, can only be solved by cut and try method.

THE ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

A Condensation of the Report to the Boards of Constituent Bodies presented by Dr. R. E. Doherty, Chairman, March 1941.

I. E.C.P.D. Should Look Ahead

The engineering profession is now facing the challenge of the unstable new world it has helped to create. In trying to meet the obligation this implies, two deficiencies appear: lack of capacity for joint action, and defects in the character and extent of the engineer's preparation for his profession. Concerted thought must be given to the correction of these conditions.

While recognizing this responsibility in the accomplishment of national stability, most engineers do not realize that the profession is not yet prepared for its share in the task. There are definite ways in which the E.C.P.D. should contribute to this end, but its constituent groups need clearer understanding and more general conviction as to E.C.P.D.'s purposes and potential usefulness.

It is urgent that the constituent organizations take a greater democratic hand in the affairs of the body they set up eight years ago. To do this, they must understand better than they do now, just what the E.C.P.D. is. Some people think it is merely an accrediting agency for engineering curricula; others fear it may try to usurp some powers of the constituent societies; some do not know or care what it is all about; so there should be an educational campaign by the several engineering groups to acquaint their members with the purposes and work of the Council.

The E.C.P.D. is what its charter says it is. This charter is a great document of engineering statesmanship that clearly points the democratic way toward the further development of the solidarity and prestige of the profession. It says: "The E.C.P.D. is a conference of engineering bodies organized to enhance the professional status of the engineer through the co-operative support of those national organizations directly representing the professional, technical, educational and legislative phases of an engineer's life." To this end it aims to "co-ordinate and promote efforts and aspirations directed toward higher professional standards of education and practice, greater solidarity of the profession, and greater effectiveness in dealing with technical, social, and economic problems.

The E.C.P.D. has been successful as an accrediting agency, in this case performing a task which could be carried out in a few years. But most of its other projects are of a kind that cannot become effective so promptly, although in the long run they may be even more important to the profession than accrediting.

Last October, the Engineering Institute of Canada was welcomed as a constituent member of the E.C.P.D. This affords a liaison with Canadian engineers which will aid the development of common interests in both countries. The Council has already benefited by the presence of its new members.

The constituent bodies have shown that they can co-operate—for example they have formed the E.C.P.D.—but in some cases their co-operation has been limited. Engineers must not stand by in indifferent isolation; the solidarity of the profession is necessary if they are to take effective part in preserving a democratic future for this country.

Constructive co-operation is at the heart of democratic life. In a democracy, if the political, industrial and professional groups are not organically related to the whole, a basis for national stability does not exist. This is the primary reason why the groups of the engineering profession should cultivate the capacity for co-operation.

As regards professional training, upon which the professional status of engineers depends, there must be better selection of students, more appropriate collegiate training, greater incentive and opportunity for post-graduate education, and fuller recognition of professional achievement. All this professional development certainly requires co-operative effort. The purposes involved are precisely those of the E.C.P.D.

Under present conditions, the E.C.P.D. is the only body which, because it has direct representation of the engineer's professional, technical, educational, and legislative interests, can deal effectively with the broad problem of professional development. It is, however, an advisory service organization, responsible to its constituent bodies, and must confine itself to matters strictly within the scope of its charter. But if co-operative progress is to be made by the engineering organizations, the Council is now the only central medium available.

II. Membership and Activities of E.C.P.D.

It will be noted that the Council has functions of advice and recommendation only, and does not administer any project unless it is definitely approved by a majority of the constituent groups.

The constituent bodies include the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education, the National Council of State Boards of Engineering Examiners, and the Engineering Institute of Canada.

The work of the Council is indicated by the activities of its five principal committees. Brief reports of their work follow:

1. Student Selection and Guidance

The Committee has organized groups of engineers to meet highschool boys and others who make enquiries as to the study of engineering. Some 8,000 boys attended such meetings last year. Various committees and local sections of national societies, and local and state engineering societies have aided. In general, the public schools have welcomed such guidance to prospective students which gives information regarding the mental, physical and personal requirements for success in an engineering career, and the many phases of engineering work. Higher standards of admission to engineering schools are being urged, looking to the selection of better engineering talent.

A pamphlet, "Engineering as a Career," has been prepared for publication.

2. Engineering Schools

A list of 542 undergraduate engineering curricula in 125 institutions has been prepared. One hundred and sixty-four curricula were inspected but not accredited. This work continues.

The basis for accrediting has been a sound educational programme. The committee's visits and the friendly advice given when requested, have, in many cases, resulted in marked improvement.

An analysis of the data gathered by the committee has been published and distributed to the officers and libraries of the various institutions.

3. Professional Training

To advance after graduation, the young engineer must do more than acquire proficiency in his immediate job. He must gain knowledge and experience through further study and through contacts with fellow engineers. The function of the E.C.P.D. Committee on Professional Training is to aid junior engineers in this critical phase of their development. Working with local sections of constituent societies, many junior engineering groups have been organized. Suggested reading lists, extension courses, lectures, discussions, and inspection trips are arranged or encouraged by this committee.

4. PROFESSIONAL RECOGNITION

This committee is concerned with "methods whereby those engineers who have not suitable standards may receive corresponding professional recognition." The E.C.P.D. has set up, as a "suitable standard," certain minimum qualifications—including education as well as capability developed in practice—which afford a basis for common requirements for society membership and legal registration.

So far the many societies devoted to technical advance have not been able to achieve professional solidarity. Legal registration by state engineering boards in seven-eighths of the states has created a new grouping on the basis of competency. But though the 70,000 registered engineers about equal the total membership of the older societies, a majority of each group does not belong to the other.

The committee urges that the societies seriously consider whether their "profession can adequately meet its obligation . . . as an aggregation of individual groups, loosely linked by numerous common agencies." It is hoped that study of engineering as a profession and of professional ethics by student groups can be organized and will lead the ten thousand engineering graduates of each year to distinguish engineering as a profession, from engineering as a technical occupation.

The committee is working to develop a more general understanding of what constitutes professional status, and to help all engineering students to appreciate professional standards and conduct.

5. PRINCIPLES OF PROFESSIONAL ETHICS

This committee was originally sponsored by the American Engineering Council (now discontinued), and was taken over and enlarged by the E.C.P.D. Existing codes of engineering ethics had been studied, and although progress, by correspondence, has necessarily been slow, a draft report is now being prepared, outlining a code of ethics for guidance in the engineering profession.

The object of this study is to stimulate ethical thinking among engineers and to inform them as to what their societies expect of them as regards professional conduct. If such a report, when approved by the E.C.P.D., eventually receives general adoption by engineering societies, a very definite contribution to the solidarity of the profession will have been made.

It is believed that the foregoing brief review of the activities of the E.C.P.D. justifies the hope that the Council will serve engineers increasingly in the cause of professional devlopment.

Abstracts of Current Literature

Abstracts of articles appearing in the current technical periodicals

WOMEN IN ENGINEERING

From *Trade & Engineering*, (London), July, 1941

In a foreword to the first number of a monthly Engineering Bulletin issued by the Ministry of Labour, Mr. Bevin states that the industry must be prepared to take on more recruits, particularly women, for training in the works. In the next few months 750,000 recruits will be wanted in the factories. As most of these will be women it is of interest to note that the employment of women on certain engineering processes, particularly on capstans, milling and milling machines, and on inspection and light assembly work is already very common. In a number of engineering works, however, female labour is employed over a much wider field than this, and, to an ever increasing extent, on precision work connected with aircraft and aircraft engines, shells and fuses, milling gun parts, and optical grinding and polishing to extremely fine limits. The elimination of breakages in various operations is said to be due to the women's more delicate touch. Female labour in engineering is, of course, no new thing, but a war-time development in one area is the successful employment of women as works managers, while one large firm of general engineers employs several hundreds on non-repetitive work.

Meanwhile, the registration of the women of 20 and 21 has brought to light the fact that very few are without occupation. Household work is accepted by the Ministry of Labour as an essential occupation, and the Ministry has rules for ascertaining the degree of necessity in the household occupation. Nevertheless, large numbers of women are required and must be found. Many will be made available by the concentration of industry, and for the rest there will have to be transference on a great scale from less essential to more essential work. The registration of young women was expected to disclose a large reserve of labour. It has not done so, and the policy of the Ministry, therefore, is the transference of young unmarried women from less essential employments. Already the panels are busy arranging transfers beginning in the industries to be concentrated and disregarding, for the present, those that are in the Schedule of Reserved Occupations, as well as the women in undertakings engaged to three-quarters of their capacity on Government work. With regard to the unemployment returns, which for May showed a total of 369,000, it is again pointed out that the unemployment of to-day is mainly that which occurs in the change-over from one job to another.

PENCILS FOR TEMPERATURE MEASUREMENT

An abstract from *schrift des Vereins Deutscher Ingenieure* (*VDI*), 1941, No. 2.

The Engineers' Digest (London) June 1941.

There exist materials which change colour when heated and revert to their original appearance after cooling. These materials have been used among others, by the firm Faber, to produce thermo-chromo pencils for eight temperatures between 120 and 600 deg. C.

The attendant has only to make a stroke with one of these pencils on the body, the temperature of which has to be ascertained, and to observe the moment when the colour changes.

Colour of the pencil when cold	*Temperature, at which colour changes*	*New Colour*
Light-green pencil	120°C.	Blue
Green pencil	150°C.	Violet
Blue pencil	200°C.	Black
Bottle green pencil	300°C.	Brown
Brown stroke of above pencil	350°C.	Red
Rose pencil	450°C.	Black
Light-yellow pencil	510°C.	Orange
Dark-blue pencil	600°C.	White

INVISIBLE LIGHT FOR PROTECTION AGAINST SABOTAGE

From *Aero Digest*, (New York), August, 1941

Numerous means of protection may be employed in setting up a "defense programme" against the would-be saboteur. While these means depend upon the requirements peculiar to the individual establishment there are two problems that are common to all establishments faced with sabotage hazards—to keep outsiders from getting entrance, and to prevent unauthorized persons (including unauthorized employees) from gaining access to restricted areas within the premises.

To achieve these objectives, many concerns are using the A.D.T. Invisible Ray Alarm, one of the electric protection services of the American District Telegraph Company. This system projects a beam of invisible light across the area to be protected, and interruption of the beam by any person or vehicle passing through its path automatically actuates an alarm system.

While the invisible ray is a comparatively recent development in burglary protection, it is by no means untried. It has proved its effectiveness in many mercantile, commercial and industrial establishments for more than five years. Yet, it is only within the past year or so, following installation of the apparatus in various defense plants, government establishments, etc., that officials realized how suited this system is for the protection of premises exposed to sabotage hazards. In many cases, where physical barriers would be impracticable, or where long distances or large areas would make adequate patrol protection by guard forces extremely costly, the invisible ray has proved an effective means of providing the necessary protection.

The invisible ray operates on photo-electric principles similar to those employed in the various electric eye devices used for opening doors, counting objects or persons, etc., but with a far greater range of operating values. The system consists of a light source, a photoelectric receiver, and a control unit.

The light source unit consists of one or more incandescent lamps of a power sufficient to project a beam of modulated light across the desired distance, and a filter glass which blocks all light waves in the visible range, allowing only the invisible infra-red rays to pass.

This beam of invisible light is directed toward the receiver unit, containing a photocell which responds to the modulated radiations from the light source, causing a change in current flow in the receiver unit which, by means of vacuum tubes, is amplified to a value sufficient to operate an alarm relay mechanism. When the beam is interrupted by a solid object of sufficient size, such as a person, vehicle, etc., the current flow in the photocell is momentarily broken. This results in actuating the alarm system.

Connected with the receiver is the control unit, which contains the alarm relay and other mechanism for initiating such protective action as may be desired as the result of an alarm. The system can be so connected that interruption of the beam will automatically result in one or any combination of various protective actions, such as notifying the local guard headquarters, or the police, or the A.D.T. central station; turning on lights inside the premises, or floodlights and searchlights in the yards; stopping the operation of automatic machinery; sounding sirens or gongs, or closing gates, doors, firestops, etc.

Among the many applications for which the invisible ray has been found particularly effective is boundary protection in conjunction with fences. Here the beam usually is projected inside the parallel to the fence, in such a manner that an intruder who might gain entrance by scaling or cutting through the fence would pass through the beam as soon as he got inside. This interruption of the beam would automatically transmit an alarm signal to the local guard headquarters, the police of the central station, as well as performing such other protective functions for which provisions have been made.

For such outdoor protection, light sources are provided which project beams that are unaffected by rain, snow, fog or other weather conditions, and which are effective for distances up to 1,000 ft., or further. For the protection of areas, indoors or out, such as yards, storage spaces, etc., to which access might be gained from several directions, a number of beams may be used to cover the protected area; or, the beam from a single light source, by means of reflectors, may be made to form a network of invisible light rays, zigzag fashion, over the protected area.

Since the invisible ray does not require the erection of physical barriers to impede normal activities, it often is the only feasible means of protection for loading platforms, railroad sidings, storage areas, open water fronts, etc. All that is necessary when it is desired to restrict access is to "turn on" the protection.

The same applies to any other areas, inside or out, which it is desired to protect from intrusion. Many defense plants are employing this method of protection to safeguard approaches to tool cribs, storage rooms for valuable metals, explosives, and rooms where confidential or valuable documents are kept. Or, in a shop, a vital machine, or group of machines, may be ringed with invisible rays so that no one can approach undetected.

Probably the most outstanding example of the adaptability of the system is the installation which, for several years has been protecting the Foreign Trade Zone (Free Port) on Staten Island, N.Y. Here the light source is on a float, keeping it always at the same level above the water regardless of tides. Special equipment projects this light for a distance of 3,000 ft. across the water, from pier to pier, and provides an intangible but effective barrier against smugglers—protection which could not be provided in any other way.

Such beams operate with equal effectiveness day and night. Operation of the system is not affected by sunlight, or by other extraneous lights such as flood lights, headlights of passing cars, etc. The photoelectric receiver is responsive only to light waves modulated to the specific frequency of the radiation projected by the light source. Thus, the system cannot be made ineffective by interposing a flashlight or any other light between the light source and the receiver. Neither will cutting of wires, or otherwise tampering with the equipment help those attempting to defeat the system; such action is just as effective in transmitting an alarm signal as actual interruption of the beam.

BRITISH AIRCRAFT INDUSTRY

Detecting Raiders our "Secret Weapon"

From *Trade & Engineering* (London) July, 1941

Undoubtedly one of the best kept secrets of the war has been the method by which enemy aircraft are detected, often when they are still miles from our shores. Most people knew that the Royal Observer Corps, Fighter Command, and the other defences had some scientific aid. Quite a number of people had made intelligent guesses as to what the device was, and a more select few were "in the know," but, generally speaking, the device was not only born in secret but has passed through adolescence and come to maturity without the general public having an inkling of its character and working.

It is now possible to give some limited particulars of the device, which is generally known as radiolocation. It is by no means a new science but rather an adaptation to war purposes of a discovery known to the whole of the civilized world. Briefly, radiolocation is a system of sending out ether waves which cannot be affected by fog, cloud, or darkness. They can extend many miles beyond our shores. Any solid substance, such as an aeroplane or ship, which is in the path of the waves sends back a "reflection" to the detecting station and thus reveals its presence. Since the outbreak of war these ether waves have been keeping, and continue to keep, a 24-hour watch throughout the year. They obviate the necessity for Fighter Command to maintain standing patrols of fighter aircraft, thus releasing both men and machines for the task of engaging any raiders discovered by this scientific means.

The Germans are believed to be experimenting along the same lines, but there is as yet nothing in the results they have achieved against our bombers to suggest that they have made any marked degree of progress.

Radiolocation was known in its primary form some years ago, and as long ago as March, 1935, the earliest experiments were conducted in this country to apply the knowledge to war use. In its origin the idea was the conception of one man—Mr. R. A. Watson Watt, Scientific Adviser on Telecommunications to the Chief of the Air Staff—who had the vision to see the possibilities inherent in certain electrical phenomena. The initial experiments were carried out in an ancient lorry on a little-used country road not far from Daventry. As a result of those experiments a team of scientists and a number of Service officers also interested in the problem collected together and worked for many months to bring radiolocation to its initial form, and this was achieved towards the middle of 1939.

It had taken four years of continuous and often trying experiments to work the device up to the standard it had attained at the outbreak of war. The threat of war in the summer and autumn of 1938 no doubt speeded progress even then, so that by the time war came the system, in a partially developed state, was in operation. The result of operations since the outbreak of war has demonstrated very clearly the vital nature of the achievement, and since that date scientists, engineers, and technical manufacturers have been combining to produce the best possible equipment for the detection of enemy aircraft. The Battle of Britain was undoubtedly won by the R.A.F. Fighter Command partly because of the help it received from radiolocation. The development of the system has been continuous and rapid. That single lorry on the road near Daventry has now grown into a vast organization covering the whole country, and it serves not only the R.A.F. and the Royal Observer Corps but the Royal Navy and the Army. Instead of the two or three civilians and a few officers there is now working on radiolocation a staff numbering thousands in the three Services.

As the scope of the system has been developed there has obviously been a need for more and more technicians The three Services have been thoroughly combed and the Central Register has brought to light many more men and women with some knowledge of radio, but still the numbers are inadequate. Therefore an Empire-wide appeal has just been made for recruits with some degree of technical knowledge. Air Chief Marshal Sir Philip Joubert de la Ferté, now A.O.C.-in-C., Coastal Command, but formerly in charge of this work, stated when the appeal was launched that the immediate requirement of the R.A.F., Royal Navy, and Army was 10,000 men and women, but that eventually the R.A.F. would need 8,000 men and 3,000 women; the Army about the same number, and the Navy about 2,000 men and 300 women. Already extensive use is being made of women, both as scientific officers and operators.

RAILWAY REPAIR AFTER AIR RAIDS

From *Civil Engineering and Public Works Review* (London), June, 1941.

The following are examples of speedy repair work which are mentioned in a little pamphlet recently published by the railway companies.

As a result of an air raid, the crown of an arch in a shallow tunnel allowed earth to penetrate on to the tracks. Unfortunately, the soil continued to fall through until a hole showed at ground level above. A mechanical excavator was taken to the site, and 2,000 cubic yards of earth removed above the tunnel; a new arch was built; the earth was then moved from inside the tunnel, when the line was reopened for traffic.

When a heavy calibre bomb struck an electric conductor rail on a viaduct, it glanced off, penetrated into the ground below, where it exploded, demolishing part of the viaduct. Two tracks on an adjoining viaduct remained intact. To enable services to be operated, a large high tension cable diversion was made, the installation of a temporary crossover 200 ft. long was built, and automatic signalling over two miles of track was reversed, resulting in the train services being restored the next day. Meanwhile, the remains of the arches were demolished with the aid of a locomotive and wire cables. A special train equipped with a large electric compressor, was worked to the site and the demolition of the brickwork by ten heavy pneumatic hammers was put in hand.

The whole of the brick debris was broken up and removed by lorries, excavation being undertaken to find a new solid bottom. The worst of the crater was dug out and the remaining weak ground was rafted over with steel rails and concrete. A trestle bridge of two spans was then constructed on the concrete raft, incorporated in the design of this bridge being a timber thrust member to take the end thrust of the remaining arches of the viaduct. Rolled steel joists with cross sleepers resting on them were provided for the rails. Hundreds of thousands of passengers have since passed safely over this place with only a slight check in speed to their trains.

During another air raid a high explosive bomb penetrated the booking hall of a busy station, exploding on the track over the station subway. The blast from the bomb in the confined space was very severe. Rails, timbers and girders over the subway were damaged and portions of the platforms destroyed, whilst all the brick and tile constructions on the platforms were demolished together with various kiosks. Numbers of cables under the platform nosing were also put out of action. Two ballast trains were at once rushed to the site, the loading of the material and the track repairs were carried out by gangs sent by lorries, with the result that the station was reopened and both lines were operating with temporary signalling the same day, less than eight hours after the incident occurred.

FRENCH CARGO LINERS

From *Trade and Engineering*, (London), July, 1941

According to information recently received; the three high-speed cargo liners of a new type ordered by the French Government some time before the war broke out have been delivered. Much interest was taken in this contract at the time it was placed, since the ships were specified to have a speed of 17 knots, which is higher than that of any other vessels in the French mercantile fleet. Moreover, although they were constructed to the order of the French Government, it was intended that two of them should be operated by the C.G.T. and the other by a well-known French shipping company.

The three vessels, the Indochinois, Malgache, and Caledonien, are sister ships apart from certain modifications in refrigerated capacity made in view of the different services on which it was intended they should be engaged. They are of 9,000 tons deadweight capacity, with a length of 459.8 ft., a beam of 60 ft., and a loaded draught of 26.4 ft. A 10-cylinder Sulzer-type engine of 7,000 b.h.p. is installed; it runs at 125 r.m.p. and has an overload capacity of about 15 per cent. The cylinders have a diameter of 720mm. and the piston stroke is 1,250mm.

It is difficult to ascertain to what extent mercantile shipbuilding is proceeding in France at the present time, but it was recently recorded that at any rate for a period after the German occupation the industry was very poorly occupied. It would be particularly interesting to know whether the 22-knot passenger liner Marechal Pétain (an 18,000-ton triple-screw Diesel-engined vessel with 22,000 s.h.p. machinery), which was ordered before war broke out for the Messageries Maritimes, is likely to be completed. The fact that she has only recently been named seems to indicate that construction has not been wholly held up until the conclusion of the war.

Fig. 1—Tanks crossing open ground.

BRITISH INFANTRY TANKS

From *"Engineering"* (LONDON), JULY, 1941

Some particulars have now been revealed of the latest type of British infantry tank, formerly known as the Mark 111, but now officially designated as the "Valentine." Figures 1 and 2 show views of the Valentine type, which weighs 16 tons and is manned by a crew of three. Infantry tanks in general are more heavily protected, but less speedy, than the "cruiser" tanks used by the mechanised cavalry regiments, but it is stated that the Valentine has a road speed in excess of 15 miles an hour, and, for the weight of guns and armour which it carries, has proved to be faster than was expected. Its manoeuvrability and cross-country riding qualities are of a high order. The turret mounts a Besa gun, at the side of which is a 2-pounder, stated to be capable of penetrating the armour of any German tank that the British forces have yet encountered.

Reference to the illustrations of the Valentine will show that the method of driving and guiding the track is by a double row of teeth; an arrangement which would appear to have superior advantages when traversing soft ground or the slope of a hill, and to offer the probability of smoother progress over rough ground such as that illustrated in Fig. 1. Tanks, like warships, must represent a compromise, and the dominant factors can seldom be the same in different armies.

DISCREPANCIES IN WAGES

From *Trade & Engineering*, (LONDON), JULY, 1941

A problem that arose in the War of 1914-18 is again proving troublesome. Factories engaged on Government work are paying much higher wages than other employers in the same area can afford, with the result that farmers and others are being denuded of their labour. If there were a properly constituted authority to settle these matters, and it were decided that a ploughman was indispensable for making munitions and far more valuable at that work than at farming, nobody would complain, but it has not yet been authoritatively decided whether the munition worker or the agriculturist is the more important to the country, the services of both being urgently needed. Nor has it been shown that ploughmen are better adapted to munition making than labour that is not essential to the land. It is very difficult to believe that a skilled farmhand could be better employed than in producing food—there cannot be many modern counterparts of Cincinnatus—but that his services should be at the command of the highest bidder irrespective of other considerations is entirely wrong. It is very unfortunate that nothing is done to stop this "beggar my neighbour" policy, which is directly due to want of co-ordination.

MODEL EXPERIMENTS ON THE GEBEL AULIA DAM

By Hasan Zaky, Ph.D., B.Sc., M.Inst. C.E.

From *Journal of The Institution of Civil Engineers* (LONDON), JUNE, 1941

The Gebel Aulia dam is one of a series of large storage reservoirs built on the Nile for augmenting its low-season supply in order to cope with the crop demands and allow for a better development of the Nile valley.

Before its actual construction the Egyptian Government wisely decided to submit the proposed plans to model-tests with the object of investigating the whole design thoroughly, eliminating all undesirable features in the structure, and calibrating the sluices for better control.

An extensive series of experiments were carried out for this purpose at the Delta Barrage laboratory. These proved to be highly satisfactory and of great practical value. In many aspects, the final design that was approved and executed was the outcome of these tests.

The models used were seven in number, and the scales

Fig. 2—Front view of Valentine tank.

ranged from two per cent to full size. The tests can be classified into three categories:

1. Preliminary experiments for investigating the initial proposals.
2. A general study of the modified and final plans.
3. A precise series for the purpose of calibrating the sluices.

The first series, which could be considered as purely exploratory, were conducted on a 1/50 scale model comprising two sluices. The study proved beneficial, as it revealed the desirability of some alterations, including an increase in the number of sluices, lowering the sill-level, and fixing the length of the apron.

A second and more extensive series of experiments were then conducted for the purpose of testing the nature of currents, the grouping of bays, and the best shape of training-walls; and for further study of the character of flow near the downstream lock-wall and the fish-ladder. Two 1/50 scale models comprising more than one bay were used for this study. The tests clearly demonstrated the suitability and effectiveness of the original position of the downstream lock guide-wall, and enabled the consulting engineers to devise two important modifications in their original plan connected with the training-walls and the fish-ladder.

The inquiry then proceeded on entirely different lines. Experiments were undertaken for the purpose of precisely calibrating the sluices. This involved the use of four different models. Considering the diversity in the scales used, and the difficulty of proper simulation of the actual position of the upstream and downstream gauges on the different models, the results exhibited close agreement. The experiments aimed at determining accurately the co-efficient of discharge for drowned conditions, and establishing clearly the limits for such conditions.

The three small models, namely, 1/25 scale, 1/10 scale, and ⅓ scale, were used for testing gate openings exceeding 1.0 metre for various upstream levels. The largest model (full size) was especially constructed for the study of gate openings of less than 0.50 metre with low upstream levels.

The total number of experiments carried out on these models amounted to about twelve hundred.

Table I gives the mean coefficients of discharge for drowned conditions: it shows the close agreement of the results obtained from the three models, the coefficient of discharge C being derived from the following equation:

$$Q = CA\sqrt{H}$$

where Q denotes the discharge, in cubic metres per second per sluice, A the area of the opening, in square metres, and H the difference, in metres between upstream and downstream levels.

TABLE I

	Opening: metres			
Model scale	1.00	2.00	3.00	3.50
	Coefficient of discharge C			
1/25	3.07	3.14	3.32	3.62
1/10	3.02	3.15	3.55	3.81
⅓	3.05	3.18	3.50	3.69
Mean coefficient of discharge C	3.04	3.16	3.47	3.70

The tendencies observed earlier in tests made at the Aswan and Sennar dams were confirmed by this investigation; namely, that the coefficient of discharge increases with the gate opening, and that the coefficient is a function of the ratio $\frac{\text{gate opening}}{\text{height of opening}}$. Finally, suitable formulas were derived for the discharge of submerged small gate openings.

The above-mentioned tests served as a useful and reliable base for the correct estimation of the discharge passing through the dam—a matter of vital importance for drawing up the preliminary programme of its filling and emptying. Moreover, the tests helped in settling many points connected with the proper functioning of the reservoir.

In general, the Gebel Aulia dam is the first major structure in Egypt which has been the subject of a detailed technical study through different stages of its construction by the aid of models on various scales, a procedure which proved quite satisfactory, as it resulted in a great saving of time, labour, and money.

SALVAGE OPERATIONS ON AIRPLANE EMBEDDED IN ICE

From *Aero Digest*, (NEW YORK), AUGUST, 1941

Landing at Lake Athabasca in the northwest part of Saskatchewan last winter, a Bellanca aircruiser belonging to Mackenzie Air Service started to taxi in over the ice when it passed over a weak spot on the surface about a half mile from shore. The ice gave way, and, as the plane's skis dropped through abruptly while the turning propeller chopped out huge chunks of snow and ice, the fuselage and wings slid through the opening, then held as the wing tips and tail surfaces contacted the lake's solid covering.

The plane was on a flight last December 11 between Fort Smith and Goldfields. Pilot D. Page McPhee had set down on the ice about two miles from shore, making a normal landing on the Mackenzie developed skis which use the landing wheel tires for shock absorbers. The taxi into shore was also normal, until a triangular crack opened in the ice about a half-mile out and the plane dropped in. The pilot and the crew jumped out of the cabin and, using the wing top as an escape to solid ice, brought out the mail and express bags.

Coming back the next day to have a look at the plane they found it had sunk farther into the ice. It was apparent that if the crack opened much wider it would take a combination of summer weather and a deep sea diver for salvage. Conditions at that time were such that it was doubted that the ice was strong enough to support the weight of additional salvaging equipment, so the work of raising the airplane had to be postponed for about five weeks until the ice was able to hold up the weight imposed on it.

Any attempt to pull the plane out at that time would have yanked off the tail and left the rest to sink. There was nothing to do but wait for colder weather to freeze the lake solid and to hope that no sudden wind storm would drive the plane on under the ice.

Salvage crews went to work under the direction of Mackenzie's service engineer, George Taylor, and despite fears that the airplane was beyond repair, they succeeded in reclaiming and fixing it so that it is now back in regular service.

Taylor first ordered out a crew of men to chop wood. He wanted firewood enough to make a fir-sized forest fire. All during the waiting period he kept men busy chopping wood. Other crews were put to work building rough wooden sheds and placing them on rollers. These sheds were to act as a combination hangar and heat treat department. Planes from the home base at Edmonton brought ice axes and other tools to be used in the de-icing process.

Gasoline was drained from the tanks in the top wing section, both to remove the danger of fire and also to lessen the weight pressing the plane into the ice. Taylor and his men literally burned the plane out of the ice. Wings and fuselage were practically filled with ice. Exceptional care was required to avoid damaging the wings while they were being raised, an inch or two at a time, since the accumulation of ice had created a tremendous load on them. Fires were built in the immediate area and were kept burning throughout the day and night while the ice was thawed out of the wings. This operation took about seven days, and when the wings were salvaged and thawed out, they were transported to a permanent camp about a mile from the lake.

Some of the fabric on the fuselage had to be cut away to facilitate salvage operations, but this was subsequently replaced on the job. Sufficient heat again had to be applied about the fuselage to keep the water from freezing in the tubing and thus cracking it. After the tubing was drained, the engine was thoroughly dried out over a wood fire and then the fuselage, with the engine, still on its mount, was transported to the camp. Since the Cyclone had been submerged while running, water had been pulled into the carburetor, supercharger, cylinders and other internal areas.

Mechanics put new spark plugs in the engine, but used the same ignition harness and magnetos. They heated up the engine oil and poured it in, turned over the engine and the Cyclone started almost instantaneously.

Examination, meanwhile, revealed no major damage to the airplane; the propellor, however, had suffered some damage, but the company's propeller repair man put it back in shape at the camp. After superficial repairs, the airplane was flown back to the main shops at Edmonton on April 2, and, after complete overhaul, went back into service none the worse for its month and four days in the solid ice.

From Month to Month

News of the Institute and other Societies, Comments and Correspondence, Elections and Transfers

CALL FOR FORESIGHT

The Engineering Journal's support has been asked in the "save gasoline" campaign which is now being conducted vigourously across Canada. This request comes from the Canadian Publishers War Finance Publicity Committee, and perhaps no better way can be found to carry out the request than to present herewith an abridgement of the communication which was addressed to the editor. It is a pleasure to do so.

"Canadians are not forced to fall back on blind faith to convince themselves that the battling people in the British Isles are working feverishly to prepare for an offensive operation in Europe. Our newspapers have been publishing dispatches which bristle with evidence that doughty Britishers are getting ready to strike back. But when the blow will be struck, none in Canada knows.

"If the inner War Council did decide on a major operation, it could not 'telegraph its punch.' No one over there is in a position to send a message to Canada—'We are about to attack. We must have every drop of gasoline and oil you can rush across to us now.'

"But surely we in Canada have enough intelligence and imagination to foresee that a sudden favourable opportunity may present itself to the armies in Great Britain anytime within the next few weeks. And that same intelligence and imagination should dictate the sharpest curtailment in the use of motor fuel for motor cars without a day's delay.

"It would be a pity if the stamina of Canadian citizenry were to be judged by the spectacle of a few thousand motor car drivers in Ontario, for example, who knew that gasoline had to be saved for the decisive battles overseas, and knowing it, deliberately travelled thousands of miles for the long week-end holiday.

"It would be too harsh perhaps to say that all of these motorists deliberately thumbed their noses at the Empire's war effort. The answer might be that they have not yet been sufficiently impressed by the seriousness of the situation. And if that is the answer, then the press of Canada has not yet reached the point where the appeal for conservation can be eased off.

"Most editors and publishers are working under a handicap in their effort to conduct the appeal for gasoline and oil conservation. Newspapers and periodicals are being forced by circumstances to work alone. There are as yet no local committees, no local authorities with whom editors may co-operate in convincing motor car drivers that the need for conservation is real and in persuading them that the co-operation of everyone is vital.

"It may be that this situation will eventually be righted, but in the meantime the press holds the fort alone. The amount of motor fuel to be saved during the next two or three weeks at least will depend on the degree of effort made by the press."

GOOD READING

It is natural that Canadians should be great readers of periodicals coming from the United States; unfortunately facilities do not seem to be available to make us equally aware of the merits of similar publications prepared in England.

In view of the fact that to-day the world's interest is centred on the Old Country, this is certainly a time to study the literature of that country. To engineers in particular this is important. Marked advances in methods and equipment, both civil and military, are coming so fast that to be out of touch with them is almost to be out of touch with progress.

There are many journals published in London that might add greatly to the sum of engineering knowledge in this country. Some of them are the organs of engineering societies, and others are commercial ventures of considerable magnitude. The outward style or "format" in general is different from that used in America, and to us may appear unnecessarily awkward, but the contents leave little to criticize. The material is excellent, and without exception is a definite contribution to the literature of engineering. The style differs from American practice, being very simple and direct, with little or no attention paid to type or layout. The editorials are of general interest, and usually touch more on matters of national or economic importance than on engineering topics.

One publication that appeals to a very wide field is *The Times Trade and Engineering*—a monthly review of industrial progress issued by the same publishers as the great newspaper *The Times*. This mammoth periodical seems to cover the field of national and international news under a variety of headings such as: Condition Abroad, Engineering and Shipbuilding, Aircraft Industry, Transport, Finance and Industry, Trade Within the Empire, Parliament and Trade, Official Regulations and so on. The cheap, rude or smart comments or jibes that too often are used in the popular business magazines published on this side of the water are absent—no attempt is made to report everything in monosyllablic or tabloid form.

If any Canadian engineer wants to read news or editorials that tell about the trend of developments in Europe, the economic situation in the United Kingdom and the Empire, industrial and political progress, as well as matters of engineering interest, let him read *Trade and Engineering*. No engineer could do this regularly without acquiring a breadth of knowledge of world affairs that would widen the boundaries of his interests and make him a better citizen.

CORRESPONDENCE

The following letter comes from a member who wishes his name omitted.

VANCOUVER, B.C.,
August 20th, 1941.

TO THE EDITOR,
THE ENGINEERING JOURNAL,
MONTREAL, QUEBEC.

Dear Sir,

I note with regret, from the Obituaries in the August *Journal* the passing of John Hamilton Gray, at the age of eighty-seven, almost eighty-eight.

Your notice states that he had retired a number of years ago. As late as 1938 Mr. Gray was, to my knowledge, still in actual practise in a small way but what is more remarkable is the fact that, in 1930, at the age of more than seventy-seven, Mr. Gray undertook surveys in northern British Columbia for a route for the then projected Alaska Highway, which involved several weeks arduous travel in the northern hinterland with pack horses over entirely uninhabited country; he also made his own plans, and his draughtsmanship for a man of that age was remarkable. He was one of those men of unflagging energy who never seem to grow old, but merely fade away.

Many of us also learn with regret the untimely passing of Pat Philip, as stated in your obituary column in the same issue. I do not feel that your notice does full justice to the late Mr. Philip. In 1921 he was appointed to the position of Public Works Engineer for the Provincial Government which position was later altered to Chief Engineer; he also became Deputy Minister of Public Works, and it was during his time that the Fraser Canyon Highway was re-built between Yale and Lytton and the Thompson Canyon Highway between Lytton and Spencer Bridge, being opened in 1926 and 1928 respectively, thus providing the first motor highway from the coast to the interior of B.C. without having to travel through the United States.

Mr. Philip was President of the Association of Professional Engineers for B.C. He was, I believe, councillor for the Victoria Branch of the E.I.C. and possibly your records may show that he was a vice-president. He was a very kindly man and well known throughout the Province of British Columbia.

Editor's Note—We are grateful to the author of the above letter for his interesting remarks. The obituaries that are published in the *Journal* are based on the information contained in the files at Headquarters and any additional information supplied by branches is always very helpful.

The records show that Mr. Philip was chairman of the Victoria Branch in 1922, and member of the executive in 1923, 1924 and 1925. He was the author of the following papers published in the *Journal:* "Consideration in the design and construction of highways," September, 1924; "Cariboo Road," July, 1928; "Highways and highway transportation in British Columbia," September, 1934.

KENYA AND UGANDA RAILWAYS AND HARBOURS

NAIROBI, KENYA COLONY,
JUNE 12TH, 1941

L. Austin Wright, General Secretary,
The Engineering Institute of Canada,
Montreal, P.Q.

Dear Mr. Wright,

I am very grateful to you for your letter of the 24th February which reached me recently.

We in East Africa have, of course, been closely connected with the war effort from this area, but the success of the Army based on East Africa has been so rapid and so complete that it looks now as if we would be less directly concerned. However, this area will always remain a base for certain units and no doubt too the advent of prisoners of war and evacuees will very much increase the transport problems of the country.

The Kenya and Uganda Railways and Harbours Administration has been fairly hard pressed to meet all demands that have been made upon it by the Army, but I am glad to say that in all cases we have fulfilled the requirements of the military authorities, satisfactorily and without accident. The results of the year's working are reflected in my Annual Report for 1940, of which a copy has already been sent to you. This will show that, while we have benefited from the war conditions that have existed, we have returned considerable sums to the military authorities in the form of rebates for traffic carried.

I am afraid that I am not able to give you information regarding the engineering efforts of the Army in Abyssinia, partly because I am not directly concerned with the Army and partly also because the censor would not pass any information of military interest or value. However, I can say that the engineering activities of the Army in repairing roads, bridges, building huts, camps, etc., have been on an immense scale and during the actual campaign the road work, provision of water supplies, bridging and other such items have been carried out with extreme speed and success, in fact, it is not too much to say that the successful conclusion of the campaign was due to the excellent engineering organization in a very large measure. Many of the skilled engineers came from South Africa, including road making companies, works companies, railway construction and operating companies.

So far as we ourselves were concerned, apart from purely transport matters, we have been very busily employed in building depots, sidings, railway yards, store sheds, etc., and in our workshops very extensive repair work and manufacture of military articles have been carried out.

I hope this will give you some idea of our activities, but, for reasons which I have already indicated to you, I cannot amplify them any further at the present time.

As a Canadian, I, of course, watch for all reports of the war effort in Canada and am glad to know that one and all, from one end to the other are doing everything they can to ensure the eventual success of our cause.

Your *Journal* arrives regularly and is read with much interest, not only by me personally, but also by my engineering staff.

I wish the Institute all possible good luck during the coming years and I feel sure that all your members will be giving a good account of themselves in the general war effort.

Yours sincerely,

(*Signed*) BRIG.-GEN. SIR GODFREY D. RHODES

WARTIME BUREAU OF TECHNICAL PERSONNEL

Monthly Bulletin

If any technically trained persons have not received the questionnaire from the Bureau by now, it would be appreciated if they would so advise the office at Ottawa. All the names secured from the national registration and from the following organizations have now been canvassed—eight provincial Professional Associations, the Engineering Institute of Canada, the Canadian Institute of Mining and Metallurgy, the Canadian Institute of Chemistry, the Royal Architectural Institute of Canada.

Approximately forty-five thousand forms have now been circulated. Naturally, there has been some duplication, although great care has been taken to avoid it. With so many membership lists included in the scheme, it is evident that hundreds of names will appear more than once. All lists have been checked against each other, but caustic comments from a handful of disturbed persons indicate that the work was not perfect. Just why anyone should be so disturbed at receiving more than one form, is a little difficult to understand, particularly in view of the statement in the covering letter to the effect that such a thing might occur.

The comments have been both interesting and amusing, and run all the way from superlative praise to withering complaint. Some persons who by their own words have indicated that their war work to date has consisted solely of filling out three or four forms, complain bitterly of the inconvenience to which they have been put by such requests. Fortunately ninety-nine per cent of the returns are encouraging. Many persons have expressed with some enthusiasm their appreciation of the huge task undertaken by a small group of engineers and chemists who are working day and night without even the elusive "dollar a year" remuneration in the hope of assisting the entire profession to amplify its contribution to the war effort.

The momentum of the work is steadily increasing. More requests for men are arriving than ever before. More men are being placed than ever before and with the fuller records now available, it is expected that the vacancies in war industry, and in government activity, will more and more be filled from the Bureau.

The emphasis is still on mechanical engineers in a variety of specialized fields. Lately, the demand for "civils" has increased both in industry and in the active service forces. In this latter group, the need for men of junior office qualifications is very great. One single request is for seventy-five to a hundred men for overseas service. Another request which came by trans-atlantic telephone is for twelve civil engineers and draughtsmen for urgent work overseas in civilian capacity.

The experience of the Bureau to date indicates clearly the great need of organization and co-operation. There is much overlapping of effort to secure technical help. There are many gaps in the systems presently used to meet the needs. There is lack of workable legislation or regulations to meet the new conditions, and it begins to look as if some comprehensive and inclusive scheme would have to be devised for national application if any high degree of efficiency is to be attained in this important field. All those persons and organizations which are now so diligently applying themselves to some particular section of the problem would welcome such a proposal.

The Universities and the Students

Among the groups most disturbed by war developments have been the universities. Almost without exception, the engineering faculties have been depleted seriously, and now a new term is faced with increased obligations and decreased facilities. The Bureau has received many requests for teaching personnel, without being able to meet the situation with any degree of satisfaction.

One point has been gained in that universities have been acknowledged to be in the same category as "essential industries," as far as protection to the present staff is concerned. This will not fill the holes already made, but it will assist in preventing any further and disastrous extension of the deprivation already experienced.

From the information available at present to the Bureau, it appears as if students should be encouraged to enter those courses at university which make a definite and direct contribution to the war. For instance, engineers are needed well beyond the available supply. More and more young men of university age are joining the combatant forces, and, therefore, it is desirable that of those who do go on to university, a high percentage should follow engineering.

Of the courses themselves, the past and present indications are that mechanical is the most useful field of specialization. The others follow in this order—electrical, civil, metallurgical, chemical and mining. A sudden change in international conditions might easily upset this order, but for the present these are the definite indications. The information is circulated in the hope that it may be useful to the universities themselves and to prospective as well as present students.

Personals

News of the Personal Activities of members of the Institute, and visitors to Headquarters

Colonel W. M. Miller, M.E.I.C., Chief Signal Officer, British Troops in Egypt, has been made a Commander of the Order of the British Empire as a result of the operations in Egypt. The appointment was actually made a few months ago, but it was only last month that the good news reached the Institute. Col. Miller, who was born in Montreal, and educated at the Royal Military College, Kingston, was at one time Senior Engineer Officer of Military District No. 1.

F. B. Kilbourn, M.E.I.C., vice-president and assistant general manager of Canada Cement Company, Montreal, is the new steel controller, appointed recently by the Minister of Munitions and Supply. He has been with the Company since 1906, being appointed general superintendent in 1919.

N. F. McCaghey, M.E.I.C., has been elected as chairman of the Saguenay Branch of the Institute. It is his second election to this office as he acted as chairman of the same branch in 1933. He is with Price Brothers & Company, Limited, at Riverbend, Que., having joined this company upon his return from overseas in 1919.

Robert F. Ogilvy, M.E.I.C., is now employed with the Aluminum Company of Canada, Limited, and is located at St. Thomas, Virgin Islands of the United States. Graduated from McGill University in the class of 1925, he has since been engaged on several large construction projects. Lately he has been connected with the General Engineering Company Limited, of Toronto.

Recent changes have been made at the City Hall of Montreal which affect some of our members as follows:

J. G. Caron, M.E.I.C., has been appointed member of the new Board of Revision. He had been assistant director of public works for the past year, and previously, he had been for eight years, superintendent of the technical division of the Public Works Department. He has had about twenty-five years of service at the City Hall.

C. J. LeBlanc, M.E.I.C., has been appointed engineer attached to the office of the Director of Public Works. A graduate of the Ecole Polytechnique of the class of 1910, he has been with the city since 1912. His previous position was that of assistant director of public works.

H. A. Gibeau, M.E.I.C., has been appointed assistant director of public works. He was graduated in civil engineering from Rensselaer Polytehnic Institute. He has been with the city for several years having occupied the position of assistant chief engineer.

A. T. Hurter, M.E.I.C., has been transferred from the engineering department of Defence Industries Limited, where he acted as project engineer, to the Bouchard Works at Ste. Therese, Que., where he is in charge of production.

Geo. R. MacLeod, M.E.I.C., has received an appointment on the engineering staff of No. 3 Air Training Command, Royal Canadian Air Force, in Montreal. He had retired a few years ago from the service of the City of Montreal, where he had occupied, for several years, the position of assistant chief engineer. He is a past vice-president of the Institute and has served on many committees.

Walter L. Rice, M.E.I.C., formerly of Toronto, has accepted a position as senior assistant engineer with the Works and Buildings Branch, No. 3 Air Training Command, Royal Canadian Air Force, Montreal.

Léon A. Fraikin, M.E.I.C., went overseas last month in command of the second detachment of Belgian soldiers to go to England from their Canadian training centre at Joliette, Que. He had returned to Canada last summer after having served as a first lieutenant with the First Royal Belgium Regiment of Artillery during the campaign of Belgium.

He was graduated in civil engineering from the University of Ghent, Belgium, in 1929, and in 1931 received the degree of Master of Science from the Massachusetts Institute of Technology. From 1931 to 1935 he was employed as designing and field engineer with the Franki Compressed Pile Company Limited, in Belgium and Norway. From 1935 to 1937 he acted as consulting engineer to Messrs. Braithwaite, Burn & Jessop Construction Company at Calcutta, India. In 1937-1938 he was assistant to the chief engineer on the Mohammed Ali Barrages contract at Cairo, Egypt, for Macdonald, Gibbs and Company (Engineers), London, England. In 1938, he was appointed vice-president and general manager of the Franki Compressed Pile Company of Canada Limited at Montreal, a position which he occupied at the time of his enlistment.

Augustus Griffin, M.E.I.C.

N. F. McCaghey, M.E.I.C.

A. T. Hurter, M.E.I.C.

Augustus Griffin, M.E.I.C., has been appointed assistant manager of the Department of Natural Resources of the Canadian Pacific Railway Company, with headquarters at Calgary, Alta. He will continue his duties as chief engineer of the department, but will relinquish his functions as superintendent of the operation and maintenance of the Company's Western Section Irrigation Project.

Mr. Griffin has been in the service of the Company since 1918. He was born in Visalia, California. In 1906 he was graduated from the University of California with the degree of B.Sc. in civil engineering, specializing in irrigation. From 1906 to 1918 he supervised a number of irrigation projects in California, and in the latter year came to Canada as superintendent of operation and maintenance of the Canadian Pacific Railway's Eastern Section Irrigation Project at Brooks, Alta., where he remained until 1935. In 1932 he succeeded the late Mr. A. S. Dawson as chief engineer of the Department of Natural Resources. In 1935 his headquarters were moved to Strathmore, Alta., where he supervised the operation of the Company's Western Section Irrigation Project. He is a recognized authority on irrigation, both in Canada and the United States, and for two years he was chairman of the Irrigation Division of the American Society of Civil Engineers.

The Department of Natural Resources has under its jurisdiction the administration of the Company's lands, townsites, irrigation works, petroleum, gas and coal rights, and timber properties, and covers in a general way the natural resources of the Company in western Canada.

E. N. Ridley, M.E.I.C., canal superintendent of the Department of Natural Resources of the Canadian Pacific Railway Company, has been appointed superintendent of operation and maintenance, Western Section Irrigation Project, with headquarters at Strathmore, Alta.

Mr. Ridley was born at Belleville, Ont., and received his early education at the Collegiate Institute of Ottawa. After serving his apprenticeship with Henry A. F. MacLeod, consulting engineer, Ottawa, he entered the service of the Canadian Pacific Railway Company in 1902 as an instrument man. In 1907 he became an assistant engineer in the Department of Natural Resources of the Company and in 1914 he was made canal superintendent.

H. W. Lea, M.E.I.C., has joined the staff of the Wartime Bureau of Technical Personnel at Ottawa. His company, Canadian Telephones and Supplies, Limited, has given him six months leave of absence to render this service to the Government. Mr. Lea, who is a graduate of McGill University is district manager of his company in Montreal.

J. E. Dion, M.E.I.C., has joined the staff of Wartime Merchant Shipping Limited, at Montreal. For the past five years he had been plant superintendent of the Laurentian Laboratories Limited, Montreal. Previously he had been for several years with Montreal Engineering Company. He is a graduate in mechanical engineering of McGill University, in the class of 1926.

A. M. Bain, M.E.I.C., structural engineer with Dominion Bridge Company, Limited, Montreal, has been loaned to the Department of Munitions and Supply, and is acting as a technical assistant to Professor R. E. Jamieson, M.E.I.C., director general of the Army Engineering Design Branch.

E. L. Miles, M.E.I.C., is now acting as supervising engineer with the Royal Canadian Air Force at the Mont Joli Airport, Que.

H. M. Martin, Jr., M.E.I.C., has been transferred from the Sault Ste. Marie to the Toronto works of the Dominion Tar and Chemical Company, Limited. He was graduated in chemical engineering from McGill University in 1937.

Lawrence O. Cooper, M.E.I.C., has been promoted to Flight Lieutenant in the Royal Canadian Air Force, and he is now stationed at Ottawa.

Edward H. Beck, M.E.I.C., is now on the staff of E. G. M. Cape and Company, and is located at Botwood, Newfoundland. He was previously connected with the construction of the new National Research Council laboratories at Ottawa.

C. K. Hurst, M.E.I.C., has left the staff of the Water Works Department of the City of Edmonton, to accept a position on the hydraulic staff of the Canals Branch of the Department of Transport, Ottawa, Ont.

C. F. Davison, M.E.I.C., has been appointed resident engineer with Defence Industries Limited, Bouchard Works, Ste. Thérèse, Que. He was previously connected with Canadian Industries Limited at Windsor, Ont.

John L. Jomini, Jr.E.I.C., is now overseas with the 14th Canadian Field Regiment, R.C.A. He was previously connected with Consolidated Paper Corporation at Grand' Mère, Que.

C. G. Kauth, Jr.E.I.C., has been transferred from Toronto to the Montreal works of the Dominion Oxygen Company, Limited. He was graduated from Queens University in 1934, and has been with the company since 1935.

A. L. Denton, Jr.E.I.C., has joined the Royal Canadian Air Force and is stationed at Brandon, Man. He was previously employed with the Lamaque Mining Company, Limited, at Bourlamaque, Que.

J. R. Rettie, Jr.E.I.C., has recently been appointed district engineer of the Manitoba Department of Mines and Natural Resources at The Pas, Man. He was previously employed with the department at Winnipeg.

W. H. Sparks, jr.e.i.c., has joined the Royal Canadian Air Force and has been commissioned as a Pilot Officer. He is stationed at Montreal. Previously he was hydraulic engineer with the Water Rights Branch, Department of Lands, Victoria, B.C.

Lieutenant R. E. Kirkpatrick, s.e.i.c., has been recalled from overseas and is attached to the Inspection Board of the United Kingdom in Canada, at Ottawa.

A. T. Dougall, s.e.i.c., has joined the Royal Canadian Navy Volunteer Reserve. He was graduated in mechanical engineering from the University of Saskatchewan this spring.

Jean Flahault, Jr., s.e.i.c., is now employed with the Aluminum Company of Canada, Limited at Arvida, Que. Early in 1940 he had gone overseas to join the French Army. After going through the Battle of France in the spring of 1940, he was taken prisoner by the Germans, but later managed to escape. After a hazardous trip through occupied and unoccupied France and northern Africa, he finally succeeded in returning to Canada a few months ago.

Mr. Flahault is a graduate of the Ecole Polytechnique, of the class of 1938. He did some post graduate work in metallurgy at the Carnegie Institute of Technology at Pittsburgh, Pa.

W. F. Jarrett, s.e.i.c., who has been on the staff of the Saguenay Power Company at Arvida, Que., since last spring has been transferred recently to the Aluminum Company of Canada, Limited at Montreal.

Jean Lefort, s.e.i.c., has joined the staff of Stevenson and Kellogg, Limited, Management Engineers, Montreal. He was graduated in civil engineering from McGill University in 1936, and in 1939 he obtained the degree of Bachelor of Civil Law from the same University. Lately he had been connected with the Aluminum Company of Canada, Limited, Arvida, Que.

A. M. Swan, s.e.i.c., has been transferred from the Toronto office to the Apparatus Sales Department of the Canadian General Electric Company, Limited, at Hamilton, Ont.

Jules Mercier, s.e.i.c., has been transferred from the Test Department of Canadian General Electric Company, Limited, Peterborough, to the Meter Engineering Department as assistant engineer.

G. W. Moule, s.e.i.c., has been transferred to the Winnipeg plant of Defence Industries Limited. Since his graduation from the University of Manitoba in 1937, he had been with Canadian Industries Limited at Montreal.

Bertram Taylor, s.e.i.c., has received the degree of Bachelor of Science in Geological Engineering at the University of Saskatchewan this spring. He is now located at Siscoe, Que.

VISITORS TO HEADQUARTERS

J. M. Mercier, s.e.i.c., Canadian General Electric Company, Limited, Peterborough, Ont., on July 23rd.

H. C. Seely, m.e.i.c., Plant Engineer, East Malartic Mines Limited, Norrie, Que., on July 25th.

H. W. Furlong, m.e.i.c., Stone & Webster Engineering Corporation, Boston, Mass., on July 25th.

W. H. Malone, m.e.i.c., Smooth Rock Falls, Ont., on July 29th.

E. A. Allcut, m.e.i.c., Professor of Mechanical Engineering, University of Toronto, Toronto, Ont., on August 6th.

J. J. Freeland, m.e.i.c., Canadian International Paper Company, Limited, Temiskaming, Que., on August 7th.

A. L. Denton, jr.e.i.c., Lamaque Mining Company, Limited, Bourlamaque, Que., on August 12th.

C. R. Young, m.e.i.c., Dean of Engineering, University of Toronto, Toronto, Ont., on August 15th.

J. G. W. Campbell, m.e.i.c., Eastern Air Command, Headquarters, R.C.A.F., Halifax, N.S., on August 15th.

S. Hogg, m.e.i.c., St. John Dry Dock & Shipbuilding Company, Limited, St. John, N.B., on August 15th.

F. C. Read, s.e.i.c., Spruce Falls Power & Paper Company, Kapuskasing, Ont., on August 16th.

H. B. Stuart, m.e.i.c., Consulting Engineer, Toronto, Ont., on August 18th.

Donald Ross, m.e.i.c., The Foundation Company of Canada, Limited, Mont Laurier, Que., on August 18th.

Eugene Vinet, m.e.i.c., New York City, N.Y., on August 20th.

Obituaries

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Charles Hamilton Mitchell, m.e.i.c. Not long ago, at a funeral service in St. Paul's Church, Toronto, many leaders in university, professional and industrial circles, assembled to pay respect and express sorrow at the death of Charles Hamilton Mitchell, engineer, soldier and Dean Emeritus of the Faculty of Applied Science and Engineering in the University of Toronto.

The President of the University conducted the service. Dr. Cody spoke of the life, character and achievements of one whom he termed "a great Canadian, a public servant, and a true Christian soldier". Members of the Engineering Institute of Canada will desire to associate themselves with this sincere tribute to the memory of a Past President of the Institute, whose professional career as a practising engineer was followed by equally distinguished active service as a soldier, and then by twenty years at the head of the engineering faculty of a great university.

Charles Hamilton Mitchell, M.E.I.C.

General Mitchell was a "son of the manse," for he was born in a Methodist parsonage at Petrolia, Ontario. He graduated at the University of Toronto in 1894, taking the professional degree of C.E. in 1898.

His engineering practice, commenced shortly after graduation, was largely in hydraulic and hydro-electric power work. He was retained as consulting engineer in the design and construction of power plants in many parts of Canada, and for some years was consulting engineer to the Water Power Branch, Department of the Interior, Ottawa, on water power investigations and conservation in Western Canada. In 1920 he was a member of a Royal Commission to report on radial railways in Ontario, and acted as arbitrator as to power shortage at Niagara and the setting of power rates. In 1924 he was appointed by the Dominion Government to the Joint Board of Engineers (Canadian and from the United States) to study and report upon the St. Lawrence waterway project for navigation and power.

General Mitchell's military career dates from 1899 when he joined the Militia Service. At the outbreak of war in 1914 he was Divisional Intelligence Officer on the General Staff, 2nd Division, Toronto; after proceeding overseas, he won marked distinction in the Intelligence Branch of the General Staff in France, Belgium and Italy. In 1918 he was promoted Brigadier-General and served in 1919 at the War Office, London. During his five years' overseas service he was mentioned in despatches seven times, and received many honours, including the D.S.O. (1916), C.M.G. (1917), C.B. (1918); he was also awarded decorations by the French, Belgian and Italian governments.

Joining the Engineering Institute of Canada as a Student in 1894, he became Associate Member in 1898 and Member in 1902. His interest in Institute and professional affairs is shown by his services as member of Council during 1908-1909, as Vice-President from 1920-1923, and as President for the year 1929. In 1922-1923 he was President of the Association of Professional Engineers of Ontario. He was a Member of the Institution of Civil Engineers (London), of the American Society of Civil Engineers, and of many societies interested in professional, civic and national welfare.

At the time of his death, he was a director of Consumers' Gas Company of Toronto, the United States Fidelity and Guaranty Company of Canada, and the Canada Steamship Limited.

General Mitchell's connection with University administration began when he was elected to the Senate of Toronto University in 1901 to represent the graduates in Engineering. He served on the Board of Governors of the University from 1913 to 1919, and in July of that year was appointed Dean of the Faculty of Engineering. On his retirement from that post in March of this year, he was given a dinner by the alumni, at which he had the satisfaction of hearing what his twenty-one years as Dean had meant to his students and colleagues.

Always proud of his profession, he lost no opportunity of impressing upon the students and young engineers with whom he came in contact, the important place held by the engineer in the economic scheme of today. He was a loveable man with a great sense of humour and a genius for making friends. His devotion to duty was shown by the fact that since the fateful days of September, 1939, he had been doing special war work for the Department of National Defence. His last public appearance was on June 22nd when he took the salute of the University C.O.T.C. upon its return from camp. His death on August 26th, in his seventieth year, takes from us a figure whose remarkable personality and wise counsel will long be missed.

Walter Robert Benny, Jr.E.I.C., was accidentally drowned on June 8, 1941, at Black Bird River near Noslo Siding, about seventeen miles east of Schreiber, Ont., while examining the waterway structure at this point. He was born at White River, Ont., on January 3rd, 1909, the son of W. W. Benny, M.E.I.C., Division Engineer of the Canadian Pacific Railway Company, now retired and residing at Ottawa. Walter R. Benny received his early education at the Public Schools of Ottawa and at Glebe Collegiate Institute. Later he attended McGill University where he was graduated in 1932 with the degree of Bachelor of Engineering. During his University course, between sessions and for some time following graduation he was engaged on surveys as chainman and instrumentman with the Dominion Geological Survey Department, the Construction and Maintenance of Way Departments of the Canadian Pacific Railway Company, the Shawinigan Water & Power Company on transmission line location, the Temiskaming and Northern Ontario Railway extension to Moosonee, the construction of airports with Canada Airways and with the Ontario Department of Northern Development.

In October, 1935, he received a permanent appointment as transitman with the operating department of the Canadian Pacific Railway Company at Smiths Falls, Ont. In August, 1938, he was appointed assistant engineer in the office of

Walter Robert Benny, Jr.E.I.C.

the engineer of maintenance of way at Toronto, and in August, 1939, he was appointed division engineer of the Schreiber Division, at Schreiber, Ont., a position which he held at the time of his tragic death.

Mr. Benny joined the Institute as a Student in 1928, and he was transferred to Junior in 1936. At the time of his death he was a member of the executive of the Lakehead Branch.

William Lewis Reford Stewart, M.E.I.C., died suddenly in the hospital at Montreal on July 13th, 1941. He was born at Toronto on October 6th, 1900. He received his early education in the Toronto public schools and later attended St. Clement's College in Toronto and the Royal Military College at Kingston, where he was graduated in 1920. Upon graduation he went with Lockwood, Greene & Company, Industrial Engineers, as assistant to the resident engineer on various factory construction work. In 1921 and 1922 he worked as assistant resident engineer with Morrow & Beatty, Limited, Contracting Engineers, on the construction of the Twin Falls power development of the Abitibi Power and Paper Company. In 1923 he was engineer on building construction work for Robert Reford Steamship Company. In 1924 he came to Montreal as engineer with the Newton-Dakin Construction Company Limited, and was employed on the Metis Lakes storage dams contract. The following year he went to Sherbrooke, Que., as manager of the local office for the same firm. In 1927 he organized the Stewart Construction Company Limited, which progressed steadily under his able leadership. At the time of his death he was still managing director of the firm. Among the works which were successfully carried out by his company, under his direction, are the most important of the industrial, commercial, and educational buildings in the Eastern Townships. Lately his firm had carried out important defence work in the Maritime provinces.

Mr. Stewart joined the Institute as a Student in 1920, and he was transferred to Associate Member in 1928.

News of the Branches

Activities of the Twenty-five Branches of the Institute and abstracts of papers presented

LAKEHEAD BRANCH

H. M. Olsson, M.E.I.C. - - *Secretary-Treasurer*
W. C. Byers, Jr.E.I.C. - - *Branch News Editor*

The Lakehead Branch held their annual dinner meeting on May 21st in the Port Arthur Golf and Country Club, which was attended by forty-nine members and guests.

The chairman, Mr. H. G. O'Leary, presided at the meeting and presented his annual report. He stated that he had appreciated serving as Chairman and thanked all the committees and executive for their splendid work and co-operation which had made it possible to have the most successful year to date, and hoped that the incoming chairman and executive would have an even better year.

The nominating committee presented the following slate of officers for 1941-42: Chairman, B. A. Culpeper; Vice-Chairman, Miss E. M. G. MacGill; Executive, E. J. Davies, J. I. Carmichael, S. E. Flook, S. T. McCavour, R. B. Chandler, W. H. Small, W. R. Benny, C. D. Mackintosh; Ex-Officio, H. G. O'Leary; Secretary, W. C. Byers.

The outgoing chairman, Mr. H. G. O'Leary, welcomed the incoming officers and handed over the chairmanship to Mr. B. A. Culpeper, who expressed his appreciation for being appointed chairman.

The financial report showed a favourable credit balance and the various committees were given a vote of thanks.

The members and guests were then entertained with a game of "Bingo" and a "Quiz" Contest.

OTTAWA BRANCH

R. K. Odell, M.E.I.C. - *Secretary-Treasurer*

On invitation of Lieut.-Col. J. P. Richards, Officer Commanding the Royal Canadian Engineering Centre at the Petewawa Military Camp, a party consisting of members of the Ottawa Branch of The Engineering Institute and their ladies visited the camp on Sunday, August 17th.

It was one of the most successful events staged by the branch in a long time. The combination of perfect weather, a well prepared and interesting programme, hospitality and congeniality, made up a day that will be outstanding in Institute history. As would be expected in a military camp, every detail had been thought of and all arrangements were carried out with delightful precision. It was a real pleasure for civil engineers to see something of the work of military engineers.

A group of officers who accompanied the party. Second from left is Lieut.-Col. J. P. Richards.

After a buffet lunch at the Officers' Mess, the men of the party visited the bridging site on the Petewawa river, travelling from headquarters by way of the Dominion Forest Experiment Station at Corry Lake.

A most interesting demonstration was given by the engineers of the bridging of streams for infantry and heavy equipment; the bridging of a ravine for the passage of motor transport; the method of construction and operation of collapsible boats; and the carrying out of other engineering operations. On return to the camp a visit was paid to the trade-shops and the field works stores where a variety of engineering equipment was demonstrated. An opportunity was also afforded of seeing large field guns used by the artillery training centre.

Some of the party watching a demonstration of pontoon bridge building.

Ladies of the party visited the library, reading and writing rooms, recreation room, and the men's mess kitchen. In the evening, a regular meal, as provided for the men of the training centre, was served in the men's mess room—and a very satisfactory meal it was too! At the conclusion of this feature, the chairman of the branch expressed to Colonel Richards the thanks of the group for his hospitality and excellent arrangements. Colonel Richards modestly gave the credit to his staff, and invited the guests to visit the camp again.

Members of the Institute test out the "Kapok" assault bridge which has just been launched.

The method of bridging a ravine with steel box beams by the cantilever method is explained.

The beams in place after the demonstration.

The Engineering Institute of Canada, through its various branches throughout the Dominion, is assisting in obtaining trained engineers for military and civil work in connection with the war effort, in air raid precaution work, and in other ways. The visit to the Petewawa Engineering Centre afforded an opportunity for members of the Institute to obtain some first hand knowledge of engineering problems connected with modern warfare.

The party was headed by T. A. McElhanney, chairman of the branch, and K. M. Cameron, vice-president of the Institute from eastern Ontario. Unfortunately, at the last moment, President and Mrs. Mackenzie had to cancel the arrangements they had made to be with the party.

SAGUENAY BRANCH

D. S. Estabrooks - *Secretary-Treasurer*
J. P. Estabrook - *Branch News Editor*

On Friday, August 22nd, a meeting of the Branch was held in the Arvida School.

About 120 members and friends were present to hear an illustrated lecture on **Sub-surface Engineering.**

Chairman N. F. McCaghey, presided and introduced the speaker, Professor R. F. Legget of the University of Toronto, who is connected with the Shipshaw power development for the summer.

Professor Legget expressed his pleasure at having been chosen as speaker for two consecutive meetings. He began his talk by illustrating and explaining various formations of rock, some of which aid and others hinder the engineer in underground construction. Consequently, before undertaking any large construction where a solid foundation is required, it is necessary to find out what is under the ground.

He then illustrated how test drilling, coupled with the knowledge of geologists, was one of the best ways to get a cross section of the conditions to be encountered.

Professor Legget spoke for a short time on tunneling operations and described a unique way of excavating the material from the tunnel, which consisted of grinding up the removal material into a fine powder, after which it could be mixed with water and pumped to the surface.

Illustrations were given of several dams where huge quantities of silt and other fine materials had to be removed so as to get down to solid rock. At the Grand Coulee dam, the material to be excavated was so liquid that it kept running in as fast as it could be removed. The ingenious engineers installed a refrigeration system, after which excavation proceeded satisfactorily.

Another very interesting point was that of a bridge in India, one end of which had been repeatedly carried away by landslides. This obstacle was overcome by building a cantilever-type bridge and connecting it to the hazardous shore by means of a timber trestle. When an avalanche now occurs the wooden trestle is carried away without injuring the main portion of the bridge and can be easily replaced in a few hours.

Reference was also made to the new Shipshaw development where test drilling is now being carried out and where, among other things, old beds of the Saguenay River are found.

A vote of thanks was extended to Professor Legget at the conclusion of the meeting by Mr. S. J. Fisher and the hearty-hand-clap as well as the unusually large attendance attested the interest his talk had aroused.

THE NEED FOR FUEL

Consumption of gasoline and oil in Canada helps to win the war only where it serves war industry, and other industries that in turn support the war effort, army vehicles, training planes and naval craft.

If Canadians were wholly intent in their ambition to leave nothing undone that should be done to insure a Victory against Hitler, most of the balance of motor fuel stocks in Canada would be put at the disposal of the fighting forces overseas. If Canadians really understood just how precious motor fuel will be in the scheme of operations soon to be launched by the British Empire forces, they could not possibly use up gasoline and oil for pleasure purposes without great pangs of conscience.

In the British Isles, where motor car drivers are so close to military operations that they can see the urgent necessity for guarding the motor fuel supply, private motoring has become almost non-existent. On this continent we need only use a little more native intelligence to enable us to see the picture more as our compatriots across the seas do. Then Canada's gasoline consumption will really drop sharply.

Employment Service Bureau

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party. Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted upon request after a lapse of one month. All correspondence should be addressed to THE EMPLOYMENT SERVICE BUREAU, THE ENGINEERING INSTITUTE OF CANADA, 2050 Mansfield Street, Montreal.

SITUATIONS VACANT

EXPERIENCED MECHANICAL DESIGNING DRAUGHTSMAN for general mechanical work and industrial piping. Apply Box No. 2375-V.

EXPERIENCED ARCHITECTURAL DRAUGHTSMEN required by large industrial concern for their Montreal office. Apply Box No. 2376-V.

JUNIOR CHEMICAL OR METALLURGICAL ENGINEER for work in plant installation and operation. Required immediately. Apply Box No. 2400-V.

STRUCTURAL AND CONCRETE DRAUGHTSMEN for industrial plant design. Apply Box No. 2401-V.

JUNIOR MECHANICAL DRAUGHTSMAN with one to five years experience for work in South America. Apply Box No. 2402-V.

TIME AND MOTION STUDY: Opportunity for man who can prove his ability in setting of wage incentive standards, methods analysis, and plant layout. Give experience in detail. Address reply to Box No. 2439-V.

JUNIOR RESEARCH METALLURGIST required immediately, with one to five years experience. Apply Box No. 2440-V.

MECHANICAL GRADUATE ENGINEER, with machine shop experience, required for work in South America on important war contract. Apply Box No. 2441-V.

SITUATIONS WANTED

ELECTRICAL ENGINEER, B.Sc. in electrical engineering, age 43, married, available on two weeks notice. Fifteen years experience in electrical work. Including electrical installations of all kinds in hydro-electric plants and sub-stations. Maintenance and operation of hydro-electric plants. Electrical maintenance and installations in pulp and paper mill. Considerable experience on relays and meters. At present employed, but desires change. Apply Box No. 636-W.

GRADUATE ELECTRICAL ENGINEER, University of Toronto, five years experience drafting and design in connection with electrical instruments and small motors. Also experienced in design of small jigs and fixtures and general machine design. Desires permanent position. Apply to Box No. 1486-W.

GRADUATE CIVIL ENGINEER, M.E.I.C., 15 years engineering on this continent and five years overseas. Experienced in design and construction of dams, hydro-electric and industrial plants. Field engineer for construction on dams and transmission lines, considerable experience in concrete work. Desires position preferably as field engineer or construction superintendent. Apply Box No. 1527-W.

ELECTRICAL ENGINEER, Age 32 with the following experience—Eight years field work in general construction, supervision, estimating and ordering materials. At present employed in general construction but wants to enter the electrical field. Apply Box No. 1992-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, married. Two years city engineer, five years experience in highway work, including surveying, location, construction, estimating and inspection. Apply Box No. 2409-W.

Library Notes

Book notes, Additions to the Library of the Engineering Institute, Reviews of New Books and Publications

ADDITIONS TO THE LIBRARY

TECHNICAL BOOKS

Elementary Aerodynamics:

By D. C. M. Hume, Toronto, Isaac Pitman & Sons, 1941. 136 pp., 5½ x 8½ in., $1.50.

Engineering Descriptive Geometry and Drawing:

By. F. W. Bartlett and T. W. Johnson, New York, John Wiley & Sons, Inc., 1941. 572 pp., 6 x 9¼ in., $4.00.

Surge Phenomena, Seven Years' Research for the Central Electricity Board, 1933-1940:

London, British Electrical and Allied Industries Research Association, 1941. 426 pp., 8¾ x 11½ in., £2 10s.

REPORTS

Canada Department of Mines and Resources, Mines and Geology Branch, Geological Survey, Memoirs:

Pictou Coalfield, Nova Scotia; Palaeozoic Geology of the Brantford area, Ontario. Memoirs, 225, 226.

Canadian Engineering Standards Association, Specifications:

Standard specification for lead service pipe, waste pipe, traps, bends and accessories, B67-1941; Construction and test of flexible cords and fixture wires (including heater cords), C22.2-No. 49-1941.

Defence of Canada Regulations:

Defence of Canada regulations, Ottawa, 1941.

Hydro-Electric Power Commission of Ontario:

Thirty-third Annual report, 1940. Toronto, 1941.

United States Department of Commerce —Building Materials:

Structural properties of "Mu-Steel" prefabricated sheet-steel constructions for walls, partitions, floors, and roofs BMS67, Asphalt-prepared roll roofings and shingles, BMS70; Structural properties of "Precision-Built, Jr." prefabricated wood-frame wall construction, BMS72.

United States Department of the Interior Geological Survey Bulletins:

Spirit leveling in Texas, part 3, West-central, Texas, 1896-1938; Geology of the Upper Tetling river district Alaska; Spirit leveling in Michigan, 1896-1938; Manganese carbonate in the Batesville district Arkansas; Quicksilver deposits in San Luis Obispo county and south-western Monterey county, California; Geology and mineral resources of the Randolph quadrangle, Utah-Wyoming; Geophysical abstracts 102, July-September 1940; Mineral industry of Alaska in 1939; Tungsten resources of the Blue Wing district Lemhi County, Idaho; Some quicksilver prospects in adjacent parts of Nevada, California and Oregon. Nos. 883-C; 917-B; 919; 912-A; 922-R; 923; 925-C; 926-A; 931-A; 931-B.

United States Department of the Interior, Bureau of Mines, Bulletins:

Coal-mine accidents in the United States, 1938; Quarry accidents in the United States, 1939; Bulletins 437 and 438.

United States Department of the Interior, Bureau of Mines, Miners' Circular:

Barricading as a life-saving measure in connection with mine fires and explosions. Circular 42.

United States Department of the Interior, Bureau of Mines, Technical Papers:

Carbonizing properties and petrographic composition of upper freeport coal from Morgantown district, Monongalia county, W.Va., and of lower freeport coal from eastern Indiana county near Cambria county, Pa., Technical paper 621.

United States Department of the Interior, Geological Survey, Professional Paper:

Geology of the Kettleman hills oil field California, No. 195.

United States Department of the Interior, Geological Survey Water-Supply Papers:

Surface water supply of the United States 1939, part 2, South Atlantic slope and eastern gulf of Mexico basins; Part 4, St. Lawrence river basin; Part 6, Missouri river basin; Part 7, Lower Mississippi river basin; Part 8, Western Gulf of Mexico basins. Papers 872, 874, 876, 877 878.

PRELIMINARY NOTICE

of Applications for Admission and for Transfer

August 29th, 1941

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 at the October meeting.

L. Austin Wright General Secretary.

*The professional requirements are as follows:—

A 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 or 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 attainment 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

BARNES—HENRY JAMES, of London, Ont. Born at Windsor, Ont., Feb. 23rd, 1912; Educ.: 1932-33, extension dept. (arch'ture), Univ. of Southern California; at present studying I.C.S. course in civil engrg.; 1929-30 ap'tice dftsman., Watt & Blackwell; 1932-33, rodman, dting., O. Roy Kelly, Los Angeles; 1933-34, dftsman., Standard Oil California; 1936, store front design, Hobbs Glass Co., London, and Bennett Glass Co., Windsor, Ont.; 1936-37, dftsman., J. R. Boyd, Windsor, Ont.; 1939-40, barracks design and foreman of works, and from Nov., 1940, to date, engr. dftsman. for D.E.O., Mil. Dist. No. 1, London, Ont.

References: W. M. Veitch, H. L. Hayman, E. B. Allan, S. Shupe, F. C. Ball.

KLINE—JOSEPH DOUGLAS, of 107 St. Joseph St., Dorval, Que. Born at Halifax, N.S., Nov. 23rd, 1917; Educ.: B.Eng. (Civil), N.S. Tech. Coll., 1940; 1938-39 (summers), gravel and asphalt inspr., truck boss, Standard Paving Maritime Ltd.; May, 1940, to date, dftsman., Defence Industries Ltd., Montreal, Que.

References: F. H. Sexton, S. Ball, H. W. L. Doane, M. S. Macgillivray, C. P. Roper, R. W. McColough.

MABLE—WILFRED H., of 10 Carleton St., Thorold, Ont. Born at Thorold, Feb. 17th, 1916; Educ.: B. Sc., Queen's Univ., 1940; 1937-38-39 (summers), testman, Commonwealth Electric Corpn., Welland, lineman and operator, H.E.P.C. of Ont.; 1940-41, test engr., Can. Gen. Elec. Co. Ltd., Peterborough; June, 1941, to date, elec. design engr., H. G. Acres & Co. Ltd., Niagara Falls, Ont.

References: J. H. Ings, G. R. Langley, P. E. Buss, A. W. F. McQueen, D. S. Ellis.

NEAVE—ROGER, of Sarnia, Ont. Born at Macclesfield, Cheshire, England, June 21st, 1906; Educ.: B.Sc. (Elec.), Univ. of Man., 1935; 1930, dftsman., 1931, right-of-way office, C.P.R., 1933, chief of party, triangulation and mapping survey, B.C.; 1935, axeman, rodman, instr'man., on highway location, Ont. Dept. of Northern Development; 1935, dftsman. and Leveller, highways dept., Man. Govt.; 1936, gen. plant constrn., National Coke & Oil Co. Ltd., Erith, Kent, England; 1936-37, dftsman-designer, high frequency transmission laboratory, Standard Telephones and Cables Ltd., N. Woolwich, London, England; 1937 to date, designing engr., gen. engrg. dept., Imperial Oil Limited, Sarnia, Ont.

References: T. Montgomery, C. E. Carson, N. M. Hall, E. P. Fetherstonhaugh, G. H. Herriot.

PADLEY—GILBERT, of Point-a-Pierre, Trinidad, B.W.I. Born at Kamsack, Sask., Feb. 6th, 1914; Educ.: B.Sc. (Elec.), Queen's Univ., 1937; 1937-39, ap'ticeship in engrg., and 1939-40, correspondent, Canadian Westinghouse Co. Ltd., Hamilton, Ont. Sept., 1940, to date, asst. elec. engr., Trinidad Leaseholds Limited, Oil Refinery, at Point-a-Pierre, Trinidad.

References: D. M. Jemmett, L. T. Rutledge, G. M. Bayne, W. E. Weatherbie, D. S. Ellis, J. M. Bloomfield.

FOR TRANSFER FROM JUNIOR

NATHANSON—MAX, of 48 Joyce Ave., Outremont, Que. Born at Balta, Russia, March 7th, 1905; Educ.: B.Sc., McGill Univ., 1926; 1926-27, dfting., Darling Bros. Ltd.; 1927-29, dfting., Monarch Electric Co. Ltd.; 1929-31, dfting. and design, Canadian Westinghouse Co. Ltd.; 1931-32, dfting. and design, and 1932-34, also Maritime representative, English Electric Co. Ltd.; 1934-41, gen. mgr. and chief engr., Canadian Armature Works, Montreal, Que. (St. 1925, Jr. 1929).

References: H. W. Fairlie, G. Morrison, E. E. Orlando, J. M. Robertson.

FOR TRANSFER FROM STUDENT

COOPER—WILLIAM EVERETT, of Arvida, Que. Born at Assiniboia, Sask., May 5th, 1914; Educ.: B.Eng. (Elec.), McGill Univ., 1935; R.P.E. Que.; 1935-38, dfting., gen. engrg., 1938-41, i/c elec. engrg. work, mostly design and layout, ordering material, etc., and at present, i/c of engrg., Saguenay Power Company, Arvida, Que. (St. 1935).

References: F. L. Lawton, McN. DuBose, C. Miller, J. E. Thicke, J. R. Hango, M. G. Saunders.

GILES—JOHN OSCAR, of 111 Kathleen Ave., Sarnia, Ont. Born at Sarnia, Aug. 9th, 1914; Educ.: B.Sc. (Mech.), Queen's Univ., 1937; 1937-41, with Imperial Oil Limited, Sarnia, control instrument dept., gen. plant experience, engrg. drawing office; from Sept., 1941, junior engr., International Petroleum Co., Talara, Peru. (St. 1937.)

References: C. E. Carson, T. Montgomery, G. L. Macpherson, J. W. MacDonald, G. E. Medlar, J. A. Vance.

HARDING—CHARLES MALCOLM of Calgary, Alta. Born at Dauphin, Man., Dec. 10th, 1912; Educ.: B.Sc. (Elec.), Univ. of Alta., 1936; 1935 (summer), electrn., Guy Morton Co., Calgary; with Imperial Oil Ltd., Calgary, 1936-37, dftsman., 1937, meterman and material checker, 1937-40, estimator and checker, 1940, process control engr.; Sept., 1940, to date, elec. engr., Calgary Power Co. Ltd., Calgary, Alta. (St. 1936.)

References: R. W. Dunlop, J. J. Hanna, H. Randle, F. C. Tempest, J. McMillan.

MACKAY—WILLIAM BRYDON FRASER, of 820 Wellington Crescent, Winnipeg, Man. Born at Winnipeg, May 21st, 1914; Educ.: B.Sc. (E.E.), Univ. of Man., 1938; B.Met.E., Univ. of Minn., 1940; June, 1940, to date, with the R.C.A.F. (Aeronautical Engineering Branch), at present, Flight-Lieut., O.C. Maintenance Flight at No. 1 Air Navigation School, Rivers, Man. (St. 1936.)

References: W. F. Riddell, P. G. McAra, J. W. Lucas, G. M. Minard, J. Gilchrist.

STRONG—ROBERT L., of 184 High St., Boston, Mass. Born at Perth, Ont., Oct. 12th, 1908; Educ.: B.A.Sc., Univ. of Toronto, 1931; S.B., Mass. Inst. Tech., 1932; 1932-34, research asst., McGill Univ.; 1934-41, with Canadian Industries Limited, 1934-35, testing and plant development, 1935-39, research engr., 1939-41, asst. to the commercial manager; August, 1941, inspection work, Associated Factory Mutual Fire Insurance Companies, Boston, Mass. (St. 1932.)

References: C. H. Jackson, A. T. E. Smith, C. A. Peachey, C. E. Hogarth, L. A. Duchastel.

TAYLOR—JAMES LAWRENCE, of London, England. Born at Clare, Ireland, Jan. 19th, 1909; Educ.: B.Sc. (Elec.), Queen's Univ., 1936; 1936-38, student ap'tice, shops, switchgear erection, and technical and research dept., and 1938-39, sales office staff, A. Reyrolle & Co., Hebburn-on-Tyne, England; March, 1939, to date; asst. shift engr. at Willesden generating station (capacity 110,000 kws., staff 269), for London Power Company. (St. 1934.)

References: H. W. McKiel, F. L. West, D. M. Jemmett. D. S. Ellis, H. H. Lawson.

YOUNG—WILLIAM RICHARD, of St. John's, Nfld. Born at Rolla, N.D., U.S.A., Sept. 10th, 1905; Educ.: B.Sc. (Civil), Univ. of Man., 1928; 1923-25 (summers), asst. on various surveys, McColl Bros., Winnipeg; 1925-26, instr'man., Manitoba Paper Co. Ltd., Pine Falls, Man.; 1927 (summer), field engr., Manitoba Power Co. Ltd., Winnipeg; 1928-30, hydrographic engr., Candn. Hydrographic Service, Dept. of Marine; 1930-31, dftsman. and survey engr., Power Corpn. of Canada, Montreal; 1932, asst. town engr., Town of Temiskaming and Candn. International Paper Co. Ltd.; 1934 (7 mos.), instr'man., Power Corpn. of Canada; 1934-36, labour foreman, Lamaque Gold Mines Ltd.; 1936, mine engr., Thompson Cadillac Mining Corpn.; 1936-37, res. mgr., Bouscadillac Gold Mines Ltd., Kewagama, Que.; 1937-41, mine mgr., Cline Lake Gold Mines Ltd., Lochalsh, Ont.; August, 1941, engr., E. G. M. Cape & Co. Ltd., St. John's, Nfld. (St. 1924.)

References: G. B. McColl, M. W. Turner, R. N. Coke, H. S. Grove, H. L. Mahaffy, A. K. Grimmer, J. G. Dickenson.

Industrial News

Industrial development — new products — changes in personnel — special events — trade literature

CHAIN SAWS

Reed-Prentice (B.C.) Ltd., Vancouver. B.C., have featured in a four-page folder the "Timberhog" chain saws. The folder contains illustrations, descriptions and specifications of the gasoline, electric, and air driven saws. Several actual photographs are also included.

ELEVATING TABLE TRUCKS

The "Lyon" line of material handling equipment featuring trucks with hydraulic elevating tables is thoroughly illustrated and described in a six-page folder by the Lyon Iron Works, Greene, N.Y. Details of standard equipment and application are included together with specifications.

ELECTRICAL CONTROLS FOR CHEMICAL FEEDERS

"Cochrane Electrical Controls for Proportional Chemical Feeders for Water Conditioning Equipments" is the title of a 6-page publication, No. 3015, issued by Cochrane Corp., Philadelphia, Pa. It features a number of control panels upon which the Cochrane Flow Meters are mounted along with other controls such as time-cycle relays, program-controllers, pH controllers, etc., with brief descriptions of the service performed.

TRUCK BODIES

A 4-page folder, issued by The Wilson Motor Bodies Ltd., Toronto, Ont., entitled "Galion Allsteel Hydraulic Hoists and Bodies," illustrates various "Galion" allsteel body types equipped with "Galion" hydraulic hoists.

HIGH CARBON—HIGH CHROME DIE STEEL

An 8-page bulletin No. 341, entitled "Jessop 3C High Carbon—High Chrome Die Steel" is being distributed by Jessop Steel Co. Ltd., Toronto, Ont. This is an oil hardening alloy steel possessing extreme resistance to wear, nondeforming qualities and improved machinability, for use where long runs per grind of die are desirable. In addition to outlining its uses, details of its qualities are given under the headings "Forging, Annealing, Hardening and Tempering."

INSULATING PAD FOR DISTRIBUTION CABLE SPLICING

A 4-page bulletin No. 6017, which is a reprint of an article from "Electrical World," March 8th, 1941, entitled "New Form of Insulation Simplifies Splicing," by C. P. Xenis and F. B. Thomson, of Consolidated Edison Company, New York, Inc., is being distributed by Canadian Line Materials Ltd., Toronto, Ont. Describes this new form of insulation manufactured by Burndy Engineering Co. Inc., New York, N.Y., and distributed by Canadian Line Materials Limited, Toronto, Ont. This is a new form of multi-layer rubber insulation called the "insulating pad" which is a unitary piece of insulation composed of three distinct layers of rubber each subjected to different degrees of curing during manufacture. The reprint contains a complete description with illustrations showing the composition of the "pad" and step-by-step procedure for applying a pad to a straight joint.

UNIT AIR CONDITIONER

With descriptive matter, specifications, drawings and illustrations, a leaflet, No. C-1100-S23A issued by the Carbondale Div. of Worthington Pump & Machinery Corp., Harrison, N.J., describes what the Company terms "A Complete Air Conditioner System in one Package," which, it is stated, provides air conditioning in its most economical and perfect form for the store, office, shop or any other limited space. These combined units are completely factory built, tested and made ready to install before shipment.

ROTARY PUMPS

Worthington Pump & Machinery Corp., Harrison, N.J., have issued a 12-page bulletin, W-483-B1, which contains descriptive data, specifications, tables of sizes and ratings and lists of applications covering seven types of rotary pumps with double-helical gears. Photographic illustrations and sectional drawings are included.

SMOKE CONTROL EQUIPMENT

Under the title "Rehtron Electric-Eye Smoke Control Robot," the Rehtron Corporation, Chicago, Ill., have issued a 4-page bulletin which contains illustrated descriptions of two models of this equipment which continuously indicates the density of smoke in breeching or stack, signals fireman when density exceeds predetermined limit and automatically controls the supply of steam and air for over-fire injection.

TOOL STEEL

Devoted to the description of "Jessop Rapid Finishing Tool Steel," a semi-high speed, tungsten-bearing tool steel especially suitable for rapid finishing cuts where a smooth, accurate surface is desired, a 4-page bulletin, No. 541 has been issued by Jessop Steel Co. Ltd., Toronto, Ont.

AUTOMATIC VOLTAGE REGULATORS

Ferranti Electric Limited, Mount Dennis, Toronto, 9, Ont., has issued a bulletin, No. 397, which, in addition to numerous illustrations, contains a lot of valuable information on the subject of voltage regulation. It features Ferranti Step-Voltage Regulators and deals with the value of "good voltage" from a revenue standpoint, and outlines a number of voltage problems that arise.

BULK CONVEYOR SYSTEM

Book, No. 1975, published by Link-Belt Limited, Toronto, describes, with numerous illustrations, the "Link-Belt Bulk-Flo Conveyors," a distinctly new power-operated conveyor system for the positive and continuous conveying of flowable granular, crushed, ground or pulverized material of a non-corrosive, non-abrasive nature. Construction features, typical arrangements, list of typical materials conveyed, tables of sizes, capacities and dimensions and installation photographs are included.

FLOW METERS

Cochrane Corporation, Philadelphia, Pa., has issued a new 52-page handbook on Flow Meters. Originating as a catalogue, "Flow Meters by Cochrane" has developed into a handbook of instrument application to steam, water, air, gas, and viscous, volatile and corrosive fluid measurement. Important operating details are given on ten different types of instruments. Construction features of the friction-free electric flow meter and the high-torque mechanical flow meters are explained. The importance of flow records in the efficient operation of boiler and turbine rooms and various process departments is stressed. Control applications, dual range recorders, detached instruments and summation meters are also featured.

LIST OF CURRENT PUBLICATIONS

"Current Publications for Production Men, Designing Engineers, Metallurgists," issued by The International Nickel Company of Canada Limited, Toronto, is an up-to-date list of the Company's publications on ferrous nickle alloys and nickel brasses, and bronzes, arranged for easy reference, with descriptive notes of the contents of each publication. A reply paid mailing sheet is attached to check any publications desired.

FOR USERS OF PIPE MILL PRODUCTS

Canadian Tube and Steel Products, Limited, Montreal, Que., Page-Hersey Tubes, Limited, Toronto, Ont., and The Steel Company of Canada Limited, Montreal, Que., jointly have issued a pamphlet emphasizing the importance of conserving non-ferrous metals to meet essential war requirements and requesting the co-operation of users of pipe mill products by making certain that "galvanized pipe" is used only where it is absolutely essential.

TREE EMULSION

"Braco" Tree Emulsion is featured in a folder published by Brantford Roofing Co. Ltd., Brantford, Ont. This emulsion is a waterproof surgical dressing for trees when pruning and grafting. Discusses the structure of trees, reasons and methods of pruning, and treatment of tree wounds.

PATCHING CONCRETE FLOORS

Seven steps in the process of patching concrete floors by the use of "Braco" Floor Mastic N-13-F are described in a folder of Brantford Roofing Co. Ltd., Brantford, Ont. The description includes preparing and priming the surface, preparing and mixing the Mastic mixture, placing the Mastic, troweling and finishing.

POWER ASSEMBLY TOOLS

Black & Decker Mfg. Co. Ltd., Toronto, Ont., has published a 56-page handbook entitled "Black & Decker Data Book on Power Assembly Tools, Portable Electric Screw Drivers, Nut Runners and Tappers." Thoroughly illustrated with large size reproductions of the various tools, descriptive and dimensional drawings, and action photographs, this handbook contains complete descriptive information, specifications and other useful technical and tabular data of value to the users of these tools.

VARIABLE VOLTAGE PLANER DRIVE

Bulletin H-7050, of Canadian Westinghouse Co. Ltd., Hamilton, Ont., describes in detail the company's variable voltage planer drive. Sections deal with the principle of the drive; the resulting increase in production due to its use; features of design, and the economics of this type of planer drive. Ample illustrations are included.

THE ENGINEERING JOURNAL

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"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public."

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THE FORGEABILITY OF METALS

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Paper presented before a joint meeting of the Niagara Peninsula Branch of the Engineering Institute of Canada and the Ontario Chapter of the American Society for Metals, at St. Catharines, Ont., on May 16th, 1941.

SUMMARY—**A recapitulation of experimental work on forgeability of metals with reference to properties of materials, technique required and results obtained in die-forging and in free-forging. The author refers to methods necessary for the forging of light alloys as well as steel and copper, and concludes with an example in detail of an eccentric cam produced in steel and in aluminum alloy of medium forgeability with an estimate of comparative cost of manufacture.**

In the author's opinion, the words "forgeability" and "malleability" are synonymous. Malleability has been defined as "the property which permits a metal to be hammered or pressed into shape without cracking." In this definition the word "forgeability" could be substituted for the word "malleability." However, there might be some justification for the argument that malleability connotes hammering or pressing at room temperature or temperatures not far removed from room temperature, while forgeability connotes hammering or pressing at elevated temperatures—temperatures above dull red heat.

The subject of forgeability or malleability has interested the author for a number of years, during which time he has conducted numerous experiments, the results of which have been published in a series of papers. The first of these appeared in 1924. It dealt with the effects of the critical points in iron and steel upon their forgeability and showed clearly that these points had an important influence in this connection.

Earlier work along these lines was done by Robin, a French scientist, who, in 1910, presented a thesis to the Iron and Steel Institute on "The Resistance of Steels to Crushing," This appeared in the *Carnegie Scholarship Memoirs* for that year. Robin conducted tests on a number of alloys, both ferrous and non-ferrous, at temperatures which ranged from −300 deg. F. to 2010 deg. F. From the results of these tests he was able to estimate the energy required to reduce "normal" cylinders (cylinders whose

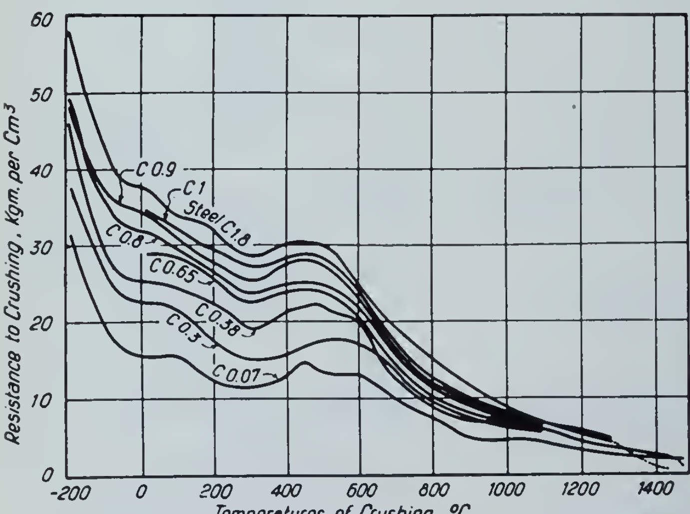

Fig. 1—Resistance of carbon steels to crushing.

heights and diameters are equal) of these alloys by 20 per cent of their initial height. He plotted curves showing the relationship between temperature and resistance to crushing, of which those shown in Fig. 1 are representative. These refer to a series of straight carbon steels and bring out clearly the well-known fact that the higher the carbon content of a steel the greater is its resistance to crushing or, in other words, the less is its forgeability, other things being equal.

In his experiments the author has used a small drop hammer, the tup of which weighs about 113 lb. Various methods of heating the samples have been employed, according to the place where the tests have been conducted and the temperatures to which the samples have been heated. Small changes in the weight of the tup can be produced by means of small lead weights.

The height of drop of the tup can be varied at will. The tup is allowed to fall freely, once it has been raised to the desired height for a given experiment. Every precaution is taken to ensure the free fall of the tup and care is exercised at all times to forge the test samples as quickly as possible after their removal from the furnace.

The essential features of the test are shown in Fig. 2. Herein is shown a normal sample in place on the anvil with the hammer descending. The height h_1, of the sample is known. After forging, the height, h_2, of the sample is measured. The difference, $h_1 - h_2$, divided by h_1 and multiplied by 100, is referred to as the *percentage reduction in height* of the sample and is the value generally reported as the result of such tests as these.

The results of a long series of tests on a straight carbon steel containing 0.4 per cent of carbon are shown in Fig. 3. Here are six curves relating energy of blow to percentage reduction in height of a number of normal half-inch samples.

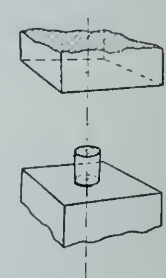

Fig. 2—Diagram of conditions of single-blow drop test.

If, in this case, we consider the energy required to cause a 55 per cent reduction in height of a normal half-inch sample of this steel, it will be seen that this decreases, as the temperature is raised, from about 470 ft.-lb. at 847 deg. C. (1558 deg. F.) to about 370 ft.-lb. at 927 deg. C. (1710 deg. F.) and then to about 310 ft.-lb. at 1010 deg. C. (1850 deg. F.).

For a blow of given energy the percentage reduction in height of a normal sample of this SAE 1040 steel increases *more or less* uniformly with increase in temperature. For example, with a blow of 400 ft.-lb. at the following temperatures the following approximate reductions in height were obtained with this steel:—

Temperature deg. C.	*Reduction per cent.*
584	31
674	37
754	44
847	52
927	58
1010	62

Percentage reduction in height does not increase *quite* uniformly with temperature, as would be discovered if the above results were plotted, since the critical points have an

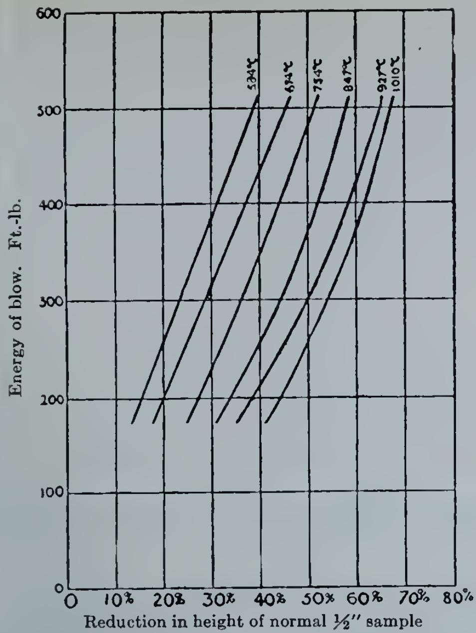

Fig. 3—Relation between reduction of height and energy of blow at different temperatures (0.4% C. steel)

important effect upon the properties of steel. This will be shown in some of the later illustrations. The influence of the A3 point on practically pure iron is particularly marked, as is demonstrated in Fig. 4, which shows the forgeability-temperature relationship of pure iron over the range 900-950 deg. C. (1652-1742 deg. F.), within which lies the A3 point, shown to be in the vicinity of 915 deg. C. (1679 deg. F.) in this particular series of tests. It will be seen that pure iron is actually more resistant to plastic deformation at temperatures just above the A3 point than at the A3 point itself. In fact, it does not become as forgeable as it is at the A3 point until it has been heated at least another 45 deg. C. (81 deg. F.) higher.

Groups of curves, like those in Fig. 3 have certain important characteristics which may now be referred to. For all practical purposes these curves can all be represented by equations of the simple form

$$E = bD^n$$

where E represents the energy in foot-pounds required to produce a percentage reduction in height D of a sample. What is rather more surprising is that the constants b and

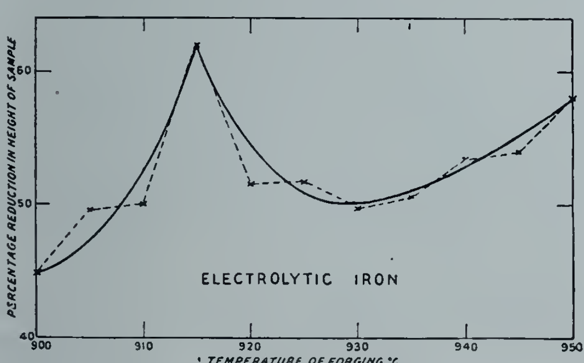

Fig. 4—Relation between forgeability and temperature for electrolytic iron.

n in this equation are related one to the other, in the case of *normal half-inch samples*, by the simple formula

$$n = 1.56 - 0.47 \log b$$

so that the equation

$$E = bD^{1.56 - 0.47 \log b}$$

gives the energy required to produce any percentage reduction of a sample if we know the energy needed to produce any one percentage deformation, say, of 30 per cent.

This equation applies not only to steel, but also to copper, nickel, lead and probably aluminum. And furthermore, it can be used in connection with samples of shapes other than normal cylinders; shapes, for example, such as cones or frusta.

Main, an English metallurgist, when discussing the paper in which the author first brought forward this equation, pointed out that it could be re-written in the form

$$3.32 - \log E = a\ (2.13 - \log D)$$

where

$$a = 1.56 — 0.47 \log b$$

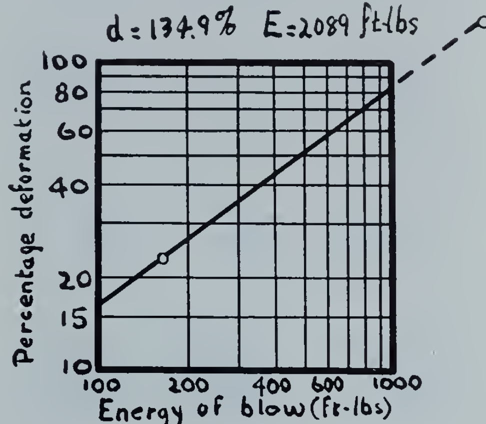

Fig. 5—Fundamental diagram of energy and percentage deformation for half-inch samples.

Now, it can readily be seen that, when $\log D = 2.13$, the right hand side of the new equation becomes zero, so that

$$3.32 - \log E = 0$$

$$\text{or} \quad \log E = 3.32$$

Hence, when $\log D = 2.13$ or $D = 134.9$ per cent, $\log E = 3.32$ or $E = 2089$ ft.-lb.

It is manifestly impossible to reduce the height of a sample, no matter what its form, by 134.9 per cent, so that the conditions described above are imaginary only. But, given this information, such a graph can be drawn as that in Fig. 5, which is one of the innumerable straight lines which could be drawn through the point corresponding to $D = 134.9$ per cent and $E = 2089$ ft.-lb. In this figure percentage reduction is plotted on logarithm paper against energy of blow. Suppose now that a few experiments on a single-blow drop test machine have proved that a blow of 170 ft.-lb. will produce a percentage deformation of 23 in a normal half-inch sample of steel of known volume at 1850 deg. F., all that is necessary to find out the energy required

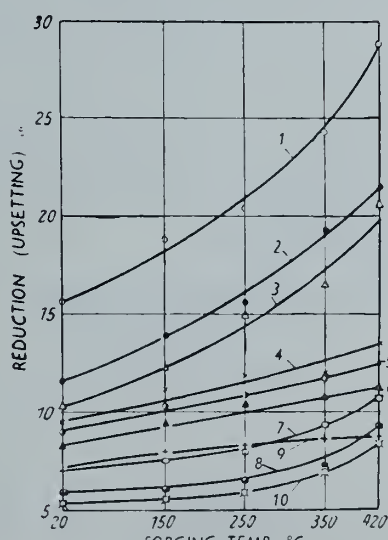

Fig. 6—Forgeability of representative aluminum alloys at different temperatures.

to produce other percentage deformations in samples of the same material having the same size and shape and formed at the same temperature is to join the point in Fig. 5 corresponding to $E=170$ and $D=23$ to the point corresponding to $E=2089$ and $D=134.9$ by a straight line and the points on the straight line so obtained will provide all

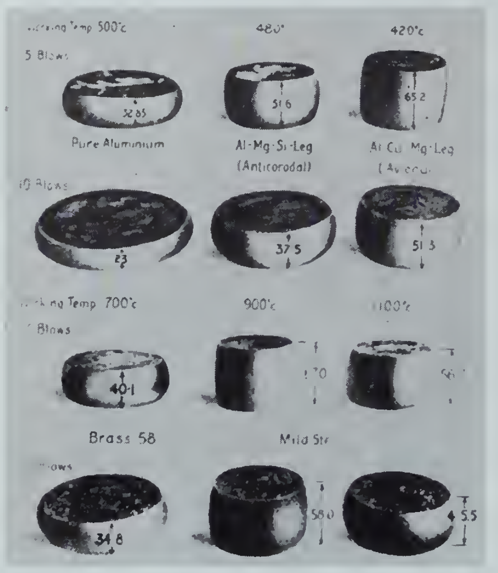

Fig. 7—Representative specimens subjected to plastic deformation.

the desired information. For example, to produce a percentage deformation of 70 per cent a blow of 800 ft.-lb. would be required, and so on. As already pointed out, these equations apply to normal ½-inch samples only, by which are meant cylinders, cones or frusta, ½ inch high and having a volume equal to that of a normal half-inch cylinder. It is possible that the formula applies as well to other shapes of height and volume equal to normal half-inch cylinders, but the author has not checked this point.

There is a well-known law known as Tresca's theorem which states that the amount of energy required to produce analogous changes of shape in geometrically similar bodies is proportional to the volumes or weights of the bodies concerned. Now what may be called the fundamental diagram (Fig. 5) for normal half-inch samples can be usefully employed in estimating the energy required to deform smaller or larger samples. How does this work ? Suppose it is desired to know roughly how much energy would be needed to reduce a normal *three*-inch cylinder of steel by 70 per cent of its height in a single blow at a temperature of 1850 deg. F. We have already found by experiment that 170 ft.-lb. of energy will reduce the height of a normal half-inch cylinder of this steel by 23 per cent and, using the fundamental graph, have discovered that 800 ft.-lb. are needed to reduce a normal half-inch cylinder of the same steel by 70 per cent at the same temperature. According to Tresca's theorem the energy required to reduce a normal three-inch cylinder of the same steel at the same temperature would be

$$\frac{800 \text{ x volume of 3-inch cylinder}}{\text{volume of } 1/2\text{-inch cylinder}}$$

$$= \frac{800 \text{ x } \frac{\pi (3)^2}{4} \text{ x } 3}{\frac{\pi (1/2)^2}{4} \text{ x } 1/2}$$

$$= \frac{800 \text{ x } (3)^3}{(1/2)^3}$$

$$= 800 \text{ x } 9 \text{ x } 8$$

$$= 57{,}600 \text{ ft.-lb.}$$

It is not likely that the result thus obtained will be mathematically exact. The order of magnitude, however, will be correct.

Comparison with some actual figures may be of interest. In a paper by Zeerleder, published in 1937, he reproduced the series of curves which are given in Fig. 6. Consideration of curve 5 in this graph shows that the aluminum-copper-magnesium alloy Avional D is reduced about 15 per cent in height at a temperature of 420 deg. C. (770 deg. F.)

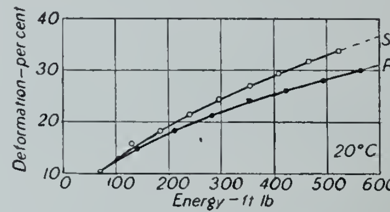

Fig. 8—Energy and deformation in single and repeated-blow drop tests at 20° C.

under a single blow of 70 ft.-lb., this having been the energy of the blow used in all the experiments referred to in this graph. The samples in these experiments were normal 20 mm. cylinders. It is somewhat remarkable that the point corresponding to $E=79$ and $d=15$ lies very close to, if not on, the straight line which was drawn in the fundamental diagram for half-inch normal samples (Fig. 5), from which one might guess, but only guess, that the energy of the single blow required to reduce a normal 20 mm. (0.79 inch) cylinder of Avional D by about 18.5 per cent would be about 120 ft.-lb. In Fig. 1 of Zeerleder's paper, here reproduced as Fig. 7, he shows that a normal 80 mm. (3.15 inch) cylinder of Avional D is reduced $\frac{80.0-65.2}{80}$ x $100 = 18\frac{1}{2}$ per cent by five blows of 1950 ft.-lb. capacity. Our very rough estimate of the energy of the single blow required to reduce such an 80 mm. cylinder would be

$$\frac{120 \text{ x } 80 \text{ x } 80 \text{ x } 80}{20 \text{ x } 20 \text{ x } 20}$$

$$= 120 \text{ x } 64 = 7{,}680 \text{ ft.-lb.}$$

The *actual* energy absorbed in reducing the cylinder in *five* blows was 5 x 1950 = 9750 ft.-lb.

In this same figure he shows that a similar cylinder of

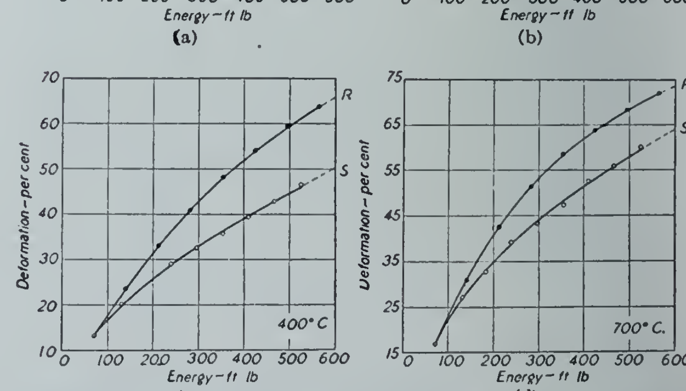

Fig. 9—Energy and deformation in single and repeated-blow drop tests at 250°, 300°, 400° and 700° C.

Avional D is reduced $\frac{80.0-51.3}{80.0}$ x 100 = 36 per cent by *ten* blows each of 1950 ft.-lb. Reference to the fundamental graph shows that a single blow of 310 ft.-lb. would reduce a 20 mm. cylinder of Avional D by 36 per cent of its height. Our estimate of the energy of a single blow required to reduce an 80 mm. cylinder of Avional D would then be

$$310 \times 64 = 19{,}840 \text{ ft.-lb.}$$

The *actual* energy absorbed in reducing the 80 mm. cylinder in *ten* blows was

$$10 \times 1950 = 19{,}500 \text{ ft.-lb.}$$

The author would be the last person to place too much stress on the fact that these estimates lie as close as they do to the experimental results, because he is well aware that, when metals or alloys are forged at temperatures at which the hardening effects of plastic deformation are immediately effaced by recrystallization, the energy absorbed in their deformation by a single blow may be considerably greater than that absorbed in producing the same deformation by a number of blows. Further, it must also be remembered that the fundamental diagram of Fig. 5 applies to normal half-inch samples, and not, as far as is known at present, to normal 0.79-inch samples.

Thus it might be expected that the estimates of the energy required to deform Avional D with a single blow would have yielded results somewhat higher than those

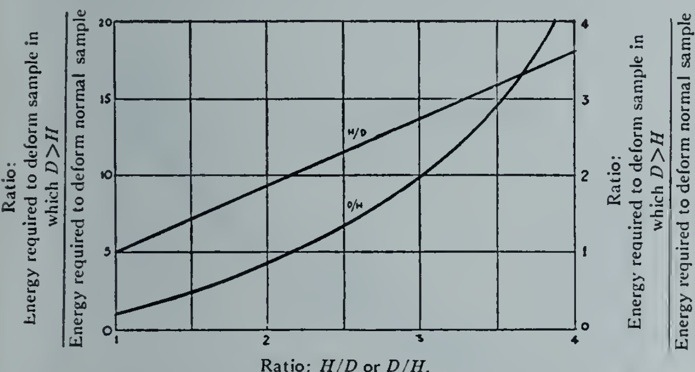

Fig. 10—Curves for estimating energy required for cylindrical samples whose heights are greater or less than their diameters.

obtained in Zeerleder's experiments with a number of blows. This may be illustrated by means of the two following diagrams which show the results of single and multiple-blow drop tests on normal three-quarter-inch cylinders of annealed copper having a Brinell hardness at room temperature of 11.5. Figure 8 comprises two curves, one showing the relationship between deformation and the energy of single blows of varying energy content (curve S) and the other showing the relationship between deformation and the total energy of repeated blows of equal energy content, viz., 70.6 ft.-lb. (curve R). All the tests were made at room temperature. A comparison of curves S (single) and R (repeated) brings out the interesting fact that, at room temperature, more energy is absorbed in forging a sample of copper in a number of blows than in a single blow or, conversely, a greater change in shape is produced by a single blow of given energy than is produced by a number of blows of the same total energy.

Similar pairs of curves could be drawn for the results of tests at 100 deg. C. (212 deg. F.) and 150 deg. C. (302 deg. F.). However, the curves for the tests at 150 deg. C. (302 deg. F.) lie very close together, though they do not coincide.

Curves for the tests at 200 deg. C. (392 deg. F.) are particularly interesting because they coincide in those parts which refer to the tests with blows of low energy (up to about 300 ft.-lb.), but separate in those parts referring to the tests with blows of higher energy. As is well known, the greater the degree of plastic deformation the lower is the

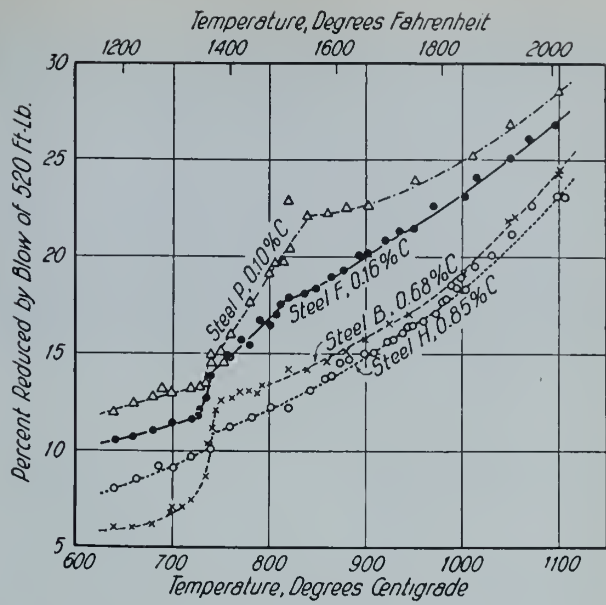

Fig. 11—Effect of carbon on forgeability of carbon steels.

temperature of recrystallization, and, since blows of high energy produce more flow than blows of low energy, it is not surprising that the curves for single and repeated blows do not coincide over their entire lengths, but tend to separate in those parts which refer to high degrees of plastic deformation or energies of blow. Curves for forging temperatures of 250 deg. C. (482 deg. F.), 300 deg. C. (572 deg. F.), 400 deg. C. (752 deg. F.), and 700 deg. C. (1292 deg. F.), which demonstrate the points just discussed, are shown in Fig. 9.

At forging temperatures of 400 deg. C. and higher the single and multiple-blow curves separate again, the former now always lying below the latter. Now, these relatively high forging temperatures are temperatures at which the hardening effects of forging are likely to be immediately effaced by recrystallization of the metal being forged. It can be said, therefore, that, at temperatures at which the hardening effects of plastic deformation are immediately effaced by recrystallization, the energy absorbed in deforming a metallic body by a single blow may be greater than that absorbed in producing the same deformation by a number of blows. The converse proposition is, of course, true, as reconsideration of the curves shown in Fig. 8 will show.

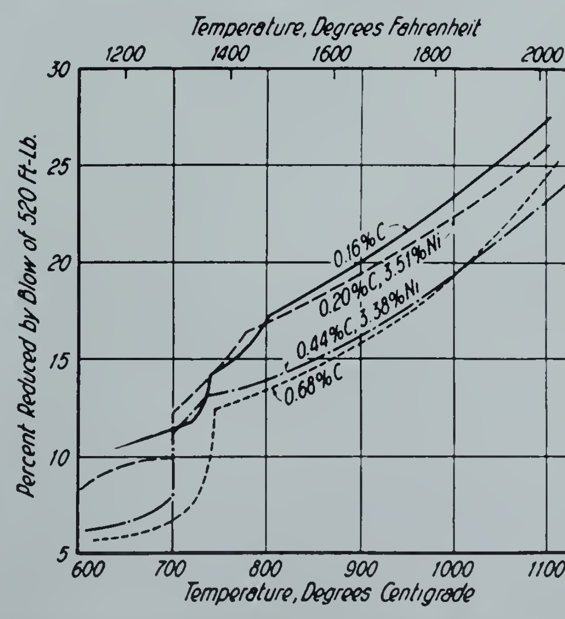

Fig. 12—Effect of nickel on forgeability of carbon steels.

Having attempted to show how the energy required to produce specified reductions in height in normal samples of different shapes and sizes can be calculated, given the energy required to produce a known reduction in height in a sample of known shape and size, a further step can be taken. Figure 10 shows two useful curves which enable rough estimates to be made of the energy, other things being equal, required to produce equivalent reductions in height in cylindrical samples whose heights are greater or less than their diameters, given the energy required to produce a given reduction in height in a normal sample. The curve marked H/D refers to cylindrical samples whose heights are greater than their diameters, that marked D/H refers to samples whose diameters are greater than their heights. If we know the energy required to produce a 25 per cent reduction in height of a normal cylinder of known analysis and state and it is desired to estimate the energy required to obtain a similar reduction in height in a cylinder of similar analysis and state whose height is three times its diameter, we first find the point of intersection of the ordinate marked 3 and the curve marked H/D, and then connect this point by an abscissa to the *right* hand side of the diagram. This gives the value 2.75±; that is, about 2¾ times the energy needed to deform a normal cylinder would be required to deform a cylinder three times as *high.* On joining the point of intersection of the ordinate marked 3 and the curve D/H by an abscissa to the *left* hand side of the diagram, the value 10.0± is obtained; indicating that about ten times the energy required to deform a normal cylinder would be required to deform a cylinder three times as *wide.*

It has already been mentioned that the critical points have an important effect upon the properties of steel. The next figures (Nos. 11 to 21 inclusive) cover this and other points of interest in regard to steel.

Figure 11 shows not only the importance of the critical points upon the forgeability of a group of straight carbon steels, but demonstrates (1) the marked effect of carbon, and (2) the influence of structure, on the forgeability of steel. At temperatures above the A_1 point (735 deg. C.—

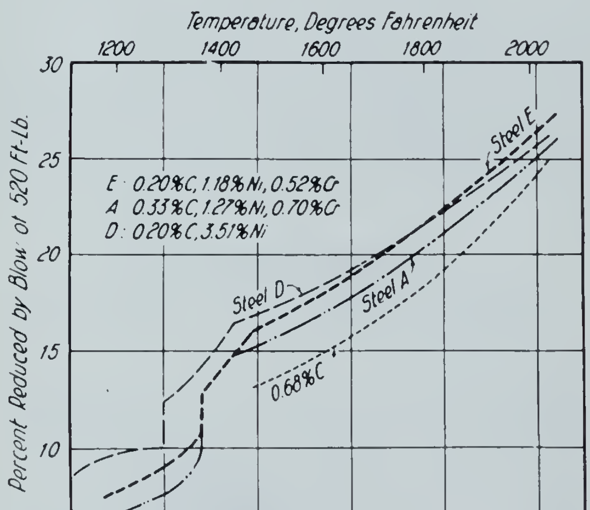

Fig. 13—Relative forgeability of a nickel steel and two nickel-chromium steels.

1355 deg. F.) the 0.16 per cent carbon steel is easier to forge than either the 0.68 per cent or the 0.85 per cent carbon steel, as might be expected. It is surprising to note, however, that below A_1, the particular 0.68 per cent carbon steel chosen for test was harder than the eutectoid steel with which it was compared. This can be accounted for only by assuming that the structure of the former was such as to make it harder than the latter. In all the experiments

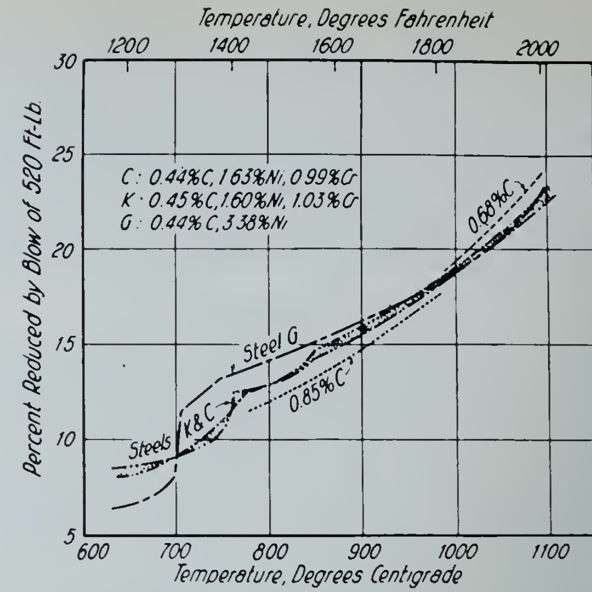

Fig. 14—Difference in forgeability of two nickel-chromium steels of very similar composition.

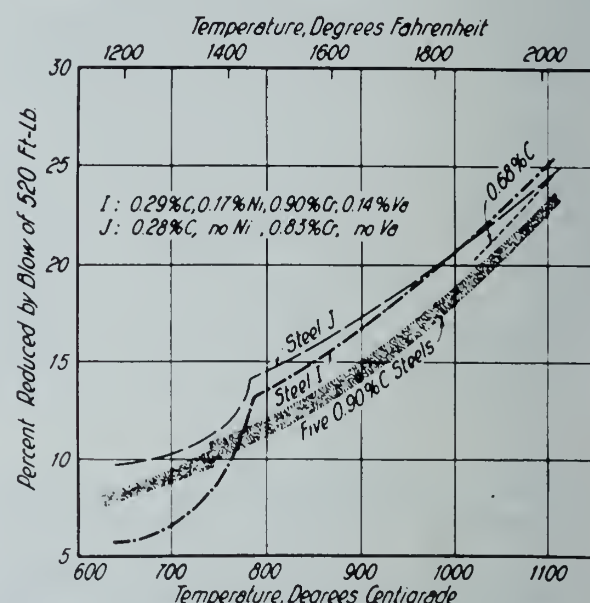

Fig. 15—Relative forgeability of two chromium steels, one of which contains vanadium.

the times of heating the samples, which were cut from bars "as rolled," were sufficient to ensure that they were uniformly heated throughout, but certainly not long enough to bring the steels to equilibrium.

Figure 12 demonstrates the effect of nickel, as compared with that of carbon, on the forgeability of steel.

Figure 13 makes possible a comparison between steel SAE 2320 (nickel) and steels SAE 3120 and 3130 (nickel--chromium). Note should be made of the preponderant effect of carbon upon the forgeability of these steels.

Figure 14 is inserted mainly for the purpose of showing how two steels of very similar composition can differ in their forgeability. Steel C contained 0.52 per cent of manganese and steel K 0.40 per cent of this element. Otherwise the two steels agreed very closely in chemical analysis. No studies were made of the microstructure of the steels after forging at different temperatures. Incidentally, it is of interest to note how similar are the two SAE 3245 steels to the SAE 2045 steel at forging temperatures above about 950 deg. C. (1742 deg. F.).

The forgeability-temperature curves for two chromium steels of similar analysis, one containing nickel (residual) and vanadium, the other free from these elements, is shown in Fig. 15.

Of recent years much has been heard of the high-yield low-alloy steels and the next three figures refer to the forgeability of three such steels as compared with straight carbon steels of equal carbon content.

Figure 16 deals with Cor-Ten, a steel containing about 0.10 per cent carbon, 0.30 per cent manganese, 0.80 per cent silicon, 0.45 per cent copper, 1.00 per cent chromium and 0.15 per cent phosphorus. The yield point of this steel is in the neighborhood of 62,500 lb. per sq. in., as compared with 45,000 lb. per sq. in. for straight carbon steel of the same carbon content. The forgeability of Cor-Ten is distinctly lower than that of SAE 1010, forgeability-temperature curves for two types of which are shown in this graph. These curves, it will be observed, differ quite materially from one another over the range 735 deg. C. (1355 deg. F.)—1000 deg. C. (1832 deg. F.). This can be accounted for by the marked difference in structure between the two steels (marked "Carbon steel" and "Steel P" in Fig. 16). Steel P, which had a very low silicon content, showed considerable banding and relatively large grain size in the ferritic areas, while the other SAE 1020 steel had a uniform structure and relatively small grain size (see Fig. 17).

Man-Ten is a typical SAE T1330 steel and can be compared with SAE 1030, as is done in the next figure, No. 18. There is little to choose between the two steels as far as forgeability is concerned. It is of interest to record that the forgeability-temperature curves for Man-Ten and a carbon steel of approximately the same tensile strength at room temperature, viz., a SAE 1040 steel, correspond closely to one another over the entire range 600 deg. C. (1112 deg. F.) to 1200 deg. C. (2192 deg. F.).

Another high-yield low-alloy steel is Sil-Ten, of which the following is a typical analysis:—

Carbon	0.36 %
Silicon	0.22 %
Manganese	0.68 %
Sulphur	0.024%
Phosphorus	0.017%

A sample of this steel, investigated by the author, had the following mechanical properties:—

Yield point	51,000 lb. per sq. in.
Tensile strength	88,000 lb. per sq. in.
Elongation	28%
Reduction of Area	54½%

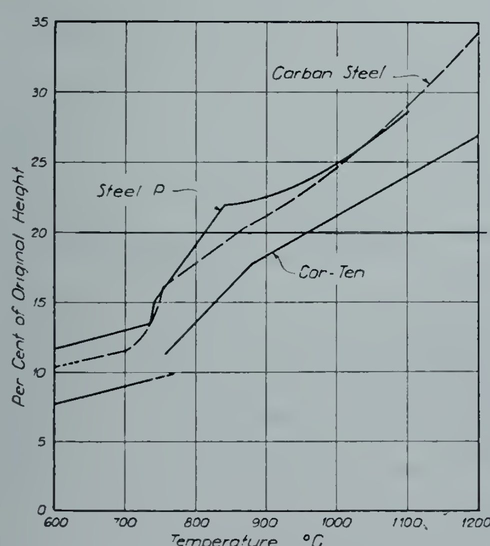

Fig. 16—Relative forgeability of Cor-Ten and two SAE carbon steels.

The mechanical properties of a SAE steel of similar carbon content, which was compared with this sample of Sil-Ten, were as follows:—

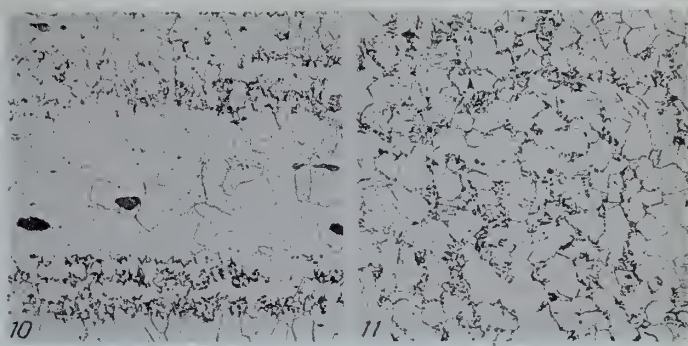

Fig. 17—Photo-micrograph of the two SAE steels of Fig. 16.

Yield point	44,000 lb. per sq. in.
Tensile strength	77,000 lb. per sq. in.
Elongation	30¾%
Reduction of area	52%

The forgeability-temperature curves for both steels are shown in Fig. 19, which brings out the interesting fact that the difference in mechanical properties between the two

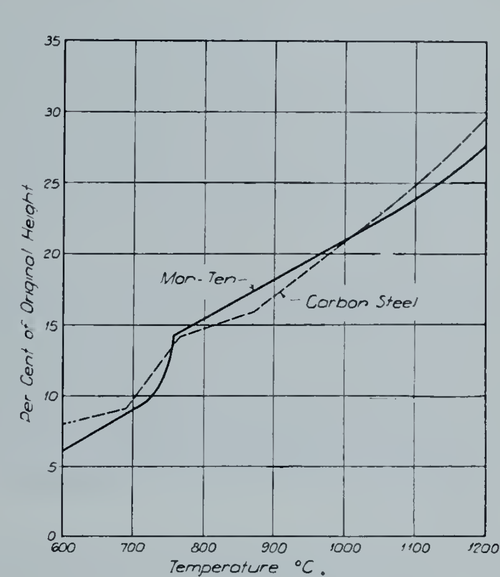

Fig. 18—Relative forgeability of Man-Ten and a carbon steel of similar carbon content.

steels shows itself throughout the entire range of these experiments. It should be noted that the grain size of the Sil-Ten tested by the author was coarser than that of the straight carbon steel, which suggests that the effect of silicon upon the forgeability of steel, while not profound, is sufficient to counterbalance the effect of grain size.

It may be asked why some of the curves in the figures intersect one another. One reason may be this: The grain sizes of these steels vary relative to one another at different temperatures. This is brought out in Figs. 20 and 21, the first of which shows the structures of two steels of practically the same analysis, one inherently coarse-grained, the other inherently fine-grained, after forging at temperatures of 900 deg. C. (1652 deg. F.), 1025 deg. C. (1877 deg. F.) and 1150 deg. C. (2102 deg. F.), respectively. The second (Fig. 21) shows the forgeability-temperature curves for the two steels. These intersect in the neighbourhood of 990 deg. C. (1814 deg. F.), where the grain sizes of the steels are almost identical, as was shown in Fig. 20. At temperatures below 990 deg. C. (1814 deg. F.) the inherently fine-grained is more resistant to deformation than the inherently coarse-grained steel, while at temperatures above 990 deg. C. the inherently coarse-grained steel is the less forgeable of the two. These experiments serve to emphasize how much more important are the effects of austenite grain size than inherent grain size on the forgeability of steel.

It may be of interest at this point to review some of the recent work which has been published on the hot forging of the alloys of the light metals, aluminum and magnesium. In this connection the author is specially indebted to an extended abstract on the subject which was published in *Light Metals*, in September, 1940.

Going back to the work of Zeerleder, reference to Figs. 7 and 6 will be helpful in this connection.

The first (Fig. 7) gives some idea of the comparative forgeabilities of aluminum, two aluminum alloys, 58/42 brass and mild steel. The samples, before forging, were 80 mm. high and 80 mm. diameter. It will be observed that the forgeability of mild steel at 1100 deg. C. (3012 deg. F.) is slightly greater than that of Avional D at 420 deg. C. (788 deg. F.).

The other, (Fig. 6), presents a series of ten curves referring to various alloys of aluminum; these curves show the percentage reduction in height of 20 mm. normal samples at various temperatures. Their similarity to the forgeability-temperature curves for steels at temperatures above the A3 point will be noted, though it justifies no further comment here.

Speaking generally, the technique of forging aluminum and its alloys at their relatively low forging temperatures, 360 deg. C. to 510 deg. C. (680 deg. F. to 950 deg. F.) is much the same as that of forging the heavy metals and their alloys at their relatively high forging temperatures. The alloys of magnesium, however, present a problem all their own; they verge on "hot shortness." In other words, they lack cohesion under stress at high temperatures. On this account they are extremely difficult to roll and to forge as cast, though they are less susceptible to rupture when forged after extrusion, owing to the consolidating effect of extrusion. Temperature too, has a profound influence on their forgeability. For example, the specific forging pressure of the light alloy (Electron A2M) containing 6¼ to 6¾ per cent of aluminum, ¾ to 1¼ per cent of zinc, 0.20 to 0.35 per cent of manganese and up to 0.30 per cent of silicon, the balance being magnesium, is increased threefold by reducing the forging temperature from 350 deg. C. (662 deg. F.) to 225 deg. C. (419 deg. F.). Further, the rate of deformation of this alloy, as of other ultra-light alloys, is of prime importance.

The sensitivity of ultra-light alloys requires that a special technique be adopted in their treatment. Before they can be forged under the drop hammer, or even the screw press, it is often desirable, if not essential, to consolidate them by free forging or under a hydraulic press, since slow rates of deformation are imperative in the early stages of forging. The first forging operations on these alloys are generally

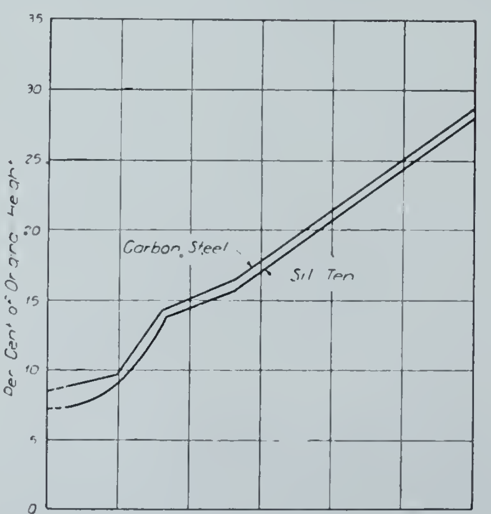

Fig. 19—Relative forgeability of Sil-Ten and a carbon steel of similar carbon content.

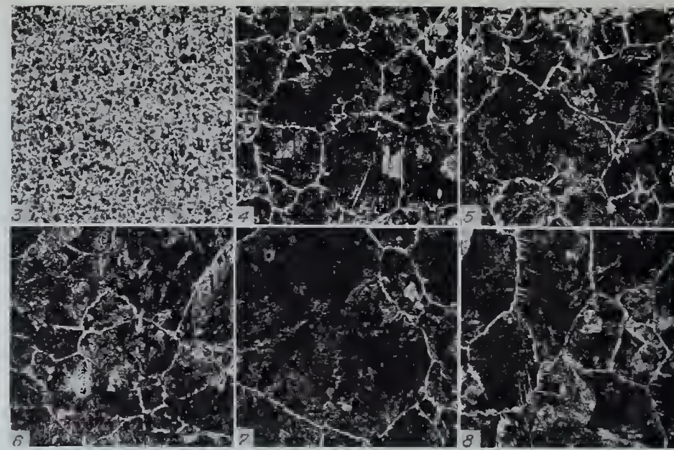

Fig. 20—Photo-micrographs showing variation of relative grain size of two steels.

carried out at the highest possible temperatures consistent with safe handling of the material.

In free forging it is essential that the blows be so controlled and directed as to guide, rather than to force, the material into the desired shape, if fissures and cracks are to be avoided in the finished article. Work must be applied to ultra-light alloys with the utmost uniformity. The hot material must be rotated and reciprocated after each blow. Surfaces should be forged slightly concave rather than flat. All these conditions presuppose both experience and skill on the part of the worker.

The later forging operations should be performed at successively lower temperatures than the first, so as to avoid

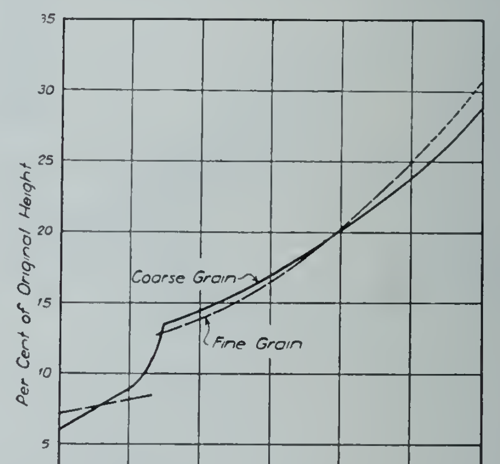

Fig. 21—Relative forgeability of coarse-grained and fine-grained steels of similar carbon content.

excessive grain growth at all stages in the formation of the parts. In order to retain as fine a grain as possible in the finished articles, they should be quenched in water immediately after forging. A fine grain size counteracts the directional effects of the fibre induced in the alloy by forging; further, it promotes homogeneity of structure and so facilitates the heat treatment of the finished forgings.

Magnesium and its alloys are as prone to grain growth on reheating as are other metals and alloys which have been subjected to critical degrees of cold working, but the deleterious effects of grain growth are, in their case, more pronounced. Hence, great care must be exercised in the reheating of components which have been forged at temperatures below the recrystallization temperature—reheating through the range where excessive grain growth is likely to happen should be as rapid as possible.

The rates of deformation of the ultra-light alloys should always be lower for equal weights and higher for equal volumes of material than those used in the forging of heavy metals. Speaking generally, rates of deformation should lie between those used in the free forging of the heavy metals and those used in the die forging of the aluminum alloys, other things being about equal. Rolled, extruded or forged stock, i.e., material that has received some preliminary consolidation, can be treated with somewhat less consideration than cast material—forging under the screw press or the drop hammer can be considered without fear. Because of the lower rates of deformation involved, drop hammers with heavy tups are to be preferred to those with light tups in die-forging these materials.

When die-forging under the drop hammer, the rate of deformation is not so readily controlled as in free forging

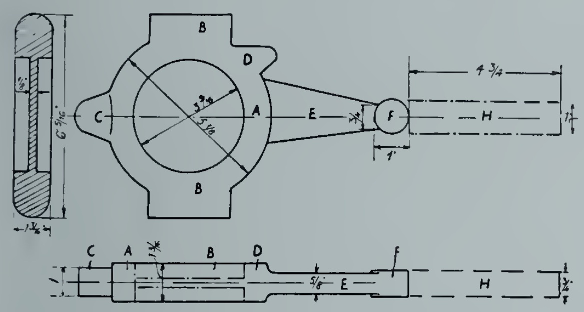

Fig. 22—Eccentric cam, workpiece for which forging schedules are discussed.

or in press-forging. A definite relationship should, therefore, be maintained between the size of the part being forged and that of the hammer employed.

The pre-heating time for dies to be used in forging light alloys of aluminum and magnesium, may be shorter than that for dies to be used with heavy material, owing, on the one hand, to the lower temperatures involved and, on the other hand, to their usually smaller size and lighter weight.

The choice of the method to be employed in the production of a component is one of considerable importance. Due regard has to be given, first, to the equipment available, then, to the forgeability of the alloy to be used, and, lastly, to the design of the component itself. There must also be borne in mind the fact that the change in shape produced by pressure may, even will, differ markedly from that produced by impact.

Finally, it will be of interest to discuss at some length the schedule of forging operations and times of forging of the typical light alloy component shown in Fig. 22 (again quoting from the article in *Light Metals* of Septenber 1940). Herein is shown an eccentric cam, the ring for which has to be increased in thickness from ¾ inch to 1 3/16 inch. This operation is better performed by hammering than by pressing, because the greater rate of deformation of the material under impact gives less time for lateral flow. In general, it may be said that for those operations involving the longitudinal extension of material it is best to use a hammer, whereas, for upsetting, the press is to be recommended. Under a press there is a greater chance of preferential flow of metal into the flash groove than into the die cavity proper. Not only is such flow itself undesirable, but, the metal being squeezed into a thin layer, opportunity is given for rapid cooling and subsequent formation of edge cracks in the finished parts.

Turning to the schedules, Table I presents the calculations involved in estimating the weight of the eccentric cam shown in Fig. 22. In this connection it is well to remember that, for any given component, its weight in light alloy will frequently be greater than that which would be deduced from a consideration of the relative specific gravities of light and heavy alloys, because the relative mechanical properties of the two materials must invariably be considered.

In Table II, which follows, there are presented the operations schedule and times for forging this eccentric cam (i) in light alloys—3.3 pounds, (ii) in heavy metal of equal volume—8.8 pounds, and (iii) in heavy metal of equal weight—3.3 pounds.

"Superficial consideration might lead to the conclusion that, with respect to production time and cost, no marked difference" would obtain "between heavy-alloy and light-alloy forgings and that, moreover, owing to the higher cost

Table I.—Calculation of Blank Weight for Workpiece Fig. 22

No.	Part		Dimensions	Calculated Weight			
				Light metal		Heavy metal	
				lb.	kg.	lb.	kg.
A	Eccentric head	in. mm.	5⅛ diam. x 1 3/16 minus 3 9/16 diam. x 1 3/16 130 diam. x 30 minus 90 diam. x 30	1.272	0.580	3.550	1.610
B	Two projections for screw	in. mm.	1 3/16 diam. x 5½ 30 diam. x 140	0.605	0.275	1.680	0.765
C	Large front projection	in. mm.	1 3/16 x 1 3/16 x 1 30 x 30 x 25	0.138	0.063	0.385	0.175
D	Small backwards projection	in. mm.	¾ x ¾ x 1 3/16 20 x 20 x 30	0.073	0.033	0.202	0.092
E	Lever arm	in. mm.	1 9/16 x ⅝ x 3¼ 40 x 16 x 82	0.322	0.146	0.892	0.406
F	Small eye	in. mm.	1 diam. x ¾ 26 diam. x 20	0.064	0.029	0.178	0.029
G	Bottom	in. mm.	3 9/16 x ¼ 90 diam. x 6	0.238	0.108	0.660	0.300
H	Waste	in. mm.	1 x ¾ x 4¾ 26 x 20 x 120	0.385	0.175	1.070	0.487
Waste round the workpiece		in. mm.	5/16 x ⅛ x 2 8 x 3 x 50	0.073	0.033	0.202	0.092
Total material consumption, about				3.18	1.44	8.8	4.00
Loss in weight, 2%				0.062	0.028	0.172	0.078
Safety allowance, 2%				0.062	0.028	0.172	0.078
Blank weight, about				3.3	1.5	9.2	4.2

Table II.—Operation Schedule and Times for Forging of Workpiece Fig. 22

(Base Times in Time Units. 1 T.U. 1 min.)

No.	Operation	I Light metal 3.3 lb.	II Heavy metal 8.8 lb.	III Heavy metal 3.3 lb.
a	To lay in furnace	0.10	0.24	0.10
b	Part of time for furnace regulation (1st heat)	0.18	0.38	0.18
c	Part of time for preheating (1st heat)	0.84	1.20	0.47
d	To take out of the furnace	0.08	0.24	0.08
e	Walk to forging hammer, about 3.3 yds	0.07	0.09	0.07
f	Hand forging, Fig. X, Nos. 1-7	1.55	2.30	0.80
g	Semi-finished par laid down	0.07	0.12	0.07
		2.89	4.57	1.77
	Total time for two men	2.89	4.57	1.77
h	To lay in furnace (2nd heat)	0.08	0.20	0.08
i	Part of time for furnace regulation (2nd heat)	0.15	0.32	0.15
k	Part of time for preheating (2nd heat)	0.70	1.00	0.40
l	To take out of furnace	0.08	0.24	0.08
m	Walk to swage hammer, about 1.65 yds	0.05	0.07	0.05
n	To lay in swaging die	0.06	0.10	0.06
o	To swage, Fig. X, No. 8	0.70	0.95	0.44
p	Walk to trimming press, about 1.1 yds	0.04	0.06	0.04
q	Burring, Fig. X, No. 9	0.12	0.28	0.12
r	Walk for laying down, about 3.3 yds	0.07	0.09	0.07
s	To lay down	0.07	0.12	0.07
	Finished shape			
	Base time	7.90	12.57	5.10
	Lost time—12% Piece time	9.00	14.00	5.70

Operations a-g, 2 operators; operations h-s, 1 operator.

Base time is composed of the main time and the necessary by-times. The base time is for instance the operating time of the machine. The base time is determined by time studies. Lost time is given as a percentage of base time. The sum of base time and lost time gives piece time.

of light alloys, per unit weight, the forging and pressing of these alloys might prove somewhat uneconomic." The fact is, however, that on a weight/strength basis a unit of light alloy may be taken as equivalent to at least two units of heavy alloy. This places the light alloys in a favourable position, since relatively smaller hammers, presses, etc., can be used in their fabrication. In particular, dies need not be so heavy or so expensive, while wasters and forging scrap command a relatively higher price. Where the same equipment has to be employed in the forging of both heavy and light alloys, these considerations naturally carry no weight.

To return to Table II, the material specified for this cam was an aluminum alloy of medium forgeability, an alloy such as No. 6 in Fig. 6. In the preliminary free forging of the blank a 220-pound compressed air hammer is used, while for the die-forging operation a 660-pound drop hammer with fixed anvil block is employed. The free forging is carried out in two operations, the die-forging in one.

The various stages in forging are shown diagrammatically in Fig. 23. The blank is preheated according to the recommendations for the material in question. It is then notched as in operation 2, after which operation 3 is performed. The purpose is to obtain a neck of reasonable length which fits better into the falling die. The notching operation is repeated (4) and the material subsequently drawn out (5). In this last operation the upper temperature limit for light-alloy forging, viz., 360 deg. C. (648 deg. F.) should not be exceeded.

The lower fillet is next shaped by means of a swage so that the component will fit the upper half of the forging die. In the same heat, waste metal is removed (6) and both parts separated. The workpiece is now again reheated and die-forging commenced (8). In this operation it is important that the dies be adequately heated in order that the light alloy be not unduly cool. The operation completed, the part is placed in the trimming die, from which it emerges in its final form (10).

Space will not allow full examination of the relative production costs of forgings of the same size and shape in steel and in light alloy. Comparisons are made in the article referred to above, these being based on the following points:—

(a) Production time for the light-alloy part is 35 per cent less than that for the steel part.

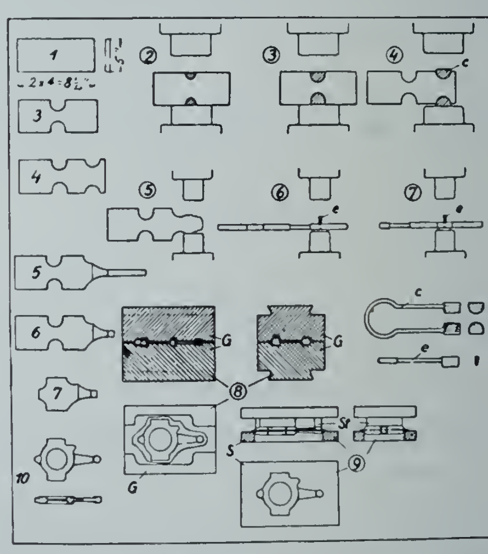

Fig. 23—Diagrammatic summary of operation schedule for eccentric cam forging.

(b) Aluminum-base alloys require lighter equipment than steel, hence, overheads can be reduced from 400 per cent to 250 per cent.

(c) Dies for the aluminum-base alloys are lighter than those for steel, and are made of a somewhat less expensive grade of steel which machines more readily than the expensive grade, hence die costs are reduced from about $204 to about $124.

The estimated cost per component—the cam which we have already considered—is $0.84 in steel, as compared with $1.05 in light alloy. The die costs are $204 in steel as compared with $124 in light alloy. To amortize the die costs in the case of the steel forging would require the production of about 240 cams, to do this in the case of the aluminum alloy forgings would require the production of about 117. Thus it appears that the use of special forging dies becomes economical for aluminum alloy forgings at an output less than one-half that for an equivalent forging steel.

This comparative study of the production of a component in steel and in an aluminum-base alloy of medium forgeability could be matched by a similar study of the production of a component in steel and in a magnesium alloy, but it will suffice to quote these words from the article to which the author is indebted for the preceding discussion—"It thus appears that, by the employment of improved methods of hammer forging and the use of *magnesium-alloy* dies, the production by die-forging of the forked lever cited becomes economical at an output figure more than 50 per cent below that required when using older types of equipment with the conventional steel dies. It is possible that still further reductions might be made in die costs due to the readiness with which magnesium alloys may be machined, and to the ease with which they may be handled owing to their light weight."

The use of magnesium-alloy dies in the hot forming of sheet is well known, but the practice referred to in the above quotation is unusual. There seems to be no question as to the reliability of the source of this information, but the remark may be made that "the satisfactory use of ultra-light alloys" in the manufacture of dies to be used in the production of solid forgings "would seem to demand either their operation at a temperature below the usual plastic range (say, not in excess of 250 deg. C.—482 deg. F.—for alloys of ordinary composition), or the use of special compositions not amenable to appreciable plastic deformation within the common range of forging temperatures."

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CHEMICAL PROCESSES—THEIR PLACE IN DAILY LIFE

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, on October 10th, 1940

SUMMARY—A non-technical paper offering a general view of present-day chemical industry with special reference to the production of heavy chemicals and of plastics by synthesis and polymerization.

The Beginning of Chemistry

The early man seems to have regarded with superstitious wonder the natural events which occurred around him. Chemical phenomena were supposed to be produced by indwelling spirits, and results were obtained by charms and incantations addressed to the particular spirit concerned. Such a philosophy is much more picturesque than that employed at the present time.

Failure to obtain a desired result could be explained by suggesting that astrological conditions were not propitious and, consequently, the spirit was sleeping. This is truly a much more romantic explanation than to admit a mere lack of knowledge.

Those who made any pretence of studying nature were suspected of dealings with evil spirits. During this period the study of chemistry was looked upon as a sort of black magic, and the names given to certain of the then known elements were very fanciful. Chemical processes were described in equally picturesque language; take for example the reaction between mercuric chloride and mercury: "The fierce serpent is tamed and the dragon so reduced to subjection as to oblige him to devour his own tail."

With such a mystic manner of describing the knowledge possessed at that time, it is not surprising that the study of natural phenomena, and chemistry in particular, was considered as impious and even forbidden.

In the second stage of philosophy man loudly proclaimed the supremacy and omnipotence of human reason. It was considered to be beneath the dignity of an educated man to conduct any experiments, and any knowledge obtained by observing nature was considered to be unworthy of attention. During this period it was held that all secret laws of nature could be invented by abstract thinking, and that real knowledge was to be obtained by reasoning, apart from all information furnished by the senses.

Thus, the early philosophers who looked with scorn on anyone who attempted to make observations on natural phenomena, actually hindered the real progress of knowledge for centuries. Their fanciful attempts to explain material things had, in many instances, little respect for truth or reality as we understand it to-day.

It is true that before the Christian era the Greeks seemed to be developing the "certain or exact type of philosophy," but the mysticism of the Middle Ages proved more attractive than any results obtained from observations, and the early teachings of the Greeks were soon forgotten. In fact, it was not until the thirteenth century that a proper view concerning nature and her phenomena began to appear. Man gradually realized that the truth was not in him, but was around him, and could be discovered by observation and diligent search.

This attitude became more evident in the seventeenth century, when the first scientific societies were formed, providing an organized means of discussing facts determined by experiment. The most outstanding of these were The Royal Society, founded in London, in 1660, and L'Académie des Sciences, established in Paris six years later. It is from this time that chemistry, as it is known to-day, had its beginning.

Arising from the study of combustion we have the first attempt at generalization in chemical phenomena. As numerous materials burned it seemed only reasonable that there must be some common explanation for this event. The earlier philosophers stated that combustible bodies contained an inflammable principle, which was little better than saying that the body itself was combustible. At the beginning of the eighteenth century it was recognized that there was a definite connection between the combustion of inflammable substances and the oxidation of metals to give oxides.

In 1772 Lavoisier's experiments on the oxidation of mercury in a given volume of air brought to light the true explanation of oxidation and combustion. His experiments proved that atmospheric air is made up of two gases—oxygen and nitrogen—of different, and even opposite, natures.

Many authorities on the subject fix this date as the birthday of our modern chemistry, and from this time onwards a constantly increasing number of experimenters added to the general fund of chemical knowledge.

The facts of chemistry, determined by a very large number of experiments, have been correlated and described in what are called the laws of chemistry. A chemical law is not something which must be obeyed, like a law governing our social behaviour, but is a description of some phase of the behaviour of matter. Chemistry is, therefore, a system whereby we can reason concerning the behaviour of matter, using as our premises the laws of behaviour which have been ascertained by experiment.

The study is, for convenience, divided into Inorganic Chemistry, dealing with mineral substances, and Organic Chemistry, which deals chiefly with compounds containing carbon. Originally the division was made because it was thought that certain animal and vegetable substances were produced under the influence of vital force and that the laws regulating their formation were different from those relating to mineral substances. This idea persisted until 1828, when Wöhler in one of his experiments discovered that he had produced urea by ordinary laboratory methods. This compound had been known for some time, but only as a constituent of the urine of certain animals. Subsequently, it was discovered that many other substances could be produced by standard laboratory methods which had hitherto been considered as resulting from the influence of vital force. This discovery was of outstanding importance, since it opened up a whole new field of endeavour for the chemist.

Chemical reactions are natural phenomena which occur and often are evident to visual observation; it is important to note that they are always accompanied by an energy change. When fuel is burned energy is liberated, and by utilization of this energy, in, say, a boiler plant, it can be converted to other forms which can be used to perform useful work. The energy changes accompanying other chemical reactions are not always so apparent, but for the chemist are of equal importance, and are an integral part of the study of the behaviour of matter.

Chemical Industry

Chemical industry might be described as an organized effort to put atoms to work for the benefit of mankind. But it must be remembered also that chemical plants established by nature are synthesizing compounds and producing many materials which are still of vital necessity to man. The truths that are concerned with the behaviour of matter are always the same whether matter be confined in a test tube in a chemical laboratory, whether it be the synthesis of substances in plants or animals, or the chemical reactions which occur in the most complicated industrial plants.

It is important that complete knowledge should be available concerning any chemical process which is to be adopted in industry. This can be obtained from the efforts and results of those who have carried out previous work in this particular field, or it may be necessary to acquire it through the prosecution of original research.

It has often been said that in chemical industry, if costs did not have to be considered, great things could be accomplished, but actually the industry must operate for the benefit of all mankind, and to survive it must, in our economic system, so operate as to make mankind richer. Therefore, the simplest and most direct method of production is to be desired, and waste products or unwanted products should not be produced in any process where they can be avoided. As an example, the synthesis of phenol from benzene may be cited.

Raschig in Germany has been responsible for the development of two processes of manufacture. His earlier process was to react benzene and sulphuric acid, obtaining benzene sulphonic acid. A further reaction between benzene sulphonic acid and caustic soda gives sodium sulphite and sodium phenate; sodium phenate on neutralization with sulphuric acid gives phenol and sodium sulphate. This may seem complicated, but the main point is that for this process the raw materials required are benzene, sulphuric acid and caustic soda, and, in addition to the phenol which it was desired to make, sodium sulphite and sodium sulphate are also obtained; unfortunately these two salts have little commercial value.

In the case of the second process, which has only lately been made public, benzene, hydrochloric acid and air are caused to react, and the resultant products are monochlorbenzene and water. The next step is to bring about a reaction between the monochlorbenzene and water, and this has been successfully taken. The products of the reaction are phenol and hydrochloric acid. Now, obviously, since hydrochloric acid is required as a raw material in the process, it may be returned to the first operation. This is a particular case of a type of reactions which are employed wherever possible, on account of their economy, and are generally referred to as cyclic processes.

Efficiency in Production

In applying chemical reactions to industrial production certain basic principles govern the construction of equipment. These are well illustrated in the design of equipment required for the production of sulphuric acid by the contact process, a specific case which serves to illustrate principles which are applied generally throughout the industry.

If the reactions in this process are expressed chemically, everything appears simple. Sulphur is burned in air to produce sulphur dioxide, the sulphur dioxide is reacted with more air, taking up more oxygen to form sulphur trioxide, which, on reaction with water, gives sulphuric acid. Passing over the methods whereby the sulphur is burned and the resulting gas cooled, it must be noted that this sulphur dioxide is dried by means of sulphuric acid.

Before describing how the desired effect is obtained, it is necessary to mention a few facts concerning the reaction whereby the sulphur dioxide is converted to the trioxide. The most important point is that heat is given off during this reaction, which takes place at a high temperature, but the heat given out is not sufficient to raise the gas directly to this temperature. Further, the speed at which the reaction occurs is greater at higher than at lower temperatures, therefore, at higher temperatures of operation a greater amount can be converted and, consequently, for a given output the equipment can be smaller. There is, however, always a "but" and in this case the difficulty has to do with chemical equilibrium, which is less favourable to the desired result at higher than at lower temperatures.

Without attempting to define equilibrium it may be explained that at the higher temperature more sulphur dioxide would pass through the equipment unchanged, than would be the case at a lower temperature. This would mean a lesser efficiency. It should also be stated that this reaction only takes place in the presence of a suitable catalyst, a substance which acts to increase the speed at which reactions occur without itself undergoing chemical change, and without affecting the chemical equilibrium. A good, but negative definition for a catalyst might be that if it is not present no reaction will take place. It is obvious that if the plant is to operate at its greatest efficiency some compromise must be reached between the desire for small equipment with a rapid reaction, and the desire to avoid loss of sulphur dioxide, or one might say loss of efficiency. This is accomplished by dividing the portion of the equipment wherein the reaction occurs into two separate parts. In the first reactor, or converter as it is called, the temperature is high, reaction is rapid, and 80 to 90 per cent of the reaction occurs. In the second reactor the temperature is lower, only 10 to 20 per cent of the reaction takes place, but the desired "clean up" of sulphur dioxide is obtained.

Heat Exchange

The means whereby the desired temperatures are maintained can best be described with reference to Fig. 1.

In the diagram we have two types of equipment, the heat exchangers and the converters. The heat exchangers consist of a steel shell with header plates near each end. These

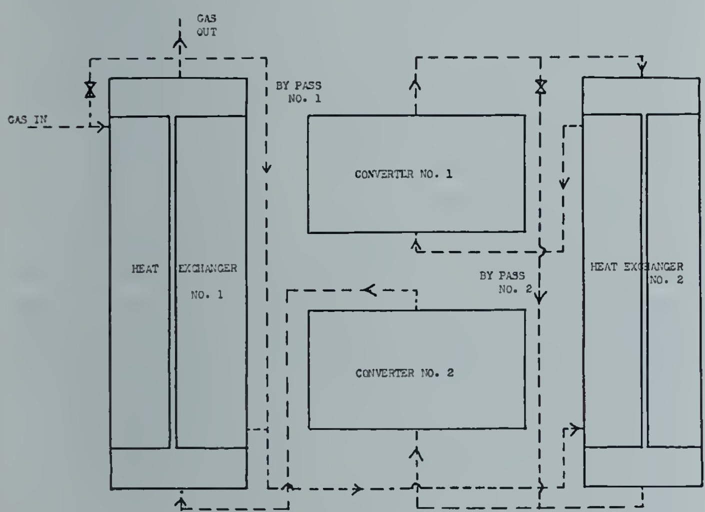

Fig. 1.

header plates are connected together by a number of tubes, and from the diagram it can be seen that gas can pass in one direction around the outside of the tubes while it can pass through a second path inside of the tubes. The converters have suitable trays for holding the catalyst used.

The dried gas, at atmospheric temperature, enters No. 1 heat exchanger, passing through it in the opposite direction to hot gas which is leaving from converter No. 2. It then passes through heat exchanger No. 2, where it meets still hotter gas leaving converter No. 1. It then enters converter No. 1 where reaction occurs, and there is a considerable rise in temperature due to the heat given up by the reaction. The gas leaving this converter passes down through heat exchanger No. 2, giving up some of its heat through the tube walls to the gas travelling in the opposite direction and therefore entering converter No. 2 at a lower temperature. Again there is a rise in temperature due to the reaction which takes place in No. 2 converter and the gas passes out through heat exchanger No. 1, giving up more heat to the incoming gas. Temperatures can be readily controlled by inserting by-passes across the heat exchangers, as shown.

If the temperature tends to rise, No. 1 by-pass can be opened and the amount of heat transferred in No. 1 heat exchanger lessened, thereby lowering the temperature of the gas finally entering No. 1 converter. Should No. 2 converter tend to run at too low a temperature No. 2 by-pass can be opened, thus admitting some of the hot gas direct from No. 1 to No. 2 converter.

In this equipment reaction does not occur until a fairly high temperature has been reached and to start operation it is necessary to provide means for heating the gas until the converters have attained reaction temperature. Once this temperature has been reached it is no longer necessary to supply any heat other than that given out by the reaction. Thus if gas of constant composition, or nearly so, is passed through the equipment the desired temperatures can be maintained almost indefinitely.

This ingenious arrangement saves a great deal of heat energy which would otherwise have to be furnished by fuel.

To illustrate difficulties of another kind that arise in chemical industry consider the gas which is leaving heat exchanger No. 1, and consists of air and sulphur trioxide. As previously stated, sulphur trioxide and water unite to give sulphuric acid; although this is perfectly true, if an attempt were made to scrub the sulphur trioxide from this gas with water, nothing of interest would happen, and the entire output of the plant would pass away as a white cloud.

It was, however, discovered that sulphur trioxide could be readily absorbed in solutions containing 98 to 100 per cent of sulphuric acid, and this is the absorbent which must be used. As sulphur trioxide is absorbed the acid strength increases, so that water must be added. It was mentioned earlier that the gas entering the plant was dried with sulphuric acid and, if desired, this weaker acid can be used, at least in part, to add the necessary water to the system. As the quantity of water added in this way is usually insufficient, an additional amount of water is added as such.

Use of Steam

The case just considered is one in which energy has been given out in the form of heat during the reaction, and while this is generally the case there are many processes in which heat energy is absorbed to attain a desired effect. The following is an example.

In a steam power plant the latent heat of vaporization of water represents energy much of which cannot be transformed into useful work. In chemical industry, however, it can be utilised more efficiently; as a medium for supplying heat, steam has a great deal to recommend it. The pressure at which it is used—which is readily subject to control—determines the temperature of the applied heat. The heat given up is due to condensation, and for this purpose, a high latent heat of vaporization is desirable. If steam must be furnished for process heating purposes it is advantageous to generate it at a higher pressure than required for the process, and to utilize the additional energy content for mechanical work, such as generating electrical power, before using the latent heat for process heating. In chemical plants where steam consumption is large this is frequently done and shows a very considerable economy of operation.

However, many industrial processes operate in such a way that the final product occurs in water solution, so that in order to recover the product the water must be evaporated. In this case the high latent heat of vaporization is not advantageous.

Wherever possible the heat required to boil off this water is obtained by condensing steam, and if for the moment questions of temperature differences, efficiencies, etc., are neglected it might be expected that the condensation of one pound of steam would boil off one pound of water and in so doing, produce one pound of steam. This second pound of steam could then be used to boil off a second pound of water, and so on. This idea finds extensive practical application in a system which is called "multiple effect" evaporation. The example shown in Fig. 2 is one working under pressure, the decrease in pressure from one step to the next can be noted from the diagram. If the temperature differences between the steam and the solution being evaporated are, in the three cases, 25 deg. C. in this particular system, then, for each pound of steam obtained from the boiler, $2\frac{3}{4}$ lb. of water would be evaporated from the evaporators making up the three effects. Such a system is not limited to three evaporators, as systems having quintuple, and even sextuple, effects are in operation.

Another system of evaporation which is worthy of mention is that of vapour recompression. In every evaporator where steam is being used as a heating medium steam is being condensed, and steam is also being given off by the evaporating solution. The condensing steam must be at a higher temperature than the solution being evaporated,

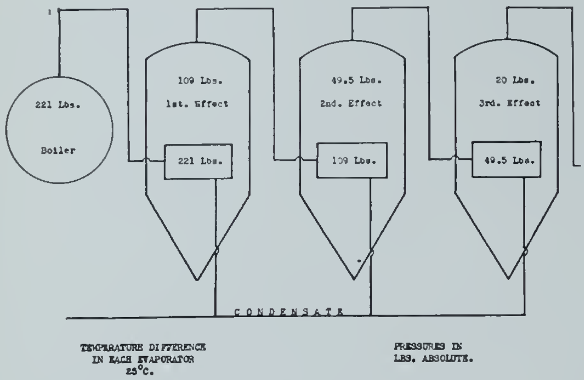

Fig. 2.

otherwise the desired effect would not be obtained. This means that the steam used for heating must be at a higher pressure than the steam formed by the evaporation of the solution. In order, therefore, to make this equipment self-supporting it would only be necessary to take the steam from the evaporating solution, raise its pressure, and then use it for heating, and this can be accomplished by means of a compressor. On compression, steam superheats, so there is no danger of any condensation occurring with mechanical damage to the machine due to the presence of water. In theory, such a system should be equivalent to an infinite number of effects, but owing to mechanical losses, actually has about the same efficiency as a quadruple effect system such as has been described previously.

Although these are only two illustrations of the means by which an economy of energy is effected in chemical industry they are illustrative of the problems which must be solved, and the manner in which chemical equipment operates.

Heavy Chemicals

The term "heavy chemicals" does not permit of exact definition, but refers to basic chemicals which are consumed in very large quantities. They might be termed the tools of industry, for they are used in practically every field of endeavour. They are consumed in such varied industries as soap, textiles, dyes, steel and metals generally, paints, fertilizers and by practically every producer who grows or makes anything. Although heavy chemicals are used in processing they very seldom form a constituent part of the finished article or material, but are discarded at some stage of the process, and in most cases their use is unknown to the ultimate consumer.

The raw materials which are required for the heavy chemical industry are surprisingly few. Energy, either in the form of coal or hydroelectric power, is, of course, a necessity. Water must be available, but all the minerals that are required are sulphur, salt and limestone. These are fairly well distributed over the earth's surface, and as they occur in a relatively pure state, can be readily transported. Herein lies a fundamental difference between the mining and the chemical industry; in mining it is necessary to erect the smelter close to the ore body and the life of the operation depends on the quality or grade of the ore. Chemical raw materials are abundant and the life of the operation depends on the process used. This has led to considerable secrecy concerning the methods whereby certain chemical operations are carried out and a general reticence about them outside the factory.

Sulphur finds little use in its natural state and is usually converted to sulphuric acid which has often been termed the backbone of the heavy chemical industry. Added to salt, sodium sulphate and hydrochloric acid are obtained. By means of the ammonia-soda process, salt and limestone may be made to yield soda ash and calcium chloride. Baking soda may also be obtained in this process. The electrolysis of salt in solution produces caustic soda and chlorine, these react to give sodium hypochlorite. Lime, on reaction with chlorine, gives bleaching powder. Soda ash may be causticized with lime to give caustic soda and so one continues.

Production of Organic Compounds

The only reason for the continued existence of any industry is that it contributes to the production of something which will ultimately be of value to the individual. The heavy chemical industry without doubt plays a very important part in this scheme. There has, however, been developed in the past few years that which might well be called a new kind of chemical industry and strangely enough it conforms to the division of chemistry into Inorganic and Organic Chemistry. The heavy chemical industry deals entirely with inorganic materials, and now an increasingly important field of endeavour deals with the production of organic compounds. It is true that organic compounds have been known since the earliest times, but their source has been from living plants, either from the plant itself or from their fruits or seeds, and even to-day for many of the more complicated products we must rely on plant growth for a source of supply. The synthesis of complex organic compounds by living plants is still a source of wonder and admiration to the chemist. These compounds, consisting as they do of carbon, hydrogen and oxygen in various combinations sometimes associated with nitrogen, sulphur and a few of the other elements are built up in some manner which has not as yet been explained. The source of these elements to the plant is carbon dioxide and water and products almost without number are produced from these two simple substances.

There is, however, a striking phenomenon in plant growth which is receiving considerable attention, namely, the necessity for the presence of what are known as trace elements in the soil in which plants are grown.

Such elements as iron, which is usually present in soils, nickel, cobalt, chromium, zinc, boron, etc., have been shown in many cases to be beneficial, if not essential. Modern organic synthesis is achieved through the use of various catalysts, and it is interesting to note that these trace elements are in many instances those which are employed as catalytic materials.

The raw materials for the organic chemical industry are almost as simple as those employed by plant life, as they are essentially carbon, air and water. There is, however, considerable difference in the method of synthesis, as in industry it is essential to carry out reactions at high temperatures and pressures, whereas plants are capable of synthesizing materials at normal temperatures, and possibly atmospheric pressures, and it seems to be an underlying principle of changes in chemical composition that low temperature, low pressure reactions are much more efficient than those carried out at high temperatures and high pressures.

Polymerization Products

Along with the development of synthetic organic chemistry a new type of reaction has been discovered which is called polymerization. This phenomenon has been known for some time, but its application to the production of useful materials has been extended very greatly in the last few years. The process is not identical with the usual chemical reaction, but is related to it.

A substance may be produced having a definite composition chemically, and may have all the properties of a liquid. In this liquid some changes may be brought about, whereby the substance becomes a solid, and this change takes place without any change in chemical composition as determined by analytical methods. It has been shown that this occurs by a grouping of the individual molecules together, by chemical attraction, to form much larger ones, thus producing a substance with different physical properties. Although the process has received considerable study, the mechanism is not entirely clear, but in some cases, an explanation for polymerization has been discovered. By analogy it can be likened to the assembling of freight cars to make up a train, where, initially, the individual cars have an existence as separate molecules, but when joined in a train they represent a single molecule.

Another type of polymerization occurs, which is more complex, but equally important. This change may be illustrated in the following manner: Let us suppose that we

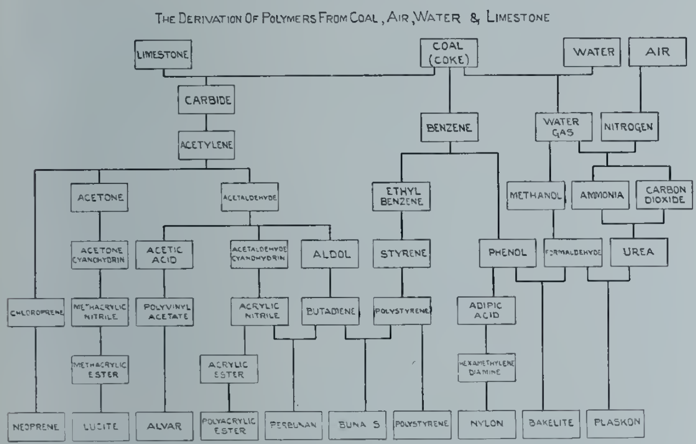

Fig. 3.

have a room full of people, that for some reason they are divided into pairs, and each member of a couple is holding his, or her, partner by both hands. In this case each couple would correspond to a molecule, say, in the original solution, and each couple is free to move independently of any other couple. Suppose that under some urge the people in this room decide to change the general pattern, whereupon every partner frees one hand and grasps the hand of a partner of an adjacent couple, thus possibly forming rings of ten or more people, or "figure eights" or any other odd figures in which all are holding hands. This new group must now move about as a whole and would correspond to a new and larger, or polymerized, molecule.

Much has been written concerning the many new products formed by this process of polymerization, most of which may be said to be manufactured from coal, air, limestone and water, and sometimes salt. The description of their manufacture would prove a very long story. Figure 3 is an attempt to show their relation to the basic materials named. In chemical synthesis coal as it occurs in nature is seldom used as such, but is first converted to coke. Many of the products obtained during the coking process find a useful place in industry.

The list of products shown in the figure is not intended to be exhaustive, but rather to illustrate the number of chemical steps required to reach the desired result.

From coke and water, methanol can be obtained. If nitrogen from the air be added it is possible to obtain ammonia, and at the same time, carbon dioxide is produced. Ammonia and carbon dioxide can be reacted to give urea, which, with formaldehyde obtained by oxidation of methanol, gives urea formaldehyde plastic, the best known of which is perhaps Plaskon. From coal, benzene can be obtained which can be converted to phenol, and this, with formaldehyde, gives rise to the well known material, Bakelite. Phenol can be converted to adipic acid, which, on treatment with ammonia yields hexamethylene diamine. The combination of the acid and the diamine gives rise to Nylon. Benzene can be converted to ethyl benzene, and thence to styrene, which, on polymerization, gives rise to polystyrene, a valuable plastic.

Calcium carbide is produced from lime and coke at high temperature and the carbide with water, yields acetylene. Acetylene with water at ordinary temperatures in the presence of a suitable catalyst yields acetaldehyde, and with steam, gives acetone. From acetaldehyde, through the aldol condensation, followed by removal of the elements of water, butadiene can be obtained. (A more usual source of butadiene is the by-product gases from oil refineries). The interpolymer of butadiene with polystyrene gives Buna S, a synthetic rubber. Again, acetaldehyde with hydrocyanic acid, which can be obtained from ammonia and menthanol, gives acetaldehyde cyanohydrin, and by removing the elements of water from the molecule, acrylic nitrile is obtained, and this, on interpolymerization with butadiene, gives Perbunan, another type of synthetic rubber.

These two rubbers were developed in Germany, and unfortunately have rendered the Germans almost independent of imports of natural rubber.

From acetaldehyde, acetic acid may be manufactured, and the acid, on reaction with acetylene, gives vinyl acetate which can be polymerized, and on further modification, gives a plastic commercially known as Alvar.

From acetone and hydrocyanic acid, through the cyanohydrin, methacrylic nitrile can be obtained, and on hydrolysis with water and esterification with methanol, methacrylic ester is produced. The ester polymerizes to give a colourless, highly transparent plastic, known as Lucite, Perspex and by various other trade names.

The addition of hydrochloric acid to the chart gives interesting products. From acetylene and the acid, vinyl chloride and chloroprene can be obtained. Chloroprene polymerizes to a synthetic rubber known as Neoprene. Vinyl chloride and vinyl acetate form an interpolymer which gives a plastic known as Vinylite, and from vinyl chloride, Koroseal may be obtained.

The list of products given above is by no means complete, but must be considered as illustrative only, and undoubtedly many new products will be added to these in the future.

The achievements of to-day are the result of painstaking effort on the part of numerous research workers and experimenters, who have, at all times, diligently sought out the truth of material things. All of them, including the earliest experimenters, and even the early philosophers, have had some part in building up that phase of endeavour which to-day is classed as chemical industry.

AERODROME CONSTRUCTION IN SASKATCHEWAN

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Paper presented before the Regina Branch of the Engineering Institute of Canada, December 20th, 1940.

Airports are generally defined as those serving a large centre, from which a number of branch lines may operate, whereas the term aerodrome is applied in a general way to fields used for more occasional or special service.

For the information of those not familiar with the different terms used in connection with airports and aerodromes, the following notes are given:

A Landing Strip—may be defined as an area forming part of an aerodrome, which area is of sufficient length and breadth, and which presents a surface of such a nature as to be suitable for the safe taking-off and landing of a specified type of aeroplane. (The minimum area which is considered satisfactory for the smallest aircraft is 1,800 ft. long, and 300 ft. wide. Dependent on the size and characteristics of the aircraft which are to be used, it may be necessary to increase the length to 5,000 ft., or even 6,000 ft., and it is desirable, in all circumstances, to have the strip at least 500 ft. wide).

A Runway—is defined as that portion of a landing strip, being not less than 100 ft. in width, which is artificially built up with crushed rock, asphalt, cement, or other material, to provide a satisfactory surface when, by reason of weather, the natural surface condition of the landing strip is unfit for safe operation.

A flightway—may be defined as an area extending along the course of a landing strip, its centre line coincident with that of the landing strip, being of a width 600 ft. greater than the width of the landing strip, and extending for an indefinite distance beyond the limits of the aerodrome in either direction.

A Taxi Strip—is defined as an area of suitable dimensions, and having a proper surface to permit the safe movement of aircraft on the ground from one part of the aerodrome to another. (As from landing strip to building area; building area to re-fuelling pumps, etc.).

In establishing the Trans-Canada Airways across the country, aerodromes were spaced between the airports roughly at intervals of about one hundred miles, so that they might be used in cases of emergency when conditions force a landing. The advantage of these intermediate fields is more distinctly felt by itinerant flyers, and particularly those aircraft that are not equipped with a radio.

In the case of airports which must serve large centres of population, the problem arises of locating a site, sufficiently close to the centre of the city, to be readily available to passenger and mail service, and at the same time far enough away to provide for a proper flight way to the runways.

In regard to the location of aerodromes for the British Commonwealth Air Training Plan, it was necessary to keep in mind that the flight-ways in the direction of prevailing winds should be clear of obstructions, that a supply of gravel should be available without a long haul, and that a supply of water could be obtained. The sites were chosen so as to avoid the construction of long power lines. It was desirable also that wherever possible, the aerodromes constructed to accommodate the personnel and trainees of the various flying schools should not be too far away from a fairly large centre of population. The sites also had to be chosen, having regard to drainage, and the amount of excavation required to level the field.

When this great plan was launched, the Department of Transport undertook to provide the necessary aerodromes, the buildings for which were to be constructed by the R.C.A.F. Saskatchewan's share in this scheme comprised nineteen fields—two of which are Bombing and Gunnery Schools, one situated near Mossbank and the other near Dafoe. Five Service Flying Training Schools have been developed near larger cities and towns. For each one of these schools three aerodromes were constructed—a main and two relief fields. This makes a total of fifteen fields for the five Service Flying Training Schools. Two schools were developed at Regina and two at Prince Albert for Elementary Flying Training classes and Air Observer's classes. This required extensions of the fields at these cities.

After the sites had been chosen a considerable number of survey parties were organized for the detailed survey of the fields. At this time, our engineering staff in Regina was very small. Help was kindly given by the Department of Highways, and the City of Saskatoon engineering staff. The City of Regina engineering staff promptly prepared the plans required for extension of the airport there.

Fifteen sites were surveyed. The contour plans showed the surface at two-foot intervals. The zoning plans indicated the precautions necessary on the area surrounding the site chosen to keep the flight-ways clear of obstructions. Soil charts were made up after test borings of each site had been completed. In the original programme for Saskatchewan there were to be two Service Flying Training Schools, two Bombing and Gunnery Schools, two Air Observers' Schools and four Elementary Flying Training Schools. A little more than half of these schools were to be established during 1940, but following the events of April and May in Europe, the programme was changed to develop nineteen aerodromes. At the present time (November, 1940), all but two of these can be used for training purposes. The construction of so many aerodromes in one season, has been a work of very considerable magnitude.

The grading operations necessitated the moving of 2,600,000 yards of earth. This, in terms of prairie highway construction, would be equivalent to grading approximately 260 miles at 10,000 cubic yards per mile.

Of the nineteen aerodromes which were surveyed, designed and constructed within a year's time, twelve were built with hard surfaced runways, and seven of the aerodromes were graded and seeded to be used as grass fields.

The hard surfacing of such large areas as are required in airport runways, presents a real problem. Great variations are encountered in soil characteristics in this province. Owing to the number of dust storms that have succeeded one another across the face of the prairies for centuries, the soil conditions in one spot may be vastly different from those of another, even fifty or one hundred feet away.

The soils in the south central and eastern parts of Saskatchewan and the southern part of Manitoba present this difficulty in an acute form. In places, these soils are capable of a change of volume up to sixty per cent. The amount depending on the moisture content. Such conditions make the use of concrete as a runway paving of very doubtful value. The use of plant-mix asphalt in material in the paving of runways did not offer a solution. Such runways were laid in Winnipeg and Regina in 1937, resting directly on a clay subsoil base. In 1938 they had failed to a point where it was necessary to replace them with runways of some new design. After consulting with the city and provincial highways authorities, it was decided to make use of stabilized gravel as a base course.

An east-west runway was built in Winnipeg in the fall of 1938 using a six-inch mat of well compacted stabilized gravel. After the subgrade was established, and the proper crown prepared, it was thoroughly rolled and compacted by the use of sheepsfoot rollers.

This runway stood up well and has not given any trouble except in places where insufficient compaction of the subgrade occurred. This runway also had the advantage of side drains which were built to take care of the surface water from the runway surface.

At the time it was constructed it was too late in the season to put down the plant-mix top of asphalt as originally proposed. The stabilized surface was merely primed and sealed. The type of stabilized gravel base used here was not that to which a small percentage of asphalt is added as is the case to-day. In some places this runway softened up owing to moisture finding its way into cracks in the surface. This was a small fault but one to be overcome.

The next year, after laboratory experiments it was found that the addition of from one to one and a half per cent of a light asphalt oil to the stabilized material rendered it almost impervious when properly compacted and set up. The next year this procedure was adopted in the construction of the N.W.-S.E. runway at Regina.

About this time it became obvious that great care should be given to the preparation of the subgrade. Methods of obtaining the maximum density of the soil were adopted. As a measure of precaution in bad soil conditions, the subgrade is now compacted to a depth of ten inches. This is carried out in two operations, each one handling five inches in a lift. The soil is just brought to its optimum moisture content in most cases by the addition of water and then rolled with sheepsfoot rollers until the required bearing strength is obtained. Having obtained its greatest density, the soil in some measure resists the absorption of further moisture and has no marked tendency to shrink.

In the construction programme of 1940, two types of base course have been used. One, known as the consolidated gravel base, was a mix-in-place crushed rock and gravel base with sufficient soil binder for compaction, and the other was, as before mentioned, a plant-mix stabilized gravel.

The consolidated base was found to be more economical since the control of the mix was not so exacting. It consisted of aggregate from 2 in. down with as large a proportion of crushed material as possible. It contained not more than 10 per cent of a cohesive soil. This type of base course differs from stabilized gravel mainly in that no effort is made to obtain density. Bearing values only are sought. It is not impervious to moisture and should have a fair amount of flexibility. The two types differ in design, but are meant to serve the same purpose.

All hard surfaced runways, except in the case of Regina, were given a two-inch cover of plant-mix asphalt. There is one exception to this. At Vanscoy a two-inch course of mix-in-place asphalt was laid.

The asphalt used for this two-inch layer is of two varieties. For Bombing and Gunnery Schools a harder quality of asphalt was used, known as 150-180 penetration. In all other cases the S.C. 2,000 or S.C. 5 heavy asphalt served the purpose.

All runway surfaces were protected by side drains except at Vanscoy and Dafoe. In most cases the side drains consisted of a perforated or open joint pipe laid in a deep trench and back-filled with gravel passing the 2-inch mesh and retained on the half-inch mesh. All drainage systems had an adequate number of catch basins available for cleaning the drains and as intakes for surface water.

At Dafoe, this method of drainage proved unsuitable owing to the nature of the soil. Here the subsoil was for the most part a fine sandy loam, 40 per cent of which passed a 200 mesh sieve. At this site it was found that the wash from the runway surfaces cut into the soil of the sides of the gravel-filled trench, rapidly choking the perforated drain pipes and finally the voids in the gravel back-fill. This soil was so light that it went immediately into suspension when contacted by flowing water. Catch basins on this aerodrome must then be relied upon for the intake of surface water and to provide drainage for the runways. Along one runway however, we experimented with a galvanized gutter trough filled with coarse gravel. This is provided with down pipes every 100 feet which feed into the main storm sewer buried along the side of the runway. So far this has proved successful.

Some statistics of the work accomplished during 1940 are as follows:

2,600,000	cubic yards of excavation
52.4	miles of storm sewers or drains
495	manholes
701,108	tons of gravel and clay in base courses.

206,139 tons of hot plant-mix asphalt, or enough material for 206 miles of bituminized gravel road in a two-inch layer twenty feet wide.

The amount of liquid asphalt used of all kinds was 3,040,000 gallons or from 380 to 400 tank cars.

Although only a little more than half the fields were seeded we did about 5,400 acres of seeding.

68 miles of fencing were erected of 4 strand barbed wire, using cedar posts spaced a rod apart.

Besides the work outlined above the supply of water to the fields had to be undertaken. At Moose Jaw, Swift Current, Saskatoon, Yorkton and North Battleford, water was piped from the cities. At Dafoe, Mossbank and Prince Albert wells were drilled to provide the supply. In all, seventeen miles of water main were laid.

Power had to be supplied to all but five aerodromes. To do this it was necessary to construct approximately 123 miles of power line. This does not include the secondary distribution lines within the building area at the sites. This work was all very capably carried out by the utility companies concerned. In order to insure proper service it was necessary to link together some of the distribution systems already established.

To clear obstructions both power and telephone lines had to be diverted in many localities.

Finally a proper telephone service had to be brought into the aerodromes which necessitated the establishment of their own switchboards. Lines of communication had to be constructed to connect the various aerodromes in each group and to provide connections to the bombing ranges.

Roads were built or are to be built or improved to connect up each group of fields and to provide access to the bombing ranges.

The field lighting necessitated the laying of miles of cable and installing of hundreds of lights of different kinds. The following figures give an idea of the amount of work of this kind:

1. Underground cable duct installed......	28,350 ft.
2. Boundary light cable installed.........	46,450 ft.
3. Contact light cable installed..........	55,000 ft.
4. Miscellaneous cable installed..........	10,000 ft.
5. Contact lights installed...............	412
6. Boundary lights installed.............	164

To build up an engineering staff capable of looking after so great a task it was necessary to increase the peace-time establishment by adding capable and experienced men. In this effective assistance was given by the Saskatchewan Department of Highways, the staff of the Prairie Farm Rehabilitation Act, the engineering departments of the cities of Saskatoon and Regina, the University of Saskatchewan and the Provincial Association of Professional Engineers.

The engineering staff then comprised one District Airway Engineer, two Assistant Engineers, and fifteen Resident Engineers.

In addition to these, instrumentmen, rodmen, chainmen and inspectors were secured through the Department of Highways, the Prairie Farms Rehabilitation Act staff and the University of Saskatchewan.

The engineers and contractors, together with the manufacturing firms, co-operated in meeting the emergency, and rapidly carried out one of the largest construction programmes ever projected in western Canada.

RESEARCH IN CANADA*

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Paper read before the Royal Society of Arts, London, Eng., April 13th, 1941

(Abridged)

It is to your precept and example in 1916, in the organisation of the Honorary Advisory Council for Scientific and Industrial Research, and the suggestion then made by the Government of the United Kingdom to our Government, that Canada should set up a similar body, that we trace the genesis of our own National Research Council. In the year 1916, we were in the earlier phases of the first World War and it had taken the impact of that event to shake the British peoples, both here and in the Dominions, from their complacency as regards research. Previously we had left research mostly to the universities, where its results as "pure science" were made available impartially to all, for the benefit of friend and foe alike. On the other hand, in industry, where mutual help would have been of great advantage, whatever each company was able to develop in the way of new apparatus, materials and processes was regarded as a trade secret, to be jealously kept to themselves, and particularly to be denied to other firms in similar business in their own country, though not necessarily to foreign associated companies.

Contrast this situation with that existing in Germany, where research—pure, applied, and industrial—had very early been recognised as a matter of profound concern, and where its organisation and correlation had been taken under the auspices of the Government itself. Under this meticulous care, every idea and invention was seized upon and subjected to intensive development at the hands of comprehensive groups of trained scientists; eager business men stood ready to exploit whatever they produced. There are many who will remember how this, and neglect on the part of other nations, had reacted to the great advantage of German world trade and so to the creation of a vast potential for munitions production in war. You know also of the great difficulties which faced the Allies on the outbreak of hostilities by reason of the German monopolies. The German dye industry, for example, which had taken the invention of a British chemist and turned it into a great commercial undertaking, led directly to efficiency in the production of explosives and of poison gas. I have often wondered why this menace was suffered to develop without adequate counter measures being taken, and it seems, on looking back, that its very gradualness must have been the answer, men's minds becoming accustomed to it by degrees.

Once started, British research in its relation to the war effort of the country developed rapidly and effectively, and at the end of the first World War it could be said with truth that one of the essential contributions to victory had been made by British and Dominion industry, once scientific and industrial research was organised and brought into play. To illustrate what was accomplished in Great Britain I mention a few significant facts. In 1914 there was no optical glass industry in the United Kingdom. Germany and Austria had a practical monopoly in this field, and even the lenses of the sights of British guns were imported. Organisation of the scientists, followed by extensive basic and applied research, corrected this situation. To-day, the optical glass produced in Britain is of the finest quality in the world. I mentioned poison gas—chlorine—a product of the German chemical industry which was used against the French and the left flank of the First Canadian Division on April 22, 1915. The Germans used it against us thinking that the Allies would not be able to reply in kind (they were contemptuous of our scientific organisation), but by the summer of 1918, as a result of organised research, our chemical industries were producing mustard gas by a new process at a rate many times that which had been found possible by Germany.

The National Research Council and its Development up to 1939—As I have said, the organisation of research in Canada as a function of Government dates back to 1916, when we followed your example and set up an Honorary Advisory Council for Scientific and Industrial Research. It was not contemplated then that this Council would establish laboratories of its own; it was to act as an agency for consultation and co-ordination between those already carrying on research in the existing laboratories of the several departments of the Dominion and Provincial Governments, in the universities, and in industry. To give you some idea of the very limited facilities then available: a report prepared at the time indicates that the total annual expenditure on research in all Government laboratories, both Dominion and Provincial, amounted to considerably less than $100,000, and that of some 2,400 leading Canadian firms engaged in manufacturing which replied to the questionnaire sent out, only 37 possessed laboratories which even pretended to engage in research work.

Looking back at the history of the Honorary Advisory Council for Scientific and Industrial Research, in the war and early post-war periods, it is remarkable what was accomplished with the limited facilities at their disposal, but it is not to be wondered at that men who were informed on the subject should have realised the utter inadequacy of the provision which had been made and that they should have pressed for some improvement. As a result of the pressure of public opinion which developed, the matter was repeatedly considered in Parliament, and eventually the Research Council Act was passed in 1924, following in very close detail a draft which had been prepared by a non-party committee representative of both the Senate and the House of Commons. The Council's main laboratories, located at the junction of the Ottawa and Rideau Rivers, were commenced in 1930 and opened at the time of the Imperial Economic Conference in 1932.

As was perhaps to be expected in the era following the Armistice of 1918, it was very dificult to obtain adequate funds for scientific and industrial research. While the need for co-ordination of this work as a war-time measure had been evident, recognition of the equally vital needs of competitive industry in peace-time came only very slowly until 1935, when the Government, despite the depression then raging, saw fit not only to double the current appropriation, but to provide substantial sums on capital account to complete the equipment of the laboratories. These increased appropriations were maintained by succeeding governments and steadily increased until, by 1939, the Council's annual budget on current account was somewhat over $1,000,000. Meanwhile, an even more striking increase had taken place in the facilities in Canadian industry itself, and by 1938 it is estimated that these comprised upwards of 1,000 industrial laboratories for research testing and plant control, with some 2,500 professional workers employed full time. Similarly, in the Dominion Departments of Agriculture, of Public Works, and of Mines and Resources the last two decades have seen the creation of a number of research and testing laboratories related to their special functions and duties, all of which represent a very substantial asset. Elsewhere the most notable addition was the Ontario Research Foundation, which operates in the most friendly relation with the National Research Council.

In 1938, provision for a further large group of laborator-

* From *Engineering*, (London), July 25th, 1941.

ies, to provide the Council with additional facilities, particularly for aeronautical engineering, hydraulics, and high-voltage electrical engineering, was sanctioned by the Government. Construction was started in 1939, and is now advanced to the point that in some cases the buildings are in occupation. As a result of these measures, we had in Canada at the outbreak of the present war, in physical existence, the laboratories and trained staffs competent to act as a nucleus in undertaking the study of the problems presented in almost every field of war requirements, both within the sea, land and air forces themselves, and also in the industrial life of the country as it had to be re-oriented to produce the vast and complicated supplies needed in transition from peace to war basis.

I have been speaking of the actual research equipment of Canada, in the way of Government and industrial laboratories, as it stood at the outbreak of the war with a view to indicating the very favourable position in comparison with the situation on the previous occasion when we had to take up arms against Germany. But the adequacy of physical equipment and technical staff is only one side of the question, and what is probably equally important as an asset is the organisation of the Council itself as a going concern and the intimate relations which had been developed with every branch of science in Canada; with universities; with industry; with departments of the Dominion and Provincial Governments concerned with research problems; with the great professional societies in medicine, engineering, forestry, etc.; with the Canadian Engineering Standards Association in the field of industrial standardisation, and with many other organisations.

The National Research Council consists of fifteen members selected for terms of three years from among men prominent in scientific work in Canadian universities or in Canadian industry. The Council is required by statute to meet at least four times annually in Ottawa. There is a president, appointed by the Governor in Council for a term of years, who reports directly to the Privy Council Committee on Scientific and Industrial Research of which the Minister of Trade and Commerce is the chairman. The office of president is now filled by Dean C. J. Mackenzie, M.C., of the University of Saskatchewan, an eminent civil engineer who served with the Canadian Forces in the last war. The Council's membership is broadly representative of all parts of Canada, and includes persons qualified to speak with authority in education, science, industry, business and finance. Apart from administration which is organised much on the usual lines of a department of Government, the staff of the Research Council is grouped in a number of divisions, each of which is under a director.

The divisions of physics and electrical engineering, chemistry, mechanical engineering, including hydraulics and aeronautics, biology and agriculture, are responsible for the direction and conduct of the technical work in the fields indicated by their designations. There is a section on research plans and publications concerned with the collection, collation and issue of scientific information and with the general development of co-operative investigations through committees, etc. There is also a section on codes and specifications, matters which are in the highest degree important in relation to mass production in war. Provision is made for the closest co-operation and collaboration between all branches concerned in any particular problem. One of the great advantages possessed by an organisation such as the Council's own laboratories, with their comprehensive representation of all branches of science, is that experts in every line required can be brought together at short notice to study a problem and to work as a team for its solution. This facility is very important, for in most research problems related to industrial or agricultural production or processing we are usually confronted with limiting factors of many kinds, and it is not easy to determine in advance in which branch of science the answer should be sought.

Associate Committees and Co-operative Research—Under the wide responsibilities placed upon the Council by Parliament, there is a duty to bring about the best possible use of all the country's facilities for research, of which the Council's own laboratories now represent only a small part. In order to bring to bear the knowledge of scientific men in other institutions and in industry and to correlate the work of research in all organisations concerned, a number of so-called "associate committees" have been set up. The function of these committees is to direct co-operative research on the problems assigned to them; to settle the objectives; to indicate the individuals or organisations which should undertake the several component parts of the inquiry; to receive and co-ordinate the resulting information, and to make it available to those who will turn it to advantage. The Council endeavours to ensure that these committees are comprehensively representative of all interests, and we expect them, each in their proper sphere, to form a national plan into which all who are in a position to contribute information can fit their own particular lines of research. The actual investigations are carried out, not only in the Council's laboratories, but in the laboratories of the various universities, Government departments and industrial institutions throughout the country. I cannot too strongly stress the fact that much of the initiative in these committees lies with the outstanding experts from other organisations who have associated themselves with the National Research Council in this work.

Time does not permit me to recite to you the long list of these associate committees or to go into, in any detail, the important tasks which they are carrying out for Canada. But, in order to give some picture of the wide range of work involved, I should like, by way of illustration, to mention one or two in several diverse fields. In agriculture I would mention the committees in charge of grain research and of transport and storage of food—these, both by reason of the great importance of the subjects and also on account of the very substantial results which have been achieved in comparison with the trifling expenditures of money which have been made. In forestry, I would mention the committee, organised in co-operation with the forest service of the Department of Mines and Resources.

This Committee has concerned itself with such matters as the study and mitigation of forest hazards, through fire, insects and other pests, and the preparation of a manual giving advice as to the management of the "farmers' woodlot," a most important source of raw material. This manual is now in general use in the Maritime Province and Quebec. I could continue with examples of the work of many other associate committees in the fields of medicine, chemistry, physics and engineering; of the detailed and exacting work carried out by our joint committees with the Department of Finance in the preparation of a National Building Code for Canada, which is now, despite the war, in process of publication, and which should bring order into a situation which, under the conflicting jurisdiction of municipality, province and dominion had become most seriously confused to the disadvantage of the public. I could cite also the work on industrial codes and specifications carried out by the Canadian Engineering Standards Association, which is a body intimately related to the National Research Council, and serves Canada as the counterpart of the British Standards Institution in this country.

Encouragement of Research in Universities, etc.—In order to make use of the facilities for research which exist in a number of our Canadian universities and to encourage their further development, the Council, in the early years of its existence, instituted a system of assisted researches through which the professors in charge could be given financial assistance for the provision of needed apparatus, laboratory help and similar out-of-pocket expenses, other than their own salaries. Applications for such assistance are most sympathetically considered and by its aid much useful work has been accomplished, of value both for the new knowledge secured and, perhaps even more important, for the training given to the workers. Another aspect of the Council's concern with the training of research workers is represented by the scholarships which each year are awarded to some 70 or more post-graduate students. These are tenable at Canadian universities or, in special cases, abroad. Though these scholarships, which are being given year by year in increasing numbers, in addition to providing the needed supply of highly trained research workers, a deliberate attempt has been made to assist the building up of the post-graduate schools in the Canadian universities.

From what I have said about associate committees, assisted research and scholarships, I hope I have made it clear that while the Council has itself a number of very well-equipped laboratories in all lines, yet there has been no attempt to monopolise research; in fact, the very opposite, for it has long been realised that for the safety of the nation against peace-time industrial competition, let alone to meet the needs in war, you can never have too much research.

Research Information and International Affiliations—In peace, in order to maintain our contact with research work going on all over the world, the Council maintains membership in the principal International Scientific Conferences and meetings, arranges for Canadian representation where required, and collects in its library in Ottawa, for reference, copies of all papers, proceedings and other information of importance. This is made available as desired to Canadian workers. For many years also the Council has maintained the closest possible contacts with the Department of Scientific and Industrial Research and the British Standards Institution here. These contacts were strengthened and developed by the Imperial Conference of 1930 and the Imperial Scientific Conference of 1936, and again in August, 1939, on the occasion of the visit to England of a representative group of Canadian manufacturers, who had come to England to familiarise themselves with the needs of war-time industry, so that Canadian production could be directed to those articles which would be most required and most useful.

War-Time Developments—I have endeavoured to give you a brief picture of the origin and growth of the National Research Council up to the outbreak of the war in which we are now engaged. Relatively satisfactory as the situation had become when compared with 1914, I have not claimed that we had in Canada anything which was in any sense an adequate answer to the problems of competitive industry in peace, and certainly, as regards war, we scarcely dare, in the years of the ascendency of the Geneva school of thought, to admit that some of the research work in hand might even have an indirect value for defence. Apart from meeting the problems of the day as they presented themselves, what had been aimed at was the creation of a nucleus round which the research resources of the nation could be crystallized in order so soon as the real needs were recognised by public opinion and Parliamentary support was forthcoming. That such a nucleus was in fact created will, I think, be evident from what now I have to tell you with reference to the war-time developments of research in Canada. In this I am under the difficulty that no specific information which would be of value to the enemy can be disclosed, so I have to content myself with a few illustrative statements which must be rather general in character.

First, as regards finance. The funds placed at the disposal of the Council for the current year by votes from Parliament and grants-in-aid from the Naval, Land and Air Forces in the Department of National Defence are some five-fold greater than for the last pre-war year. In addition, the Council and its technical staff will be responsible for the scientific and technical organisation and advice in connection with other projects not directly administered, which will involve about twice to three times as much again. Further, in order to provide some measure of elasticity in the finances of the Council a number of Canadian corporations, large and small, and private individuals have joined together to establish a trust fund of well over a million dollars, with more available if required. The committee in charge has been enjoined by the donors to make it their business to ensure that no worthwhile project of research, related to the war effort of Canada, which is sponsored by the National Research Council, should be delayed or hampered by the lack of money. In this public-spirited group the mining industries of Canada have, as usual, been conspicuous for their generous support of research. Another example of the assistance received from this source is the support given to the Canadian Corps in the organisation and equipment of our Tunnelling Companies. One of these, as is well known, is now at Gibraltar making effective use of the modern machinery presented by the Canadian mining industry. The other Company is using similar equipment in this country.

What is, in effect, a further additional expansion of the Council's activities is represented by Research Enterprises, Limited, a wholly owned Government corporation which has been set up by the Canadian Ministry of Supply primarily to produce for the armed Forces, and for industry, inventions and apparatus which had been developed in the Council's laboratories. Already, optical instruments, including gun sights and range finders, radio gear and similar articles, are in production in the large new factory which has been erected, and very shortly the company will be turning out its own supplies of optical glass in quantity. Thus a small nucleus established in the optical and radio laboratories in the years before the war has been given substance and developed into a key industry of essential importance for our war effort. The Council's metrology laboratories are another example of a small but effective nucleus which has been expanded to large dimensions to care for the standardisation of the vast number of gauges necessary in the munitions industry.

In the field of radiology, special attention has been paid in the Council's laboratories for many years to the examination of castings, particularly those in light alloys required to carry stress in aircraft construction. Working with the producers, the technique of making sound castings had been developed before the war to a high degree of perfection, and the knowledge of this art is now proving of great value to the Canadian aircraft industry. X-ray photographs can be taken at up to 600 kV, which is sufficient to penetrate several inches of steel. For greater thicknesses a plentiful supply of radium is available by reason of the fact that the bulk of the world's new supply derived from the mines at Great Bear Lake and refined by the Eldorado Company at their Port Hope plant comes to the Council for test and certification. Turning to another of many fields, I should like to mention the very important programme which has been initiated by the Committee on Aviation Medicine under the chairmanship of the late Sir Frederick Banting.

In conclusion, I wish to assure you that all this great range of work of which I have been speaking is going forward in Canada in the closest sympathy and understanding, both with the authorities here and also with our mutual friends and colleagues in the United States. In order to help in the maintenance of effective contact the British Government has established a Scientific Liaison Office with the Council in Ottawa, and we have been privileged to receive first, Professor Fowler, and more recently, Sir Lawrence Bragg. At the present time a number of the senior members of the Council are in England to familiarise themselves with the latest methods and requirements so that our work may be kept related to problems of immediate practical importance. There is a constant flow and interchange of workers and the various problems are taken up as available facilities best indicate. Needless to say, there is no delay or reservation in making the results available for application and use.

EQUIPMENT AND ARMAMENT OF THE ROYAL AIR FORCE

LIEUT.-COL. W. LOCKWOOD MARSH
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SUMMARY—The two articles which follow have been released by the censors, and give some data regarding new types of aeroplane now in production at the works of the British aircraft industry, and information as to the armament of some of them.

Planes of the R.A.F. and Fleet Air Arm

Since they came into prominence in the spring of 1940, both the Hurricane and Spitfire have been improved to give even higher performance. A more powerful Rolls-Royce Merlin engine is installed which develops some 1,250 horse-power. The later Hurricane is fitted with "stressed-skin" metal-covered wings, while the Spitfire, in the Mark III version, has had 22 inches taken off each end of the wings—the resulting square tips rather marring the appearance of the original elliptical shape—to give it an increase in speed to a figure which is only a few miles below 400 m.p.h.

Both have been used most successfully on moonlight nights in defence against the enemy bombers and the Spitfire III, at any rate, is frequently fitted with a shell-firing "cannon" gun. But both the Hurricane and the Spitfire are due for replacement by the new Hawker Tornado and Typhoon.

The Tornado has the new Rolls-Royce Vulture engine of interesting design, with 24 cylinders arranged in the form of an X, developing something over 2,000 horse-power. The Typhoon is equipped with the Napier Sabre engine which produces 2,400 horse-power. This engine is a development of the early Rapier and later Dagger engines—the latter fitted in the Hereford version of the Handley Page bomber, known as the Hampden when fitted with Bristol radial engines. All these Napier engines are designed by Major F. B. Halford and are unusual in that the cylinders are arranged in the shape of the letter H with the crankshaft and camshafts forming, as it were, the cross-bar in the middle.

The Sabre differs from the Rapier and Dagger, apart from the size, in being liquid-cooled instead of air-cooled. All Rolls-Royce engines are, of course, and have been for a good number of years now, also liquid-cooled. The Typhoon is officially stated to have a maximum speed "well over 400 m.p.h."—an American paper says 410 m.p.h.—and the Tornado's speed has been stated by an American paper (quoted by Lord Beaverbrook) to be 425 m.p.h.; but in fact, the former is probably slightly the faster.

NEW NIGHT FIGHTERS' RECORD

Two aeroplanes in the twin-engined fighter class have been produced—the Westland Whirlwind and the Bristol Beaufighter. The former is a single seater, low-winged monoplane, with two Rolls-Royce Merlin engines, of which no more details can be given. The Beaufighter is known to have been developed, as the name implies, from the Bristol Beaufort general-purpose type, with, of course, a smaller fuselage, as only a crew of two have to be accommodated.

Equipped as a long-range day and night fighter, the Beaufighter is an all-metal midwing monoplane, powered by two Bristol-Hercules engines developing 1,400 h.p. for the take-off.

This interesting aircraft mounts ten guns, has a range of 1,500 miles and flies at a nominal speed of 330 m.p.h. Great destructive power is provided by the four 20 mm. cannon guns in the fuselage and six Browning machine guns in the wings, while extensive fuel tanks make the plane suitable for long-range raids, escorting bombers on their expeditions and carrying out lightning attacks on enemy planes raiding Britain. Special hatches under the fuselage allow the crew to make a safe and speedy exit when necessary, and other devices which are still secret remain far in advance of anything the Germans have been able to develop. It has lately been revealed that Beaufighters made a highly successful attack upon aerodromes in Sicily on June 28 last, when between thirty and forty enemy aircraft were destroyed on the ground and many others damaged.

No performance figures are yet available for the Whirlwind but, like the Beaufighter, it is intended to provide effective fighter protection for long-range bombers, at a greater distance from its base than is possible with the single-engined type with its limited range, and also for seeking out and destroying enemy bombers, such as the Focke-Wolf Fw 200 Kurier which carries out marauding attacks on convoys in the Atlantic.

Pending the appearance of these two machines, the bulk of their work has been carried out by the Bristol Blenheim Mark IV bomber, modified to act as a twin-engined fighter. The Beaufighter has also been used with success for night protection against enemy raiders; as has, of course, the Merlin-engined Boulton Paul Defiant with four-gun power-operated turret.

An idea of the success that has been achieved by the new night fighting methods is shown by the fact that, in the month of April, 50 enemy machines were brought down by night fighters out of a total of 88 destroyed, This figure of 88, incidentally, compares with the previous "record" of 46.

NEW FOUR-ENGINED BOMBERS

A series of new four-engined bombers are coming into service, of which one—a Stirling—made a remarkable daylight raid on Emden on one of the last days of April, audaciously coming down to 1,500 feet from the ground to drive the attack home by machine-gun fire. This machine is the latest product of Short Brothers of Rochester who have hitherto concentrated on a long line of successful seaplanes such as the Empire flying boats and Sunderland reconnaissance boat, used by the Coastal Command of the Royal Air Force. It has been stated to have a wing span of 99 feet, range of 3,000 miles and maximum speed in excess of 330 m.p.h.

The "Hurricane" *Photo "The Aeroplane"*

Handley-Page have brought out the Halifax as a successor to the Hampden, of which it may be considered the four-engined development.

A new heavy twin-engined bomber is the Avro Manchester, powered by two Vulture engines—a high performance machine of somewhat unusual appearance. According to Lord Beaverbrook (quoting American papers) it has a wing-span of 90 feet and a speed of 325 m.p.h.

The Training Command has been strengthened by the acquisition of the Blackburn Botha, with two 930 horse-power Perseus sleeve-valve engines, originally designed as a torpedo-bomber.

The Fleet Air Arm of the Royal Navy has now been almost completely re-equipped with Perseus-engined Blackburn Skua dive-bombers and Roc two-seater fighters and the Fairey Merlin-engined Fulmar two-seater fighter and Albacore torpedo-carrying general reconnaissance bomber with a Bristol Taurus-engine.

The "Blenheim IV" *Photo "The Aeroplane"*

Development in Aeroplane Armament

In any weapon of warfare—aeroplane, battleship, tank or machine gun, apart from such considerations as mobility (speed) and manoeuvrability, the final, dominating factor, when action is joined, is fire power.

It is interesting, therefore, to see how this has been developed by the two sides in the present struggle after two years' experience of combat. In September, 1939, there is no doubt whatever that this dominant importance of fire power had been better appreciated by the British than the Germans; the credit for which has been variously attributed to Air Marshal Sir Hugh Dowding, Air Officer Commanding the Fighter Command, to Mr. Mitchell, the designer of the Spitfire, and to others. Be that as it may, the two British fighters, the Supermarine Spitfire and the Hawker Hurricane, were overwhelmingly superior in offensive armament to those of any other nation. Each was fitted with eight .303 Browning machine guns—four in each wing—all firing outside the disk of the revolving airscrew, to avoid the necessity for interrupter or synchronizing gear, with a combined striking force of 9,600 rounds a minute (1,200 rounds per gun). By comparison, the German Messerchmidt Me 109E, though fitted for a 20 mm. shell cannon firing through the airscrew hub, was actually rarely equipped with this but relied on two 7.9 mm. Rheinmetal-Borsig machine guns mounted on each side of the engine, firing through the airscrew disk and interrupted each time one of the three blades passes across the muzzles, with two Oerlikon 20 mm. cannon in the wings. The rate of fire of the two cannon (200 rounds a minute) was, of course, nothing like so rapid as that of the machine guns and this, combined with the interruption of the steady flow of bullets from the centrally placed machine guns, meant that the volume of fire which could be brought to bear at close quarters in a short space of time was incomparably less than that of the eight Brownings of the British machines, being only about 2,000 rounds a minute—allowing for the effect of the interruption on the rate of fire of the machine guns. The Heinkel He 113, which was in any case not a success and was never used in great numbers, was similar to that of the Me 109E except that instead of the two wing cannon it had one, firing through the airscrew boss. The American fighters, such as the Curtiss Mohawk, were originally very lightly armed with only two machine guns, but for the Allies have been modified to take two .50 in the fuselage and four .303 in the wings; those mounted in the fuselage being, like the German, interrupted for firing through the airscrew disk.

Taking two representative types of the fighters we have mentioned—the Spitfire and the Me 109—it is interesting to see how their armament has been changed as the result of two years' experience. The Spitfire V has two cannon and four machine guns—all in the wings outside the airscrew disk. The Me 109 F.I. has one Mauser 20 mm. cannon firing through the airscrew boss and still the two "interrupted" machine guns on the fuselage. The rate of fire of the Spitfire has, therefore, been reduced to 5,000 rounds a minute, and the weight of projectile fired per minute reduced from 270 lbs. to about 240 lbs. a minute. The range at which firing can be started has, however, been considerably increased by the introduction of cannon.

Owing to the fact that the new Mauser cannon fitted in the Me 109F has the phenomenal, for a weapon of this calibre, rate of fire of 900 rounds a minute, the total rate of fire of this machine has theoretically been increased from 2,000 to 3,000 rounds a minute and the weight put up from about 180 lb. to some 800 lb. a minute. This figure is not, however, in practice so formidable as it sounds as, owing to the weight of the cannon, the aeroplane only carries 200 rounds for it—which are exhausted in about 13 seconds. After less than a quarter of a minute's engagement, therefore, its rate of fire is reduced to 2,100 rounds a minute and its weight of fire to about 50 lb. a minute—and even this is purely theoretical as it only carries 500 rounds for each machine gun, which are exhausted in about 30 seconds. This figure is, therefore, the extreme limit of time over which it can actually continue firing.

This compares with the 3,000 rounds for each gun carried by the Spitfire; giving a firing period of 2½ minutes.

The armament of the latest type of American fighter to be supplied to Great Britain—the Bell Airacobra—shows a formidable increase over earlier U.S. types. This unusually designed monoplane, the Allison engine of which is behind the pilot driving the airscrew by a long shaft between his legs, carries a 37 millimetre cannon, two .50 calibre and four .30 calibre machine guns. The cannon, which weighs about 110 lb., has a nominal rate of fire of 120 rounds a minute, and 30 shells are carried for it so that it can continue in action for 15 seconds. The .50 calibre machine guns have a rate of fire of 750 rounds a minute and 280 rounds are carried for each gun; giving a firing period of 22 seconds. The effective range of these two guns is 750 feet. The four .30 calibre machine guns have a nominal rate of fire of 1,200 rounds per minute (the same as those of the Spitfire) and 1,000 rounds is carried for each of them; giving a firing period of 50 seconds, which is the maximum period the aeroplane can maintain action. It will be seen, therefore, that the British fighters can continue

Photo "Real Photographs"

The "Messerschmidt," showing nose of aircraft with quick-firing cannon firing through airscrew boss.

an engagement without having to break off for lack of ammunition longer than any of their contemporaries.

Reverting to the Me 109 F.I., it at first sight seems strange that having produced a new weapon offering greatly increased fire power the Germans have apparently failed to take advantage of it by thus limiting its period of effectiveness. This is, however, due to the necessity they felt of at the same time improving the performance of the Me 109 by enabling it to operate at greater heights and increase its rate of climb to those heights—requirements which were not compatible with any serious alteration in the weight of the armament, with its ammunition, carried by the aeroplane.

In the same way, the new Spitfire armament has involved

Photo "The Aeroplane"

The Boulton Paul "Defiant."

some sacrifice in rate, and even weight, of fire in order to start hitting at a greater range with projectiles of increased striking force. The cannon and machine guns now installed may be likened to the "primary" and "secondary" armament of the 14-in. and 6-in. guns in a battleship; the former being used to open the engagement at long range and the latter reserved after closing in for "the kill."

Similar armament to that of the Spitfire V is believed to be fitted in the twin-engined single-seater Whirlwind long-range escort fighter, first mentioned in connection with a British raid on North West Germany early in August, when Whirlwinds accompanied a force of Blenheim bombers as far as the Dutch coast on the outward journey and met them again in the same area on their return, to escort them home.

Turning to other British types, the two-seater Boulton Paul Defiant made a dramatic appearance over Dunkerque in June, 1940, and swept the Junkers Ju 87 dive bombers out of the sky owing to its heavily armed power-operated electrically-driven North (Boulton Paul) turret fitted with no less than four Browning machine guns. This armament enabled it to come up on the beam of the Junkers and fire a broadside into their unprotected flanks, with a devastatingly surprise effect. At that time the Defiant was not equipped with fixed guns for the pilot to operate, which meant that it was itself vulnerable to attack from the front. This defect was remedied and it is now fitted with forward-firing machine guns, which makes it a most formidable machine—as it has proved in night-defensive operations. The latest British two-seater fighter, the twin-engined Bristol Beaufighters, has a heavy armament consisting of four cannon in the central fuselage, firing clear of the disks of the two wing-airscrews, and six Browning machine guns four in the starboard wing and two in the port wing. This gives it a total rate of fire of 7,400 rounds—or about 420 lb.—a minute. These guns are all operated by the pilot, the second member of the crew being observer-navigator cannon-loader, but it is hinted that a power-operated four-gun turret may be fitted in the observer's cockpit.

Two-seaters of the Beaufighter, and, to some extent, the Defiant type (although this, being a single-engined machine really intended for night-fighting is not quite in the same class) are designed for fixing guns firing forward and turrets firing on the beam and aft, so as to equip them to fight anything they may encounter when on the escort duty for which they are designed. Reasonably fast, with a maximum speed of about 330 m.p.h., and manoeuvrable they can meet enemy single-seater fighters with a greater firing power in front, while also having four trainable machine guns in the turret for defence, or offense, against enemy fighters or bombers.

It is undoubtedly the electrically-operated (Boulton Paul) and hydraulically-operated (Fraser Nash) turret which has given the British bombers—and more particularly, perhaps, the day bombers of the Blenheim and Wellington class—their superiority in effectiveness over those of other nations. Prior to its invention, and far-sighted adoption, all kinds of devices such as retractable fixed turrets, revolving windshields and counter-weighted and balanced gun rings had been evolved to overcome the effect of the air stream and make it possible for the gunner to train his gun and fire it in all directions. The bombers being supplied by the U.S.A. were at first, where possible, fitted with turrets on arrival in England but are now modified to be so equipped in the American factories. This will enormously increase the defensive powers of these, and future, types and make them much more valuable weapons. No other country, except Italy, seems to have made any serious attempt to develop this device, which gave England a great initial advantage. The Italians, however, have not, up to the present, been successful in producing a satisfactory turret and the Americans had previously been content for lateral defences to mount machine guns on ordinary mountings firing through windows or "blisters" in the side of the fuselage—a method which has been adopted as a temporary expedient in at least one type of British bomber. Another special machine-gun mounting which is at present in use in Blenheims and Beauforts is designed to meet the bugbear of all bombers—attack from the rear and below. This carries a rearwardly-pointing gun below the nose of the fuselage trained by indirect sighting through a mirror in the gunner's compartment. This is a modification of the ventral retractable turret (not power-operated) at one time fitted in the Whitely and Wellington, and still found in some German bombers. This indicates that the problem of defence against attack from this particular quarter has

The "Spitfire" Photo "The Aeroplane"

not yet been satisfactorily solved and it will be interesting to see what method is eventually adopted.

Generally, the tendency undoubtedly is to increase the armament, both offensive and defensive, in bombers as well as fighters, which is going to set a nice problem for the aeroplane designer, who already sees the gross weight of his fighter, for instance, approaching five tons. Meanwhile, the daily sweeps carried out by the R.A.F. over northern France with occasional raids far into Germany—all made in broad daylight—are sufficient proof of the adequacy, for immediate purposes, of the armament, offensive and defensive, of British fighters and bombers; particularly when the appalling losses suffered by the Luftwaffe when attempting similar operations over England in "The Battle of Britain" in September, 1940, are recalled.

CO-ORDINATION OF LIBERAL ARTS AND ENGINEERING EDUCATION*

WILLIAM P. TOLLEY
President, Allegheny College, Meadville, Penn.

An address delivered at the Sixth Annual Meeting of the Allegheny Section of the Society for the Promotion of Engineering Education, Pittsburgh, Penn., on October 26th, 1940.

If America can be said to have any one philosophy, certainly it is that of pragmatism. We are an active, energetic people. We prefer the man of action to the man of thought. We are a practical, tough-minded people. We put all ideas to the empirical test. We believe wholeheartedly in education, but we think education should be of practical value. We find it difficult to appreciate a higher learning that liberates the mind but leaves it without specific preparation for the earning of a living.

It is not surprising that technical training has outdistanced liberal culture. It is not to be wondered at that our brightest boys are seeking admission to schools of engineering rather than to colleges of liberal arts. Culture in America has been primarily a culture of the physical sciences. What would most impress a visitor from some other planet would be our great cities, our gigantic industries, and our magnificent public works.

There is no evidence that the temper of our people is changing. We shall undoubtedly continue to be hardheaded and practical. There is evidence, however, that the practical demands of our national life will bring about advance in areas that have been neglected. It is clear, for example, that the progress of the physical sciences creates a pressure that should soon result in equal progress for the biological and social sciences.

In his stimulating book "Man, the Unknown," Dr. Alexis Carrel makes the observation that "There is a strange disparity between the sciences of inert matter and those of life. Astronomy, mechanics, and physics are based on concepts which can be expressed, tersely and elegantly, in mathematical language. They have built up a universe as harmonious as the monuments of ancient Greece.... Such is not the position of biological sciences. Those who investigate the phenomena of life are as if lost in an inextricable jungle, in the midst of a magic forest, whose countless trees unceasingly change their place and their shape."[1]

In this field "our ignorance is profound. Most of the questions put to themselves by those who study human beings remain without answer. Immense regions of our inner world are still unknown....It is quite evident that the accomplishments of all the sciences having man as an object remain insufficient, and that our knowledge of ourselves is still most rudimentary."[2]

The change from the peace and solitude of the early village to the noisy confusion of the modern city, from a life of exposure and hardship to one of complete protection from the elements, from a diet of coarse flour and meat to one of fruit, dairy products, vegetables and sugar, from a day of walking to one of airplanes and automobiles, from a day of plagues and famines to one of sanitation and an abundant food supply, have all had a profound influence on social organization and the human system.

Dr. Carrel reminds us that cities that consist of "monstrous edifices and of dark, narrow streets full of gasoline fumes, coal dust, and toxic gases, torn by the noise of the taxicabs, trucks, and trolleys, and thronged ceaselessly by great crowds"[3] obviously have not been planned for the good of their inhabitants.

"Man," he says, "should be the measure of all. On the contrary, he is a stranger in the world that he has created. He has been incapable of organizing this world for himself, because he did not possess a practical knowledge of his own nature. Thus, the enormous advance gained by the sciences of inanimate matter over those of living things is one of the greatest catastrophes ever suffered by humanity. The environment born of our intelligence and our inventions is adjusted neither to our stature nor to our shape."[4]

And so he concludes that "since the natural conditions of existence have been destroyed by modern civilization, the science of man has become the most necessary of all sciences."[5]

What Dr. Carrel has said about the backwardness of the biological sciences he might have also said about the cultural lag of the social sciences. America was scarcely conscious that it had any social problems until Jacob Riis published his little book in 1890 on "How the Other Half Lives." Our cities had given practically no thought to the problems of poverty or housing, sweat-shops and child labor, the prevention of delinquency and crime, or of disease and sanitation. When Jane Addams organized Hull House in Chicago in the fall of 1889 there were no social workers. There was no department of sociology in any American university at that time. The first department of sociology established anywhere was created, with many misgivings, at the University of Chicago in 1892, less than fifty years ago.

If the public is still ill-informed on social questions, if we still have slums and child labor, out-moded penal systems and police third-degrees, sweat-shops and labor spies, entrenched privilege and hopeless poverty; if we still have soil erosion, dust storms, drought and floods, it is because the field of social relations has not been under the scrutiny of our best minds. Out attention has been elsewhere. We have been preoccupied with the practical problems growing out of our study of the physical sciences.

It should be noted, however, that it is not necessary to slow down the march of the physical sciences because other fields have not kept the same pace. Dr. Carrel should not feel too pessimistic. In the long run, progress in any one area promotes progress in every related field. When the automobile was first introduced, its market was restricted by inadequate roads. Before the automobile industry could thrive it was necessary to develop the oil industry, improve the quality of highway and bridge design, and speed up technical progress in a score of allied fields. Is it not possible that in somewhat the same way the pressure of mechanized civilization will force us into more and more research and exploration in both the biological and the social sciences? Because it is a practical problem, our people will insist that we begin an intensive study of the question of social direction and control.

This pressure is already felt by the engineering schools. Our engineering faculties have been made aware that it profits us nothing to train our young men in physical science if their sole purpose in life is to operate a bombing plane and destroy enemy cities. Somewhere in the programme of education attention must be given to a study of values as well as facts, to the problem of social control as well as technical advance.

The so-called three-two plan for engineering education

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[1] *Man, the Unknown*, by Alexis Carrel. Harper and Brothers, New York, 1935. p. 1.
[2] Ibid. pp. 2-3.
[3] Ibid. p. 25.
[4] Ibid. pp. 27-28.
[5] Ibid. p. 29.

has been proposed as partial answer to this problem. Under this plan a student spends three years in a college of liberal arts and two years in an engineering college. At the conclusion of the fifth year he receives the degree of Bachelor of Arts from the college of liberal arts and the Bachelor of Science in Engineering from the school of engineering.

The plan is not a Utopian solution. It has a number of disadvantages. From the point of view of the student, it is a disadvantage to be kept in college an extra year. If he is handicapped financially or is in a hurry to complete his engineering course, he may think of the additional year as time largely lost. There is also the disadvantage of a break in the continuity of his education. Just as he is beginning his advanced work at the arts college and enjoying his first experience of freedom and self-direction he is pulled up by the roots and transplanted in a new environment. It is possible, moreover, that his preparation in such subjects as Mathematics and Mechanical Drawing is less thorough in an arts college than it would be in a college of engineering. He may be handicapped in engineering subjects as he competes with students who have spent all their time in the engineering school.

There is a danger, moreover, that the engineering college may lay out a prescribed course for the pre-engineering students in the arts college which gives him little opportunity to study non-engineering subjects. Such a policy would, of course, destroy the chief reason for the five-year plan.

Even the arts college does not regard the plan as ideal. The faculty of the arts college does not like students to miss the vitally important senior year. They complain that the programme vocationalizes the arts curriculum and reduces a four-year college to the level of a junior college.

On the whole, however, the advantages greatly outweigh the disadvantages. The student's reward for the extra year is a second degree. By attending two institutions he becomes familiar with two points of view in higher education. These points of view are quite different and they are equally valuable.

If he takes his work in a small college of liberal arts it is probable that he enjoys more personal attention and has a closer relationship to full professors than would be the case in some large urban engineering schools. In the main, the laboratories designed and equipped for undergraduate work are quite as well adapted for the requirements of pre-engineering work as those of the engineering school. If, for any reason, his exploratory study of engineering shows that his talents do not lie in that field he can modify his course without loss of time.

It is an advantage to the liberal arts college to have more boys who have a serious intellectual purpose. The pre-engineering students are willing to work hard. They have a good influence on other students. If they follow syllabi or programmes outlined by the engineering school, departmental standards are likely to be raised. Some students who expect to attend only three years may become so interested in their work that they complete the four-year course before beginning their engineering studies.

It should also be an advantage to the engineering school. It makes it unnecessary to duplicate a complete arts programme and it is a step in the direction of making engineering a graduate course of study. Even if the methods of the engineering school are not followed in all of the pre-engineering work it is still true that students are a year older, have had a wider educational background, and are more mature.

In the beginning the advantage of the new plan may not be self-evident. If, however, it has sufficient trial it may mark the beginning of a new era in engineering education, when the mind disciplined in science will also be disciplined in arts. It will be a happy day when the engineer is broadly educated as well as technically trained.

DISCUSSION

WILLIAM R. WORK*

Dr. Tolley has presented strong arguments for inclusion of a social-humanistic programme in the education of engineers. He has described a plan by means of which there can be co-operation between liberal arts colleges and engineering colleges to secure this result.

The Carnegie Institute of Technology has this plan now in operation. Arrangements have been made not only with Allegheny College, but five others, Washington & Jefferson, Denison, Albion, Geneva, and Westminster.

The novelty in the plan is not in the transference of students from a liberal arts college to an engineering institution. That has always taken place. We have had many students, who after one, two, three, or four years at a liberal arts college, had then entered on a programme in our engineering college.

The novelty consists rather in devising a planned programme to conserve the student's time through a conscious effort to arrange courses of study in the earlier collegiate years so that a smooth transfer can be made to the engineering college.

A student who follows the three year pre-engineering programme in the liberal arts college may then enter on the engineering school as a regular Junior. All prerequisites for the technical courses will have been met and there will be no necessity for schedule irregularities of any kind.

The late Mr. Alan Bright, Registrar here at Carnegie for many years, studying certain statistics in his office, became impressed with the fact that a large number of students had had some liberal arts training. Further, he found that as a group these men had done very well; they had scholastic records distinctly above the average. In fact, in the particular year when Mr. Bright made these studies, it happened that the Electrical Engineering Senior Class had two men in it who had come to us as transfer students. At graduation they ranked respectively as No. 1 and No. 3.

About that time President Tolley had the idea that maybe some arrangement could be made whereby pre-engineering work in liberal arts colleges could be co-ordinated with a curriculum in engineering; this was the genesis of the 3-2 plan which was worked out first with Allegheny College and later with the five other colleges mentioned earlier.

Under the 3-2 plan, as we see it, neither the liberal arts college nor the engineering school gives up any rights or loses independence in any degree. We are not insisting that any liberal arts college must agree to work only with Carnegie. Any college may make similar arrangements with any other technical school. In fact, several of them have done so.

Since the 3-2 plan is so young, we have admitted but few students under it and none have graduated. Nevertheless we sincerely believe it will prove to be a forward step in education.

Possibly at some future session, when we have accumulated data based on several years experience with the plan, we will be able to discuss the actual results achieved.

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PIG IRON CONSERVATION IN GRAY IRON FOUNDRIES

Report of an investigation made in the Ore Dressing and Metallurgical Laboratories of the Department of Mines and Resources, Ottawa, Ont.

NOTE—The investigation which resulted in this report was carried by the Department of Mines and Resources as a means of helping small foundries conserve pig iron in the present emergency. The information contained in the report is intended in particular for small foundries in small towns scattered across the country which possibly melt a few tons a day, but which are using 35 to 40 per cent pig iron in their cupola charges. If the use of the pig iron could be reduced even by as little as five per cent, a considerable saving in the aggregate would be effected.

At the request of the Department, the editor is pleased to reproduce this report in the hope that it may help conserve supplies. Copies of the report may be obtained from the Chief, Bureau of Mines, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.

During the present emergency, an increasing shortage of pig iron will be encountered by gray iron foundry operators. This may be alleviated to some extent by substituting scrap iron for part of the pig iron requirements. The accepted practice in many gray iron foundries is to use pig iron and foundry returns with possibly small amounts of foreign scrap iron in making the mixtures for melting in their cupolas. Foreign or outside scrap iron is used to describe material which is purchased from outside sources and which was not originally cast in that particular foundry. It is so named in comparison with domestic or "own" scrap, better known as foundry returns, which is that particular foundry's own product consisting of gates, sprues, risers, shrink bobs or heads, over iron or gangway pig, defective castings, etc., all a necessary part of a previous melting operation.

Present Use of Scrap Iron and Steel

The use of large amounts of foreign scrap, both iron and steel, in cupola mixtures, as high at times as 60 per cent of the total charge, has been the general practice for quite a long time in the large, continuous-operating foundries of the so-called "production" type which require metal made and held to strict specifications at all times. This is made possible by very close supervision and control at all stages of the process. In smaller foundries with considerably less supervision available, it would hardly be advisable to try to duplicate this practice. However, it can be done on a smaller scale which, with careful attention to the various details of the melting process, should yield satisfactory results.

It should be stated at the outset, however, that conditions vary not only from one foundry to another making similar castings, but vary from time to time in the same shop. This calls for considerable application of common sense. The following remarks concern general conditions, not any one particular instance, to serve as a guide in the utilization of scrap.

The use of various classifications of steel scrap in gray iron foundries melting iron for various applications requiring superior physical qualities, usually known as "semi-steel" has been common practice for many years. The success of this operation has been mainly due to the close attention given to all foundry operations generally and the melting practice in particular. However, by application of the same careful attention to the details of operation, satisfactory iron for ordinary castings is being made, using considerable percentages of foreign scrap iron to replace part of the pig iron in the charge.

Preparations for Use of Scrap

Every gray iron foundry operator knows what constitutes good melting practice in a cupola. A foundry cupola given reasonable care and attention, with charges of pig iron, foundry returns with or without some foreign scrap in the mixture and a reasonably good grade of coke will produce an iron that will be satisfactory enough for the intended purpose. The substitution of part of the pig iron by foreign scrap will entail somewhat closer attention to the various details involved. Before commencing the substitution of scrap, it would be beneficial to check the various phases involved in cupola operation in order to obtain maximum efficiency in the melting operation.

The physical characteristics of a cupola, the tuyere area and ratio, the height of tuyeres about the bottom plate, and their type are usually determined over a considerable period of time, and for the present purpose should not be changed, unless found necessary for increasing the holding capacity of the crucible, tank or well that receives the metal when it is melting down.

The preparation of the cupola for the day's heat or cast should be conscientiously done with the proper care given to the chipping out, patching, the repair or replacing of tap hole and slag hole areas, and putting in the sand bottom.

After lighting up the cupola, special attention should be given to the burning in of the first coke bed and obtaining the proper height of the second coke bed before starting to charge the materials for melting. The proper height of bed for best melting conditions has to be determined by experience. When this height has been determined, it should be strictly adhered to. Commencing operations with the coke bed properly burnt in and of prescribed height is one of the most important considerations of efficient cupola operation regardless of the length of time metal is required, whether it be for one hour or eighteen.

The weight of each cupola charge, (the term used to describe the mixture of various materials to be melted together simultaneously), is usually determined by the cross sectional area of the cupola, with certain variations to meet particular conditions. It is important that the size of the various materials used be of the proper proportion to the cross-sectional area of the cupola in order to obtain uniform melting conditions and a homogeneous molten iron. Other very essential details are the accuracy of the weighing, the proper sequence of placing in the cupola, and the spreading of the materials evenly. The same care is also required in the weighing and placing in the cupola of the coke required to replenish the bed coke for melting the following charge.

One other important point to be considered is that of fluxing or "slagging" of the cupola, to remove the refuse which accumulates from the ash of the coke, the rust of the pig iron and scrap, and the burnt sand that adheres to the foundry returns by the addition of limestone on top of each coke charge. The "tapping-out" of the slag is as an essential operation as the "tapping-out" of the iron if smooth running cupola operation is to be insured.

One final point is uniformity of blast pressure, which, once determined for a desired melting rate of iron should be maintained, although slowing down is not as hazardous as speeding up which causes all kinds of trouble.

Classifications of Gray Iron Foundry Scrap

In contemplating either the substitution of foreign scrap for part of the pig iron or increasing the amount being used at present, consideration must be given to the kind of iron required for the general class of castings being made. The American Institute of Scrap Iron and Steel have a standard classification of scrap which is followed as a basis by the purchasers of large amounts, and may serve as a guide for those whose requirements will not be so great. For smaller foundries, consideration should be given to the kind and amount available in local scrap yards. The scrap classifications as given in Simplified Practice Recommendation R-58-36 of the U.S. Department of Commerce, 1940, for Gray Iron Foundries are as follows:

58. No. 1 Machinery Cupola Scrap—Clean machinery cast-iron scrap. Must be cupola size, not over 24 by 30 inches in dimensions, and no piece to weigh over 150 pounds.

59. No. 1 Machinery Breakable Scrap—Clean machinery cast-iron scrap, weighing over 150 pounds, and which can be easily broken by an ordinary drop into cupola size.

60. No. 1 Standard Cupola Scrap—Clean cast-iron scrap, such as columns, pipes, plates, and castings of miscellaneous nature, but free from stove plate and agricultural scrap. Must be cupola size, not over 24 by 30 inches in dimensions, and no piece to weigh over 150 pounds. Must be free from foreign material.

61. No. 1 Standard Breakable Scrap—Clean cast-iron scrap, such as columns, pipes, plates, and castings of miscellaneous nature, weighing over 150 pounds, and which can be broken by an ordinary drop into cupola size.

62. Burnt Cast Scrap—Burnt cast-iron scrap, such as grate bars, stove parts, and any miscellaneous burnt scrap.

63. Stove Plate Scrap—Clean cast-iron stove plate. Must be free from malleable and steel parts, window weights, plow points, grates, burnt iron, etc.

64. Agricultural Scrap—Cast-iron parts of agricultural machinery, including plow points. Must be free from steel, malleable, and full-chilled iron.

65. Cast-Iron Car Wheels—Cast-iron car and locomotive wheels.

66. Brake Shoes—Driving and car brake shoes of all types, exception composition-filled shoes.

67. No. 1 Radiator Scrap—Broken radiator castings, cupola size, with all steel parts removed. Must be free from excessive scale, rust, and corrosion.

68. No. 2 Radiator Scrap—Unbroken radiator castings. Must be free from excessive scale, rust, and corrosion.

69. No. 1 Malleable Scrap—Malleable parts of automobiles, railroad cars, and miscellaneous malleable castings. Must be free from steel and cast-iron parts.

70. No. 2 Malleable Scrap—Malleable parts of agricultural implements and other miscellaneous malleable castings. Must be free from steel and cast-iron parts. May include No. 2 rail steel, cropped rail ends under three feet long, 50-pound and over standard section.

These specifications are given as a guide only. For foundries operating with small diameter cupolas, the dimensions given would probably be too large and also too heavy. Classes 62, 65, and 66 should not be considered by the average shop and Classes 69 and 70 only in special cases.

Selection of Class of Scrap

The selection of the scrap to be used for any particular type of iron requires a certain amount of judgement. For example, it would not be advisable for a foundry melting iron for casting into small, light, easily machineable castings to endeavour to use heavy machinery cast scrap or scrapped automobile cylinder blocks or heads for the reason that the heavy machinery castings are usually made of an iron with a silicon content of 1.25 to 1.75 per cent, and the automotive scrap, although containing satisfactory amounts of silicon, as a rule contains appreciable amounts of alloys, nickel, chromium, copper, etc. In this case, it would be better to commence the use of scrap by using stove plate scrap, (No. 63) which in addition to clean stove plate usually contains other scrap parts of various small articles, sewing machines, lawn mowers, kitchen pumps, flat irons, etc. This material is usually made from iron with a minimum silicon content of 2.25 per cent and in addition with a fairly high phosphorus content, usually well above 0.50 per cent. Scrap of this classification can be used in substitution for part of the pig iron of the grade known as "Foundry." For foundries engaged in making a heavier class of work, consideration can be given to the other grades of scrap, and for those requiring a superior grade, stove plate scrap should not be considered.

Suggested Method for Commencing Use of Scrap

In commencing the use of scrap in the cupola mixtures, it is best to begin with the replacement of a small amount of the pig iron content, possibly two or three per cent. This amount can be increased at regular intervals of two or three operating days until such time as the maximum usable amount is reached. The highest possible yield of good, satisfactory castings is the desire of every foundry operator. The greatest percentage of scrap that can be used in the cupola mixture without affecting this yield can be considered the maximum usable amount under that particular foundry's conditions. It is not possible to replace all of the pig iron in the mixture but it is possible in many cases, with careful attention to details previously mentioned, to replace part of it, the amount varying—as conditions vary—in different foundries. It should also be remembered that the percentage of scrap in the cupola mixture as decided upon in any particular foundry may have to be changed from time to time, and at times it may even be necessary to return to the mixture previously used.

Percentages of pig iron used in cupola mixtures vary from foundries casting individual cast piston rings which at times require 70 per cent down to foundries using 10 per cent or less of specially made grades of pig iron.

Calculating Cupola Mixtures Using Scrap

In calculating the mixture, it may be necessary, especially if the scrap to be used is small and light, to allow for a slightly greater oxidation loss of the silicon and the manganese contents. If considerable silicon and manganese are required in the base cupola mixture as calculated, and it is not possible to obtain these contents from the material on hand, it is possible to increase these amounts by the addition of ferro-silicon and ferro-manganese. These ferro-alloys may be conveniently added in the form of briquettes which are made to contain a definite weight of the desired alloy. Since the sulphur content of the scrap is higher than that of pig iron, it is essential that, as previously mentioned, the cupola be kept properly fluxed. Careful observation of the results obtained will establish precedents to follow.

Control of Molten Metal

The character of the molten metal tapped from the cupola is usually observed by some manner of test. This consists of taking a small amount of the iron from the cupola stream and pouring it in some form of a wedge, step bar or other shape made in either a green sand or dry sand mould, and may or may not be cast against a chill. These allow for very rapid cooling and may be quickly broken for visual inspection. It is important that a standard routine be carefully followed to eliminate variations due to temperature, time, etc. Experience will tell the condition of the iron and if any corrections are necessary, the requisite action can be carried out immediately.

The test pieces in most general use in the automotive foundries, who have developed the control of the metal by chill tests to quite a high degree, are the triangular wedge and the "key-hole." The former test piece is in the form of a triangle approximately ⅝ x ⅝ x ⅜ in. and about four inches in height, cast vertically in a dry sand core. This is about the fastest test possible, as it can be poured, cooled, quenched, broken and inspected in much less than a minute. The "key-hole" test, so named from its resemblance to a key-hole in an ordinary door lock, is approximately 1¾ in. in its overall long dimension, 1 in. at the widest part with the key way portion ½ in. to ⅝ in. wide and about four inches in height, cast vertically in a dry sand core, with the key way bottom closed by placing the core against a metal chill. This test piece requires a little more time before it may be cooled and quenched, but with experience yields considerable information regarding the character of the metal. The utility of these tests for rapid control purposes can be readily seen, as the most rapid chemical analyses in specially set-up control laboratories require considerable time before results are available. However, the information on these two test pieces is offered as a suggested method, not a recommendation to replace the particular control tests that may now be in use.

The test pieces give a good indication of the operating conditions in the cupola, in addition to information on the characteristics of the metal. From observations of the depth of chill on test pieces, corrective measures may be immediately taken if such are required.

Need for Pig Iron Conservation

In normal times, the economy that might be obtained by substitution of foreign scrap for part of the pig iron in a cupola charge probably might not be worth the extra effort and vigilance required to maintain consistently a uniformly satisfactory product. In view of the seriousness of the pig iron supply at the present time, however, any assistance in even partially relieving this situation would be well worth the extra exertion required.

Abstracts of Current Literature

Abstracts of articles appearing in the current technical periodicals

120-KVA FLASH BUTT-WELDING MACHINE

From *Engineering*, (London), July, 1941

Under present conditions, it is particularly important that no material should be scrapped when a simple repair with the minimum of new material will produce or reclaim a serviceable article. Welding processes have been used in a variety of ways with this object in view, and the welding machine described below merits attention for its utility in this direction. Flash butt-welding machines can make homogeneous joints in rolled-steel sections or tubes and are both quick and reliable in operation. No special machines are required for the preparation of the work prior to welding; neither are there any expensive finishing processes.

Briefly, flash butt-welding is a process of welding by bringing together the ends of two parts carrying a heavy current and separating them several times. One of the two parts is held in fixed jaws and the other in movable jaws. The current is switched on and the two surfaces to be welded are brought together by the movable jaws. Current flows through the joint and causes it to heat up, but when heated to redness the bars are separated again and the partly-joined surfaces are torn apart. This butting and separating procedure is repeated several times, so that all projections and impurities are burned away and the faces of the joint are brought up to a bright red heat uniformly over their whole area. At this stage, the flashing operation is started by separating the surfaces once again and bringing them together slowly so that a continuous flash is produced from the joint. This flashing is repeated until a predetermined amount has been burned off the ends of both bars and the two surfaces are then pressed together, or up-set, under a high pressure and the welding current switched off.

THE COST OF ABSENTEEISM DUE TO ILLNESS

By Kingsley Roberts and Martin W. Brown

From *Advanced Management*, April-June, 1941

Absenteeism due to illness is costing industry more than $60 per employee per year. It is costing the employees more.

On any given day, among every thousand employees, twenty are, productively speaking, non-effective; many more are only partially effective. Strikes in 1940 resulted in a loss of about two hours per worker per year. Absenteeism due to illness, which never makes the headlines, resulted in a loss of approximately eight days per worker. The toll of illness has been estimated as 400,000,000 man-days per year. Absenteeism due to illness, in effect, has closed more than a thousand factories each employing a thousand workers.

Sickness levies an indirect tax on industry. It causes turnover of personnel, transfer to new work, and increases the cost of employee training. For every absent employee, there are those in poor health at work. And this drags down the level of production. The psychological hazard of insecurity, the fear of illness and its consequent cost, breaks in on the concentration of the employee and affects his work.

The cost to industry of absenteeism due to illness runs into billions of dollars annually. The cost of the partially effective employee is incalculable. There is grave danger that industry will become complacent over the success of industrial medical services for the prevention and control of occupational injuries and diseases and will be blinded to the fact that they have under cultivation not a farm but a flowerpot. Occupational injuries and diseases cause less than 10 per cent of absenteeism due to illness. They constitute less than 10 per cent of the problem. In the present situation, the 90 per cent of absenteeism due to non-industrial illness must be the concern of responsible management.

ALUMINIUM WORKS IN AUSTRALIA

From *Engineering* (London), August, 1941

A work for the production of rolled plate, sheet and strip, forging billets, and extruded bar, rod, tubing and structural shapes of aluminium and aluminium alloys, has recently commenced operations at Granville, New South Wales. It is the property of Messrs. Australian Aluminium Company Proprietary, Limited, a firm established in February, 1939, and jointly owned by Messrs. The British Aluminium Company, Limited; Aluminium Limited of Canada; and The Electrolytic Zinc Company of Australasia, Limited. It is stated in *Tye Commonwealth Engineer* that virgin ingots of aluminium are imported from Canada and that all the alloys required are made up at Granville. In addition to wrought material, the new works also produces foundry casting ingots of various grades. The works includes a forge shop as well as rolling-mill and extrusion shops. The latter is equipped with a 3,000-ton extrusion press in which the forging billets, as well as extruded bars, rods, etc., are to be produced. The forging billets are to be used in the manufacture of aircraft propeller blades, aero-engine crank-cases and pistons. The forging department, the construction and equipment of which is now practically completed, contains a 35,000-lb. compressed-air hammer. Another material to be produced in the new works is Alclad, which, as is well known, consists of sheets of Duralumin coated with pure aluminium. It was anticipated that the works would commence production in May, 1940, but difficulties in obtaining equipment led to a delay of some twelve months; finally, the necessary plant was obtained from the United States. After the conclusion of hostilities aluminium foil and other materials not made under war conditions will be produced.

200-TON REINFORCED-CONCRETE BARGES

From *Engineering* (London), August, 1941

In a recent issue of *Engineering*, reference was made to the 200-tons deadweight reinforced-concrete barges, many of them of precast-slab construction, which have been built during the past twelve months or so to the order of the Admiralty. The brief particulars then given can now be supplemented by illustrations, Figs. 1 and 2, which show, the method of construction and the finished barge, ready for launching, and provided with the necessary wooden fenders and equipment of deck fittings. It will be seen that the type illustrated does not differ greatly from the conventional steel Thames barge; although it may be observed that even so unpromising an underwater form as that shown can be improved to an appreciable extent by careful design, as was demonstrated by the tests, in the William Froude Tank, described in a paper read in 1930 by Dr. G. S. Baker and Miss E. M. Keary before the Institution of Naval Architects. There is reason to suppose that the experimental work there summarised had some influence on the eventual design of the new concrete barges.

Fig. 1

Fig. 2

The decision of the Admiralty to turn once again to reinforced concrete as a shipbuilding material caused considerable surprise when their intention was realised, rather more than a year ago, for the concrete-ship programme of the last war was by no means an unqualified success. That scheme was mooted in 1917, though it was not adopted until the end of that year. Possibly it was launched on too ambitious a scale, and at so late a stage in the war that the man-power then available was of an even lower grade of average skill than was contemplated by the sponsors of the proposal. At all events, according to the *Official History of the War*, only one 1,000 ton barge had been completed by the end of October, 1918, although eight small shipyards were either laid out or adapted for the purpose, and over 200 orders had been placed. Some of the vessels were subsequently completed, and several tugs and at least one concrete coaster, the *Armistice*, eventually passed into private ownership and were operated commercially with a certain amount of success. They were not notably popular, however, especially among the repairers into whose hands they came periodically for survey and overhaul. There seems little reason to suppose that the present revival of the reinforced-concrete barge will outlast the period of the war, or that this method of construction will ever be able to compete successfully with steel under normal conditions.

CHEMICAL JOINT SEALING AND SOIL SOLIDIFICATION

By C. Martin Riedel, Civil Engineer, Chicago, Ill.

From *Engineering News-Record*, August 14th, 1941

Chemical solidification of loose soils, dry or wet, and sealing of joints in leaky masonry have been practised successfully in Europe for some years. One of the promising methods is the Joosten process, patented in this and other countries by Dr. Hugo Joosten, Dutch mining engineer. During the past three or four years the writer, representing Dr. Joosten in this country, has conducted numerous experiments and tests on this process in both laboratory and field, in collaboration with the Philadelphia Quartz Co., and the Solvay Sales Corp. Results of these tests indicate the chemical solidification process is adaptable to many problems encountered in this country in permanently consolidating troublesome soils encountered in foundation excavation and tunneling; also that it is satisfactory for sealing leaky joints and cracks in concrete and masonry walls and in tunnel lining.

The Joosten process is simple. It consists of consecutive applications, under pressure, of two chemicals into the ground or joint to be treated: (1) a commercial grade of silicate of soda, with certain other chemicals, diluted to the required specific gravity, followed by (2) a strong solution of calcium chloride. The composition and strength of the two chemicals and the proportions used, as well as the method of application, are covered by the patents. Several instances have come to my notice recently where the chemical process has been unsuccessful, but such cases are no doubt due to improper strength or proportions of the two chemicals. As far as the author knows no application of the Joosten process has proved unsuccessful when prepared and conducted correctly.

Unlike cement grout which, for fear of disrupting the mass or separating the cement and water, cannot be forced into all the fine pores and cracks of the material being treated, the chemicals reach into and fill all voids rapidly with an impervious gel that forms as soon as the two chemicals come into contact. This instantaneous action of the gel, together with its steady binding force, is another advantage over slow-setting cement grout.

Just recently the author sealed several badly-leaking joints and fissures in a section of the Chicago Freight Tunnel to demonstrate the effectiveness of the chemical process for such purposes. The section treated was a stub off the Franklin St. tunnel, 41 ft. below the surface and 1½ blocks east of the Chicago River. This stub formerly led to a warehouse, now abandoned, and a concrete bulkhead had been placed 6 ft. from the tunnel line to create a telephone chamber in the old stub section. Considerable water was coming through cracks, seams, joints and even through porous, disintegrated areas in the old concrete lining.

All leaks were effectively stopped by simply drilling 14 holes into the worst spots and applying chemicals by the Joosten process. Equipment used included a small electric-drive air compressor, a pneumatic rock drill with 1⅛-in. bit, two small electric force pumps for handling the chemicals, powered by a six-volt automobile battery, copper tubing from the pumps to a Siamese connection leading to a special rubber expanding sleeve wedged into the drill hole, and two five-gal. cans containing the chemicals.

THE DESTRUCTION OF UNEXPLODED SHELLS AND AERIAL BOMBS

By L. G. Fraser, B.E., A.M.I.E. Aust.

From *Journal of the Institution of Engineers Australia*, July, 1941.

Most shells and bombs contain high explosive, which, also, is usually employed to destroy them if they are found unexploded.

Explosives are unstable solids or liquids which on application of a suitable stimulus can be converted to more stable gaseous substances in a very short interval of time, with the liberation of much heat. The change in volume from solid to gas is of the order of 10,000 times for a "free" explosion. There are two ways in which explosives may change their state of being—first by the relatively slow process of burning and, second, by the rapid process of detonation. This constitutes the division between "low" and "high" explosives.

In detonation a wave, set up by shock or sudden heating, runs throughout the whole bulk of the explosive, decomposing each molecule almost instantaneously. An explosive may detonate in sympathy with another charge which has been fired, due to transmission of the shock of detonation through the air, water or earth.

With the high explosive the detonation and shattering are so sudden that the inertia of the air is sufficient tamping and an intense local effect is produced on whatever is in contact with the charge.

There is no such thing as a "dud" shell. After a shell has been projected all of the safety devices incorporated in the fuse are put out of action and the shell is armed and remains so.

The amount of high explosive in a shell is usually from 10 per cent to 12 per cent of the weight of the shell and it is necessary to use an intermediary or exploder in order to build up a detonating wave of sufficient intensity to detonate the large mass of the shell filling.

The fuse contains the first two steps in the train of detonation, and may be designed to operate on impact, on graze, or at any point in the trajectory. Safety devices are incorporated in the fuse to ensure safety in transport and storage, but once the shell has left the gun these cease to function and the shell is "live."

An unexploded shell should be treated with great caution. It should be exploded as it lies or very gently handled if it is necessary to remove it to a more suitable place.

There are four types of aerial bomb; general-purpose, semi-armour piercing, armour piercing and anti-submarine.

General-purpose bombs are made up to 500 lb. in weight and is the type of bomb most commonly used against civilian objectives. A 500 lb. general-purpose bomb is 7 ft. in length and 1 ft. 6 in. in diameter. Its destructive effect is very great and if dropped from an aeroplane flying at 200 m.p.h. at 10,000 ft. would penetrate, if of the delayed action type, 2 ft. 6 in. into reinforced concrete or up to 25 ft. into earth before exploding.

The method of dealing with an unexploded bomb depends on its location and accessibility. If it is set for delayed action, which is most likely the case, it may explode at any time up to seven days after falling, and it is officially recommended that an unexploded bomb should not be touched during that period.

The most effective type of incendiary bomb is that known as the electron bomb. It consists of a cylindrical case 9 in. in length and about 2 in. external diameter, with walls about ⅜ in. in thickness. The case is made of electron metal, a magnesium alloy containing 96 per cent of magnesium alloyed with aluminium, zinc and manganese. Its filling consists of a primary composition (barium peroxide and aluminium) and thermit. The principal incendiary agent, however, is the magnesium alloy case and the purpose of the filling is to raise the case to ignition temperature. One large bomber can carry from 1,000 to 2,000 incendiary bombs of this type, which are released in groups of ten or twenty. It is estimated, however, that only about 8 per cent of the bombs released actually cause fires.

LARGE TANKERS

From *Trade and Engineering*, September, 1941

Although there are now about 150 ocean-going tankers on order in American yards, totalling between 1,400,000 tons and 1,500,000 tons gross, it is generally believed that, when the war ends, there will be a great shortage of such vessels. Before the war a considerable volume of motor tanker tonnage was being built in Scandinavian yards, and even under present conditions it is understood that important numbers of oil-carrying ships are being constructed for Norwegian, Swedish, and Danish owners.

In most instances they are designed for speeds higher than those which were common before the war. At the Kockums works at Malmo a vessel of 16,250 tons deadweight, the Malmohus, was lately completed for the Trelleborgs S.S. Company, and a sister ship has been launched and is no doubt approaching completion, if she has not already run trials. The length is 500 ft. with a beam of 63 ft., and an eight-cylinder double-acting two-stroke engine of 5,500 b.h.p. gives a service speed of 14½ knots. A third similar ship for the Svea S.S. Company, of Stockholm, has also been launched, while two even larger tankers, the Julius and the R. Stenersen, are fitting out at the Gotaverken shipyard at Gothenburg. These are stated to be larger than any vessels yet built in Scandinavian yards, being 540 ft. in length with a beam of 66 ft., and having a deadweight capacity of 16,800 tons on a draught of 29 ft. 10 in. The propelling engine is a Gotaverken two-stroke unit, developing 7,000 i.h.p., and the service speed is 14 knots with the vessel fully laden.

All the tankers in question are wholly welded, and the R. Stenersen and her sister ship are constructed to a new design in which the longitudinal and transverse bulkheads are corrugated. It is claimed that the new construction increases the oil cargo capacity by 300 tons. The fact that all these new ships, as well as at least 90 per cent of those building in America, are designed for a speed of 14 knots or over will no doubt have a marked influence on ocean oil transport after the war.

SWEDISH ALUMINIUM

From *Civil Engineering and Public Works Review*, (London), August, 1941

In view of the important part that aluminium plays in modern engineering construction, the steps being taken in Sweden to develop its own sources of that metal are of considerable interest to engineers in this country.

The Swedish Aluminium Co. plans to begin construction soon of its new plant for the production of alumina from andalusite. In peace time the plant will be capable of producing 6,000 metric tons of alumina from bauxite annually, and in war time about 4,000 tons from domestic andalusite. The site of the plant has not been decided upon, but as access to low-cost electric power is necessary it will probably be in Northern Sweden. Negotiations have been conducted for its location at Kubikenborg, near Sundavall, in Northern Sweden, or at the deepwater harbour at Oavlo, also in Northern Sweden. At Kubilenborg ground drillings and other investigations show that the water supply apparently is not adequate, but it is believed that an adequate water supply can be provided. Andalusite is an excellent substitute for bauxite, and has an average alumina content of 50 per cent., compared with 60 for bauxite. However, andalusite contains large quantities of silica, which is difficult and expensive to remove. The Norwegian parent company has been successful in removing the silica by using the same method as for bauxite, with certain modifications. This new process is considerably more expensive.

COMMENT

By Ordway Tead

From *Advanced Management*, April-June, 1941

Morale is the total attitude resulting from the mobilizing of energy, interest and initiative in enthusiastic and effective support of some project or aim. Morale may arise or be striven for at numerous levels and for diverse ends. Defense is one major goal for which a high morale is wisely being sought today among the industrial workers engaged in defense production.

Industrial managers on the whole believe in and try to assure high morale among the upper supervisory staffs of their companies. Those efforts of personal acquaintance, friendliness, exchange of information, the proffer of praise where praise is merited—all contribute in a natural, almost spontaneous way to good morale at the executive levels. The entire defense programme will thrive if the morale of managers can be taken as representative of the morale of all workers. But that such an assumption is valid is open to grave doubt on the part of anyone at all close to the sentiment and attitude of the rank and file in our defense factories. This is not to impute lack of patriotism to the workers. This is not to conclude that all the newspaper alarms about strikes are to be taken as seriously as the headlines intimate. In fact, the strike record, comparatively with 1917 is phenomenally low.

Rather, the crucial point is that the goal of defense—which may at any moment become a goal of offense and positive military victory—is not the kind of goal which the American worker takes to his heart without some specific morale-building efforts taking place.

Let any who entertain doubts on this score re-examine the history of industrial relations and of industrial morale-cultivating programmes in 1917-18, when the gradual change in total attitude was tremendous, countrywide and unified to an unprecedented degree. Nor did this change arrive by chance. It came about by plan and might have come earlier had the need for the plan and the elements of a wise plan been widely recognized earlier. My purpose here is not to set forth the "how" but rather the "why" of this problem as managers confront it. And the "why" has to do with human desires and motives. How do we stir individuals into sustained effort toward a goal, is a question to be answered only as we know about basic drives, the mechanisms of substitute release, the effects of shared joint experience, the consequences of frustrations and the impact of personalities upon one another.

Indeed, I sometimes think that the big function of management itself, in so far as it is the task of personal, supervisory direction, has to be radically redefined to be seen in its true character. For, on its personal side, management is the continuing effort to bring the deep satisfaction of associated, co-operative experience to a group of persons bound together by ties of a responsibility having to be jointly assumed. Management is the summons to a sense of community and common striving among individuals who would rather be led to achieve than be left to atrophy. Management is the guidance of that subtle reality, a collective will to do because to do is to be and to register as alive.

If managers could once begin to grasp in its deeper meaning that familiar truth that "man is a social animal", they would see that to provide an experience on the job which is an experience of happy sociality, is in reality the big executive job. If we could assure among workers a warm, sensitive, secure awareness of social belonging, the entire outward expression of this awareness would become attentiveness to the creative activity of production. People's will to work has been vastly underrated—and chiefly because the social inducements to work have been so frightfully lacking. And high among those social inducements is or can be the sense of each worker that he belongs to a purposeful and friendly gang. He wants and deeply needs to be "a regular guy in a regular bunch of fellers".

Do managers try in the factory—and especially in the tensions of the defense drive—to provide conditions of happy sociality, of communal sense, of wholeness and unity of drive in common with others who are like-minded and like-feeling ?

If we do not attend to the provisions of these total attitudes toward the corporate and the national task, we are working against tremendous odds of psychic resistance and friction. Never yet, in the working of the machine economy, I venture to say, have we shown what we could do toward abundance of output, if we were collectively wise enough to summon people's communal sense into satisfying being.

MOTION PICTURE ENGINEERING

From *Trade & Engineering* (London), July, 1941

Although the use of the motion picture may not as yet have been fully exploited in this country as a means of either propaganda or education, cinematography will be closely wrapped up with the reorganization of industry and the training of employees after the war. As it is, the immensity of its scope in the field of entertainment has had an inevitable reaction on many branches of engineering and physical research, both of which have benefited by the adoption of scientific developments worked out initially for motion-picture purposes.

Cinematography is finding increased application in fields outside entertainment. Thus specially designed cameras are being used for the study of high-speed machinery and mechanical problems. Improvements in sound reproduction with 16mm. or substandard film and in the portability of the apparatus have made it possible for salesmen or trade representatives to carry about equipment which will both demonstrate the articles concerned and provide suitable sales talk. This development has been utilized on a wide scale in America, where the mere magnitude of business and the distances involved in travelling justify the expense.

Important changes in design have been seen in the newer motion-picture cameras, sound equipment, projection apparatus, and the theatre itself. Admirable projection, in daylight, can be made with travelling theatres; a recent instance is the Thornycroft mobile truck of the Ministry of Information, which carries a powerful arc projector throwing pictures on a translucent screen in the rear, and is fitted with direct and alternating current generators for the lamp and the sound equipment respectively.

The modern studio partakes more of the nature of an engineering shop than a stage. The complicated lighting of a set may demand a score or more of electricians to control the heavy lighting units on the floor and in the galleries; electricians, sound engineers and lighting experts may, indeed, completely outnumber the artists and photographers. Mechanical handling devices have added to the complication of the newer studios. In one of these the stage floor can be made to disappear at a touch, leaving a full-sized swimming pool in view, complete with glass sides and with lighting equipment which enables all kinds of under-water performances and illusions to be photographed. Among the acoustical problems of the studio efficient but completely soundless ventilating machinery has involved much arduous work.

A noiseless camera of recent design employs controlled hydraulic resistance in overcoming noise from friction when tilting or panning while following the action on the set. It is only one of innumerable improvements in construction. More conspicuous are the elaborate trucks on which the modern camera is mounted and manipulated by its crew of two or three standing or sitting on the platforms. A novel feature in the engineering field is a massively constructed camera taking 2,000 pictures a second, with an electric spark of pre-arranged frequency recorded on the edge of the film for timing purposes; this has proved of value in studying problems connected with aeroplane engines.

From Month to Month

News of the Institute and other Societies, Comments and Correspondence, Elections and Transfers

THE PLAGUE OF QUESTIONNAIRES

Everywhere one turns these days he faces a questionnaire. It may be issued by a governmental department, a commercial organization, a social body, a service club, a charity, a professional society or a voluntary group. Unfortunately, such forms are too frequently received with criticism and expressions of annoyance. Some persons even take time to express their feelings in withering communications intended, no doubt, to crush the responsible parties so that they cannot rise to repeat the offence.

Let us look at this questionnaire business for a moment—quietly, thoughtfully and rationally. In the first place, what is the purpose of such an inquiry ? Usually it is intended to bring to some well-meaning body information upon which some plans for the common good can be based. Invariably, these plans are in the interest of the individual himself as part of a group, and yet his reaction may be that he is doing a favour to the inquirer. Either the purpose of these questionnaires is misunderstood, or we have reached a stage of disinterestedness in national affairs.

The experience of the Wartime Bureau of Technical Personnel has been illuminating. A prompt, courteous return has been received from most prominent engineers, and the criticisms have come mostly from those whose records leave something to be desired in professional attainment. Too great a percentage has not made any return at all.

It looks as if the questionnaire approach to a problem were here to stay, at least for the duration. There appears to be no better way to get certain necessary information. It would be wise, therefore, to accept it, and work with, rather than against it. After all, it does not demand much of the individual, and it may be the basis of a real contribution to the war effort. It should be kept in mind that the sacrifice necessary to complete the form is nothing compared with that made by the individuals initiating the inquiry, and yet all the time and thought spent by them will be wasted if an insufficient number of completed forms are returned. Your co-operation may be of considerable assistance to someone else in a worth while effort to aid the national cause.

WARTIME BUREAU OF TECHNICAL PERSONNEL

Monthly Bulletin

The activities of the Bureau have now entered a new phase. At the suggestion of Sir Lawrence Bragg, British Research liaison officer, and C. J. Mackenzie, acting president of the National Research Council, a register is being set up to cover research and science workers throughout Canada.

Believing that personnel service is best rendered to any one group by someone from within that group, the Bureau has secured the co-operation of Dr. David A. Keys, Professor of Physics at McGill University, who is eminently fitted for the work. McGill University has done much for the war effort by loaning its facilities and its staff. This is but another example of its whole-heartedness in all things that have to do with the national emergency.

Dr. Keys is already at work on matters of procedure, and it is expected that shortly forms will be ready for distribution to all persons who come within this group. Basically, the mailing list will be made up of those who hold master degrees or higher. It is evident that such a list will include many names that were canvassed in the first list of the Bureau, but it is hoped this new form will be received with equal approval as naturally it contains several questions not asked previously. It affords a better opportunity to such persons to describe their .training and experience.

It has been proved with startling emphasis that research work has a tremendous influence on a country's effort in time of emergency. It may be a long time after the war before the whole story can be told, but already it is apparent in many places that great things have been done by the Empire's research groups. This is particularly true in Canada. Leadership has been given by the National Research Council, excellently supported by the universities, industrial organizations and provincial groups. This portion of the Empire's effort will bring great credit to Canadian workers and Canadian institutions, and should be the gateway to even greater things after the war. It is to utilize all persons who have had any research training that this new register is to be established. The proposal has the support of many of those scientists who are closest to the needs of the country.

CORRESPONDENCE

A Suggestion for the Conservation of Fuel, Money, and Man-power

605 Victoria Avenue,
Victoria, B.C.

The Editor,
The Engineering Journal,
Montreal, Que.

Dear Sir,

Certain orders have been issued by the Department of Transport, from the office of the Oil Controller, regarding the conservation of gasoline and other liquid fuels, regulating hours of sale, cutting out credit sales, etc., without regard to the regulation of transportation required in our daily life.

It appears that a much greater percentage of conservation in cities, could be accomplished if commodity deliveries were regulated, and truck and delivery runs were made illegal outside of defined areas, naturally in the location of the vendor or vendors, of essential and generally used articles.

Assuming that all standard retail articles are the same price at all distributors for that article, as they should be, then an area dependent on his clientele should be set for each distributor:—

(1) The distributor will then distribute his goods in that area and no other.

(2) No other distributor will be allowed to deliver similar goods in that area.

There are various commodities and goods such as milk, bread, gasoline, etc., of which the price and delivery can be and is controlled, and, while the matter requires consideration and deliberation and a lot of ground work before a working basis can be arrived at, the saving in mileage and therefore in gasoline and diesel fuel, would be enormous.

(a) It can safely be said that 25 per cent of the motored delivery vehicles would not be required, and their non-use would release the fuel and do away with the repairs they at present have to be supplied with.

(b) The man-power would also be reduced in releasing the drivers of these trucks and the service men who cater to their needs, for the more essential war duties.

(c) The workmen, tools and material necessary in manufacturing these vehicles would also be diverted to war effort.

(d) There would be added expedition in the delivery of goods at a lower mileage delivery cost.

(e) Fresher comestibles would be supplied than are available under present conditions, and this would lead to better relations and satisfaction to those concerned.

(f) The release of actual money is shown as not being expended on fuel and wages for labour.

It was noted on August 25th in an actual check up made in the city of Vancouver, B.C., between the hours of 8 a.m. and 9 a.m., that eighteen milk delivery trucks (all motor) were operating in four blocks on one street. These vehicles were owned by seven different firms whose headquarters were situated miles apart. This instance gives one food for thought in these days of exploration into avenues of conservation of fuel, money and man-power.

Taking Vancouver as one instance, where, as in other large cities, milk, bread, gasoline, fuel oil, and other commodities are all in the hands of comparatively few firms, as distributors, it is not outside the bounds of realism to suggest that even the distribution between wholesalers, jobbers and retailers, can be controlled and reduced to a minimum. In the first instance, it might be arranged through an interchange of customers and that, while only the entering edge of the wedge, could be evidently carried out quite amicably as, commodity prices being the same, no cash would be involved.

Naturally an undertaking of this nature would have to be put in operation and carried on as a Government measure, and would entail considerable census, mapping and statistical work, besides personal contact with all interested parties, but the cure would certainly pay for the treatment. It is not an impossible, although an intriguing situation, and it is not even improbable that steps will have to be taken and regulations made and carried out, in this respect, before long.

As the route from initial distributor to retailer would be shortened, there would be, as before stated, a curtailment of mileage, fuel and time. There would naturally follow a lower delivery cost and thus a saving in the delivered cost of the article made up from these savings which, the price of the commodity being pegged, would not be absorbed by the distributor or the retailer, but would be passed back to the producer and forward to the customer. In this manner the farmer, for instance, would get an enhanced value for his product and the customer better goods, being fresher, at a lower cost.

Similarly in the case of fuel distributors and retailers, the same applies and these savings in both cases would further release a considerable amount of money, which at the moment is unnecessarily and wastefully tied up, as the producer and the customer would have this extra cash to use.

The saving to the country at large would of course center principally in the fuel, the man-power and the time released by this set up and secondarily in the added cash in circulation in the hands of the producer and consumer.

While possibly the above thought may savour somewhat of dictatorship, if we, as Canadians, are at "total war" then it behooves us to bear in mind that we must pay for this war and how better than by starting at the root and cutting out the non essentials of our social life, rather than starving the fruitful branches of war effort.

(*Signed*) Jas. H. Blake, m.e.i.c.

MEETING OF COUNCIL

A meeting of the Council of the Institute was held at Headquarters on Saturday, September 13th, 1941, at ten-thirty a.m.

Present: President C. J. Mackenzie in the chair; Past-President J. B. Challies; Vice-Presidents K. M. Cameron and McNeely DuBose; Councillors J. H. Fregeau, J. G. Hall, H. Massue, C. K. McLeod, B. R. Perry, G. M. Pitts, J. A. Vance, and the General Secretary.

Out of the discussion of the Sir John Kennedy Medal ballot, a proposal was made that some change in the regulations should be brought about whereby it would not be necessary to have a unanimous vote before an honorary membership be awarded. It was pointed out by the president that it was an extremely difficult process to obtain an absolutely unanimous opinion on any nomination for this honour. The meeting was of the opinion that some changes could be made to advantage, and the general secretary was instructed to discuss this matter with Mr. Durley so that a definite proposal might be submitted to a later meeting.

Mr. Challies, chairman of the Committee on Professional Interests, reported that in New Brunswick an agreement had been approved of in principle. It had been submitted to the Institute's lawyers and certain changes which they had proposed had seemed less acceptable to the Association than the original wording. Mr. Challies suggested that Mr. Kirby, the secretary of the Provincial Association, might be able to come to Montreal to discuss this matter with him and the General Secretary. It was agreed that an effort should be made to have Mr. Kirby come to Montreal.

In Manitoba Mr. Challies reported that the situation was favourable. He hoped that during the proposed visit of the president and the general secretary to Winnipeg some further progress might be made.

The general secretary reported figures for the changes in membership due to the workings of the co-operative agreement in the Province of Alberta. It was suggested that the president go into these matters with the Association and with the branches when he is in Alberta.

The general secretary read a report from the Institute's committee on A.R.P. in which it was recommended that the Institute combine with other interested societies to form a joint technical committee which could co-operate on engineering matters with the Federal organization for A.R.P. This was in accordance with a suggestion made by Dr. Glidden, the general controller of A.R.P. work.

Council felt that Mr. Munro's proposal should be accepted, and to that end it was suggested that the National Research Council might call a meeting in Ottawa inviting representatives from all appropriate societies. This was agreed to and the general secretary was instructed to make this request of the Research Council.

Mr. Pitts reported that the architects were naturally interested in this work and was confident that they would be glad to co-operate through the medium of such a committee. He agreed to bring the matter to the attention of the executive committee of the Royal Architectural Institute of Canada at its next meeting.

The president indicated that in home defence work there were many matters requiring consideration by engineers and scientists. He thought it desirable that a meeting be called so that the matter could be discussed by all interested parties in all its aspects. He pointed out that the Institute was not interested in the ordinary phases of A.R.P. work, but principally those phases dealing with explosions, both from the angle of reducing the amount of damage done and methods of quick repair after attack. It was thought that organizations or individuals interested in public utilities, public works, architecture, chemicals and gases should be brought together for deliberations on this subject.

In the absence of the chairman of the Finance Committee, the general secretary presented the reports of two meetings, one held on July 22nd, and the other on September 12th. The financial statement to the end of August had been examined and approved, the situation between normal income and expenditure being slightly better than at the same time last year.

The Finance Committee recommended that Council approve of some method by which recognition might be made of professional engineers from other countries who are now working in Canada; these were principally English and Polish. The committee thought something should be worked out whereby all such persons would be given the privileges of branch meetings and perhaps also the *Journal.*

In this latter case some special consideration might be made whereby actual costs would be met. These people might be known as "Guest Members" or some other appropriate term.

The general secretary read a letter from the secretary of the Institution of Electrical Engineers in which this proposal was received very cordially, and it was suggested that if the Institute extended these privileges to the English members, the English institutions would like to have an opportunity to reciprocate towards those members of the Institute who are now in the Old Country.

It was the unanimous opinion of the meeting that everything possible should be done to make pleasant the stay of these people in Canada. Council was willing to approve of any definite proposals which were acceptable to the Finance Committee. It was stated specifically and emphatically that the arrangement to be worked out should be such that it would be possible for every such visiting engineer to participate in all Institute activities. The secretary was instructed to obtain from the English Institutions the names of any of their members in this country, and also to obtain a similar list from the members of the Polish Engineers' Association. He was instructed to communicate with each branch as soon as the plan was formulated, so they might get in touch with any members of this group who might be in their branch area.

The general secretary reported that contributions had been received from thirteen Institute branches but that twelve had not yet completed their campaign. It was expected in these latter cases that the matter would be reopened after the fall season commenced, and that satisfactory results would be obtained in each case. The secretary was instructed to write a letter to each of the branches in this latter group reporting on the results to date and asking for their co-operation.

The president gave a brief outline of his proposed visit to the western branches. He was leaving Ottawa on Saturday, September 20th, and would stop at the Lakehead Branch, Winnipeg, Regina, Calgary, Vancouver and Edmonton. He regretted that the urgency of business of the Research Council made it impossible for him to take in other branches such as Lethbridge and Victoria. Due to the pressure of these other business affairs it is necessary for him to make the trip within the minimum length of time. He said that he would be pleased to have any other members of Council accompany him who could do so. Vice-President Cameron announced that he expected to go with him at least as far as Winnipeg. The general secretary reported that due to further developments in the activities of the Wartime Bureau of Technical Personnel at Ottawa, it was necessary for him to be in Ottawa on certain dates so that he would only be able to be present at the Lakehead and the Winnipeg branches.

Councillor Perry presented a final report on the repairs to the building foundations. This report showed that the work had all been completed and paid for, and appeared to be very satisfactory. Councillor Vance said that it was readily evident that Mr. Perry had done a real service for the Institute in carrying out this work as chairman of the committee. He moved that a motion be recorded on the minutes of Council indicating Council's gratitude to Mr. Perry for his fine service. Council unanimously agreed to this proposal, after which the president called attention to the time which it had been necessary for Mr. Perry to devote to this work as head of the committee, for all of which he received absolutely no remuneration. Accordingly, it was moved and seconded that the Council of the Institute wishes to record its appreciation of the splendid service which has been rendered by Councillor Brian Perry, as chairman of the House Committee, in supervising the engineering work associated with the underpinning of the Headquarters' building. His careful planning and consideration for Institute finances have done a great deal towards producing an extremely satisfactory piece of work at a minimum cost.

The report of the Nominating Committee was presented by the general secretary, who reported that all nominees were in good standing, and that a written acceptance of nomination had been received from each nominee. Accordingly, it was unanimously RESOLVED that the list of nominees for officers for the year 1942, as submitted by the Nominating Committee, be accepted and approved.

The president indicated his desire that Dean C. R. Young, presidential nominee, be invited to all Council meetings for the balance of his term of office, and that minutes of all meetings be sent to him so that he might have an opportunity to familiarize himself in detail with the affairs of the Institute before actually coming into office. This was unanimously approved.

The general secretary read a report from Mr. Harry Bennett, chairman of the Institute's Committee on the Training and Welfare of the Young Engineer. This report outlined the work that had been done by the committee in preparing the manuscript of a booklet to be distributed among high school or secondary school pupils who might be contemplating proceeding to college to take up engineering. Mr. Bennett also submitted a copy of the manuscript for the approval of Council. The report included a statement of quotations which had been received for the printing, as well as recommendations as to quantity and distribution. It was agreed that Mr. Bennett's proposal for the manuscript itself, as well as his recommendations as to price, quantity and distribution be accepted by Council, subject to approval of the Publication Committee.

The general secretary reported briefly on the activities of the Wartime Bureau of Technical Personnel, emphasizing particularly that at the request of the National Research Council and Sir Lawrence Bragg, the liaison officer between the British research organizations and the National Research Council, the Bureau was undertaking a register of research workers and scientific personnel. It had been arranged that Doctor David A. Keys, Professor of Physics at McGill University, would head up this department of the Bureau's activities. His time had been made available by McGill University, although it was not expected that it would require his whole time, except perhaps in the organization stage.

The general secretary read a letter from the National Construction Council in which the co-operation of the Institute was asked in making surveys to determine what work might be planned for attention immediately after the war. It was reported that the Council had had a meeting of its executive and had gone into the subject in detail, the outcome of which had been that two resolutions were passed. The Council of the Institute was asked whether or not it could support these resolutions. After considerable discussion, in which it was clearly expressed that Council felt that after-war conditions could not be met by sectional planning but must be considered on a national basis, the general secretary was instructed to send copies of the National Construction Council's communication to all councillors so that they might prepare for a fuller discussion at subsequent meetings.

The general secretary read a communication from this organization which dealt with economic and social planning for the post-war period. Council agreed that this matter, too, should be considered on a national rather than on a sectional basis, and that these proposals should come up for discussion when the National Construction Council's communications were again before Council.

A number of applications were considered and the following elections and transfers were effected:

Admissions	
Members	11
Juniors	4
Affiliate	1
Transfers	
Junior to Member	2

Student to Member.................... 4
Student to Junior..................... 9

Vice-President Cameron suggested that it would be a good idea to hold a regional meeting of Council in Quebec City. This met with unanimous approval. The President stated that he would very much like to have an opportunity to visit that branch. It was thought that the October meeting might be arranged in that city, and the selection of an actual date was left with the President.

The Council rose at one-thirty p.m.

LIST OF NOMINEES FOR OFFICERS

The report of the Nominating Committee was presented to and accepted by Council at the meeting held on September 13th, 1941. It is published herewith for the information of all corporate members as provided by Sections 19 and 40 of the By-laws.

List of Nominees for Officers for 1942 as Proposed by the Nominating Committee

President	C. R. Young	Toronto
Vice-Presidents:		
*Zone "B" (Province of Ontario)	J. L. Lang	Sault Ste. Marie
*Zone "C" (Province of Quebec)	H. Cimon	Quebec
*Zone "D" (Maritime Provinces)	G. G. Murdoch	Saint John
Councillors:		
†Victoria Branch	E. W. Izard	Victoria
†Lethbridge Branch	J. Haimes	Lethbridge
†Calgary Branch	S. G. Coultis	Calgary
†Winnipeg Branch	J. W. Sanger	Winnipeg
†Sault Ste. Marie Branch	A. E. Pickering	Sault Ste. Marie
†Hamilton Branch	W. J. W. Reid	Hamilton
†Niagara Peninsula Branch	P. E. Buss	Thorold
	W. R. Manock	Fort Erie North
	A. W. F. McQueen	Niagara Falls
†Ottawa Branch	T. A. McElhanney	Ottawa
†Toronto Branch	Nicol MacNicol	Toronto
†Peterborough Branch	H. R. Sills	Peterborough
‡Montreal Branch	J. E. Armstrong	Montreal
	R. E. Heartz	Montreal
†Quebec Branch	E. D. Gray-Donald	Quebec
†Moncton Branch	G. L. Dickson	Moncton
†Cape Breton Branch	F. W. Gray	Sydney

*One vice-president to be elected for two years.
†One councillor to be elected for two years.
‡Two councillors to be elected for three years each.

ELECTIONS AND TRANSFERS

At the meeting of Council held on September 13th, 1941, the following elections and transfers were effected:

Members

Alton, Jack, (Regent St. Polytechnic), designing engr., Canadian Bridge Co. Ltd., Walkerville, Ont.

Bullick, Clarence John, B.A.Sc., (Univ. of Toronto), asst engr., Tropical Oil Company, Barranca Bermeja, Colombia, S.A.

Dufort, Cleophas Leroux, B.A.Sc., C.E., (Ecole Polytechnique), Registrar, Corpn. of Prof. Engineers of Quebec, 354 St. Catherine St. East, Montreal, Que.

Estabrooks, Donald Steeves, B.Eng. (Civil), (N.S. Tech. Coll.), records engr., Price Bros. & Co. Ltd., Riverbend, Que.

Middleton, John, (Tech. Coll., Greenock), asst. engr., office of the engineer-in-chief, Naval Service Headquarters, Ottawa, Ont.

Scheunert, Hans, Mech. Engr. (Frankhausen Engrg. Coll.), production engr., aircraft divn., Canadian Car & Foundry Co. Ltd., Fort William, Ont.

Spriggs, William, B.Sc. (E.E.), (McGill Univ.), elec. design engr., Shawinigan Engineering Company, Montreal, Que.

Stickney, William Ralph, B.A.Sc. (Chem.), (Univ. of Toronto), welding engr., Canadian Bridge Co. Ltd., Walkerville, Ont.

Warnock, Samuel, B.A.Sc. (Elec.), (Univ. of B.C.), A/C Inspector, No. 15 Technical Detachment, R.C.A.F., Winnipeg, Man.

Williams, Ralph Emerson, B.A.Sc. (Univ. of Toronto), asst. engr., Defence Industries Limited, Winnipeg, Man.

Wrigley, Frederick Richardson Gordon, (City and Guilds of London Inst.), elec. engrg. dept., Aluminum Company of Canada, Montreal, Que.

Juniors

Dembicki, Steve, B.Sc. (Univ. of Alta.), M.Eng. (McGill Univ.), metallurgist, Defence Industries Limited, Verdun, Que.

Estabrook, James Pierce, B.Sc. (Chem.), (Queen's Univ.), junior chemist, Price Bros. & Co. Ltd., Riverbend, Que.

Gorowski, Charles S., B.Sc. (Elec.), (Univ. of Man.), engr., Canadian Associated Aircraft Ltd., Montreal, Que.

MacKenzie. Ian Donald, B.Sc. (Queen's Univ.), asst. geologist, Shawinigan Engineering Company, Shawinigan Falls, Que.

Affiliate

Matthews, Clifford Bruce, asst. to the city engr., Belleville, Ont.

Transferred from the class of Junior to that of Member

Kent, William Leslie, B.Sc. (Civil), (Univ. of Alta.), engr., Stuart Cameron & Co. Ltd., Lang Bay, B.C.

Pask, Arthur Henry, B.Sc. (Elec.), (Univ. of Man.), project engr., Canadian Industries Limited, Windsor, Ont.

Transferred from the class of Student to that of Member

Akin, Thomas Bernard Jr., Pilot Officer, R.C.A.F., B.Sc. (Civil), (N.S. Tech. Coll.), School of Aeronautical Engineering, 4895 de Bullion St., Montreal, Que.

Baldwin, William Alanson, B.Sc. (Elec.), (McGill Univ.), supt., High Falls Generating Station, Maclaren Quebec Power Co. via Buckingham, Que.

Howard, Henry Mervyn, B.A.Sc. (Mining), (Univ. of Toronto), metallurgical sales engr., E. Long Limited, Orillia, Ont.

Purves, William Franklin, B.Eng. (Elec.), (McGill Univ.), elec. engr., Schick Dry Shaver Inc., Stamford, Conn.

Transferred from the class of Student to that of Junior

Dunn, James Rankin, B.A.Sc. (Elec.), (Univ. of Toronto), Sub-Lieut., R.C.N.V.R., Halifax, N.S.

Goodspeed, Herbert Newcombe, B.Sc. (Elec.), (Univ. of N.B.), electrician, International Nickel Co. Ltd., Sudbury, Ont.

Howard, Albert Warren, B.A.Sc. (Univ. of Toronto), asst. elec. engr., Montreal Engineering Co. Ltd., Montreal, Que.

Mackie, George Arthur, B.Sc. (Elec.), (Univ. of N.B.), Lieut., 1st Brighton Fortress (E & M) Coy., R.C.E. (A.F.), Saint John, N.B.

Miller, Lindsay, B.Eng. (Mech.), (McGill Univ.), dftsman., Aluminum Co. of Canada, Kingston, Ont.

Monaghan, Cecil, B.Sc. (Elec.), (Univ. of Alta.), senior engrg. clerk, elec. light and power dept., City of Edmonton, Alta.

Myers, Gordon Alexander, B.Eng. (Elec.), (N.S. Tech. Coll.), res. engr. and acting mgr., Colas Nfld. Ltd., Clarenceville, Nfld.

McKibbin, Kenneth Holdsworth, B.Sc. (Mech.), (Queen's Univ.) Major, Dist. Ordnance Mech. Engr., Mil. Dist. No. 3, Kingston, Ont.

Wong, Henry Goe, B.Eng. (McGill Univ.), dftsman., Federal Aircraft Ltd., Montreal, Que.

Students Admitted

Abbott, Hugh Martin, (Univ. of B.C.), 5930 Granville St., Vancouver, B.C.

Berry, William Murray, (Univ. of Man.), 241 Harbison Ave., Winnipeg, Man.

Coupe, Herbert Ferguson, B.A.Sc. (Univ. of Toronto), Saguenay Inn, Arvida, Que.

Estabrook, Howard A., B.Sc. (Queen's Univ.), Saguenay Inn, Arvida, Que.

Frost, Paul Joseph, (Univ. of B.C.), 4261-12th Ave. W., Vancouver, B.C.

Hurley, James J., (Univ. of Toronto), 17 Lindsay Ave., Toronto, Ont.

Jagger, Paul S., (Univ. of B.C.), 1259 Gordon Ave., Hollyburn, B.C.

Kingsmill, Hugh Anthony Gault, B.A.Sc. (Univ. of Toronto), Saguenay Inn., Arvida, Que.

Miron, Jacques, (Ecole Polytechnique), 340 DeLanaudiere, Joliette, Que.

Moore, William Alan, B.A.Sc. (Univ. of Toronto), 17 Roxborough Drive, Toronto, Ont.

McEown, Wilbert Ross, inspr., Dept. of Trade and Commerce, Winnipeg, Man.

Ouellette, Robert Pascal, (McGill Univ.), 5363 Duquette Ave., Montreal, Que.

Personals

News of the Personal Activities of members of the Institute, and visitors to Headquarters

Lt.-Col. A. R. Sprenger, M.E.I.C., is at present engaged in the supervision of shipyard extensions with the Wartime Merchant Shipping Limited.

John C. Oliver, M.E.I.C., Registrar of the Association of Professional Engineers of British Columbia, has joined up for overseas service and his Council has given him indefinite leave of absence. Previous to taking the position as registrar of the Association in 1938, he had been for several years assistant city engineer at Vancouver.

A. D. Creer, M.E.I.C., has been appointed Registrar of the Association of Professional Engineers of British Columbia, replacing John C. Oliver for the duration of the war. Mr. Creer, who has been in private practice in Vancouver as a consulting engineer for several years, was at one time chairman of the Vancouver Branch of the Institute.

Capt. A. C. Rayment, M.E.I.C., has joined the staff of the Department of Munitions and Supply, Arsenals Branch, as technical officer. He has had a varied and extensive engineering experience in Canada, Britain and Australia. Since the beginning of the present war, he has been active in instructional military work.

S. D. Lash, M.E.I.C., has joined the engineering staff of Queen's University as Lecturer in civil engineering. Mr. Lash, who is an honour graduate of the City and Guilds Engineering College, London, England, and a Ph.D. of the University of Birmingham, came to Canada in 1929 as draftsman with the Northern Electric Company of Montreal, and later was employed with the Dominion Reinforcing Steel Company Limited, Montreal. In 1930, he went to Vancouver as a structural detailer with the British Columbia Electric Railway Company Limited. From 1931 to 1933 he did post graduate work at the University of Birmingham, England, and from 1933 to 1935 he worked as a research assistant with the Steel Structures Research Committee in England. Returning to Canada in 1935, he was instructor in civil engineering at the University of British Columbia until 1938, when he joined the National Research Council at Ottawa as a junior engineer. Lately Dr. Lash has been acting secretary of the National Building Code project with the National Research Council. He is a frequent contributor to *The Engineering Journal.*

Lt.-Col. John Handley, M.E.I.C., is now on active service with the Royal Canadian Engineers and is at present Second in Command of the Third Battalion at Noranda, Que.

L. G. Scott, M.E.I.C., has been transferred by the Hudson's Bay Company from Winnipeg, Man., to Vancouver, B.C.

Flying Officer K. Y. Lochhead, M.E.I.C., has completed his course at the School of Aeronautical Engineering, Royal Canadian Air Force, Montreal, and has been posted as Station Engineer Officer at Alliford Bay, B.C.

Jean Bouchard, M.E.I.C., is at present employed as field engineer with A. Janin and Company at Gaspé, Que. Lately he had been employed as assistant district engineer for the Civil Aviation Division of the Department of Transport.

W. G. Dyer, M.E.I.C., has been appointed division engineer with the Canadian Pacific Railway Company at Moose Jaw, Sask. He was previously located at Lanigan, Sask. He has been with the Canadian Pacific Railway Company ever since his graduation from the University of Saskatchewan in 1925.

C. H. McL. Burns, M.E.I.C., has recently been appointed assistant to the manager of munitions of Otis-Fensom Elevator Company Limited, at Hamilton, Ont.

R. K. Williams, M.E.I.C., has severed his connection with the Geo. S. May Company, and has accepted a position with Stevenson and Kellogg Limited, Toronto.

W. F. Campbell, M.E.I.C., is now employed with the Aluminum Company of Canada, Limited, at Arvida, Que. He was previously acting county engineer for the County of Holdimand at Cayuga, Ont.

Victor Michie, M.E.I.C., who is inspecting engineer with the Department of Munitions and Supply is temporarily located in Newfoundland. Mr. Michie is the chairman of the Winnipeg Branch of the Institute.

Eric Grant, M.E.I.C., has joined the Royal Canadian Air Force and is located at Halifax with the Works and Buildings Department. For the past two and a half years he was employed with the Canadian National Railways on design and drafting work for the Montreal terminal station.

J. S. Cooper, M.E.I.C., is now on active service with the Royal Canadian Navy and is attached to the Engineer-in-Chief's Division at Naval Service Headquarters, Ottawa. He had lately been employed as an inspector of tanks with the Inspection Board of the United Kingdom and Canada. Previously he was connected with the Wabi Iron Works Limited, at New Liskeard, Ont.

D. B. Rees, M.E.I.C., has been promoted from Flying Officer to Flight Lieutenant in the Royal Canadian Air Force. He is at present stationed with No. 4 Air Training Command at Regina.

A. M. Paull, M.E.I.C., has left the Department of Public Works, Highways Branch, of Alberta, and has been appointed a temporary Flying Officer with the Works and Buildings Department of the Royal Canadian Air Force at Edmonton.

J. A. Reynolds, M.E.I.C., has joined the staff of the Department of Munitions and Supply, Directorate of Engineering. He was previously employed as an aircraft inspector at Belleville, Ont.

G. R. Treggett, Jr.E.I.C., has severed his connection with the Montreal Tramways Company to accept a position with the Coca-Cola Company of Canada Limited at Montreal.

Squadron Leader A. D. Nesbitt, S.E.I.C., has recently received the Distinguished Flying Cross for his leadership and devotion to duty with the Royal Canadian Air Force in England. The citation of the Air Ministry states that "on a particular occasion in December, 1940, Nesbitt led a section of aircraft over the sea for two hours without wireless assistance in extremely adverse weather conditions. The visibility was practically nil. His judgment enabled the section eventually to land safely—although their petrol was practically exhausted—without loss to personnel. Nesbitt has destroyed two enemy aircraft." Squadron Leader Nesbitt has been in the thick of the fighting over Britain for the past fifteen months.

D. L. Rigsby, S.E.I.C., employed with the British Air Commission, has been transferred to Consolidated Aircraft Corporation at San Diego, Calif.

R. J. Brydges, S.E.I.C., has recently been transferred by the Northern Electric Company Limited from Montreal to Winnipeg. He was graduated from the University of Manitoba in 1938 and took a two-year apprenticeship course with A. Reyrolle & Company Limited, England. Upon his return to Canada in 1940, he joined the staff of the Northern Electric Company Limited in the Power Apparatus Division at Montreal.

H. W. Colditz, S.E.I.C., is now employed with the Bethlehem Steel Company, Shipbuilding Division, on Staten

Island, New York. He was graduated from McGill University last spring.

Jean Lacombe, S.E.I.C., is now employed with the Dominion Bridge Company Limited in the plate and tank department at Lachine, Que. Lately he had been on the staff of the Quebec North Shore Paper Company at Baie Comeau, Que.

W. B. McIntyre, Affl.E.I.C., who was employed with the Canadian National Railways at Toronto, has been transferred to Regina, Sask.

VISITORS TO HEADQUARTERS

T. Foulkes, M.E.I.C., Plant Engineer, J. R. Booth Co. Ltd., Ottawa, Ont., on August 22nd.

R. R. Oulton, Jr.E.I.C., Canadian Broadcasting Corporation, Sackville, N.B., on August 26th.

F. S. Small, M.E.I.C., Fraser Brace Co. Ltd., Montreal, on August 27th.

N. Beaton, M.E.I.C., Powell River, B.C., on August 29th.

J. W. Thompson, M.E.I.C., Debert Aerodrome, Debert, N.S., on August 29th.

G. B. Batanoff, S.E.I.C., Blaine Lake, Sask., on August 30th.

Geoffrey Stead, M.E.I.C., Saint John, N.B., on September 8th.

Jean Flahault, S.E.I.C., Aluminum Company of Canada, Arvida, Que., on September 10th.

K. M. Cameron, M.E.I.C., Chief Engineer, Department of Public Works, Ottawa, Ont., on September 13th.

R. M. Hardy, M.E.I.C., Professor of Civil Engineering, University of Alberta, Edmonton, Alta., Chairman Edmonton Branch, on September 15th.

J. L. Balleny, M.E.I.C., Canadian General Electric Co. Ltd., Toronto, Ont., on September 17th.

Mrs. F. A. Gaby, wife of Past-President Gaby, Toronto, Ont., on October 4th.

Obituaries

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Lionel Coke-Hill, M.E.I.C., died on July 7th, 1941, in England, as the result of an accident. He was born at Derby, England, on February 25th, 1872, and received his education at the local technical college, at the same time serving an apprenticeship in his father's office, the late A. Coke-Hill, architect.

From 1893 to 1902 he was employed as a draftsman and an inspection engineer in the engineering department of Bass & Company, Brewers, Burton-on-Trent, England. He came to Canada in 1903 and was employed for a few months with the Bell Telephone Company as draftsman and inspector of building construction in Montreal. In 1904 he joined the staff of J. A. Jamieson, grain elevator engineer, as a draftsman on concrete and steel elevator construction. He went to the United States in 1906 on similar work with the Macdonald Engineering Company at Chicago. The following year joined the staff of John S. Metcalf Company, in their Chicago office, and remained with this firm for a number of years. From 1908 until 1914 he was in Montreal as a designing engineer on Harbour Commissioners of Montreal and Canadian Pacific Railway elevators and many other plants of similar character. From 1914 to 1919 he travelled extensively in England, Siberia, Russia and France as European manager and engineer for the Metcalf Company. During the year 1919 to 1920 he was in charge of the company's business and construction of elevators at Buenos Aires, Argentine. He later returned to Montreal and became chief engineer and director of the company. For the past few years he had lived at Mickleover, Derby, England.

Mr. Coke-Hill joined the Institute as a Member in 1922.

Frederick George Cross, M.E.I.C., died at his home at Lethbridge, Alta., on September 9th, 1941, after a long illness. He was born at Exeter, Devonshire, England, on September 2nd, 1881, and received his education in the local schools, and in London.

He came to Canada in 1906 and entered the service of the Irrigation Department of the Canadian Pacific Railway Company on August 1st, 1907, at Calgary; from 1907 to 1914 he was engaged on location and construction of the irrigation systems, from rodman to general inspector, supervising concrete, steel and timber construction up to the time of his enlistment for overseas service in the last war. He served with the Canadian Railway Troops in France from 1915 to the termination of the war, retiring with the rank of Major. In 1919, Major Cross returned to the service of the Canadian Pacific Railway Company as canal superintendent at Brooks, Alta. In 1925 he was promoted to assistant superintendent of operation and maintenance of the Company's Lethbridge irrigation project, which position he held up to the time of his death.

F. G. Cross, M.E.I.C.

The late Mr. Cross was one of Canada's leading artists and his works hang in many parts of the world. At the early age of sixteen he exhibited two oil paintings in the Royal West of England Academy. During early construction days in Alberta he spent many evenings drawing and sketching animals on the range. Following the war he won a dual competition for a war memorial and record of service conducted by The Engineering Institute of Canada. Both bronzes are erected in the Institute's headquarters at Montreal. Paintings of the deceased are included in Canada's first water colour collection to Scotland in 1932-33. They are represented in Canada's collections to the Southern Dominions (Johannesburg Exposition). Some of his art was included in Canada's exhibition of paintings sent to London for the coronation of King George VI.

Some of Mr. Cross' works hang in Birmingham city's art gallery and many of his pictures are in private collections. He was a member of the Canadian Society of Painters in Water Colours, of whom there are only thirty-one in Canada. In 1937 he was honoured in his election by the Council of the Royal Canadian Academy as an associate member.

Mr. Cross joined the Institute as an Associate Member in 1912 and he was transferred to Member in 1932.

Alexander Scott Dawson, M.E.I.C., died on August 8th, 1941, at Guelph, Ont. He was born at Pictou, N.S., on September 6th, 1871, and received his education at McGill University, Montreal, where he was graduated in 1894. For three years after graduation he worked as assistant engineer with the Metropolitan Water Works Department at Boston, Mass. In 1899 he joined the Canadian Pacific Railway Company as assistant engineer at Winnipeg. In 1903 he became division engineer at Calgary, Alta. A year later he was made division engineer of the Company's irrigation department at Calgary, and in 1907 he became assistant chief engineer of the same department, later becoming chief engineer. In this capacity he had direct charge of the construction and operation of all the larger irrigation enterprises of the Company in Alberta. Since his retirement in 1932, he had lived in eastern Canada.

A. S. Dawson, M.E.I.C.

Mr. Dawson joined the Institute as a Student in 1889 and he was transferred to Associate Member in 1895. He became a Member in 1909 and was granted Life Membership in 1932. He was a charter member of the Calgary Branch of the Institute and was chairman of its Executive Committee in 1917. He was a vice-president of the Institute for 1925-1926.

Herbert Samuel Holt, LL.D., D.C.L., M.E.I.C., died at his home in Montreal, on September 28th, 1941, after a month's illness. He was born at Geashill, King's County, Ireland, on February 12th, 1856. He was educated at Albert Training Institute at Glasnerin, near Dublin. Upon receiving his diploma in engineering, land surveying and drafting, he came to Canada in September, 1873 and until December was employed as assistant to the engineer of the Toronto Water Works. From then until May 1874 he was assistant engineer and transitman on a topographical survey for the Credit Valley Railway, and following this became transitman and assistant engineer on the Victoria Railway. In the next year, he was division engineer on the Lake Simcoe Junction Railway, and he later returned to the Credit Valley Railway as engineer in charge of track, buildings, and bridges on 93 miles. When engaged on this work, Mr. Holt formed a friendship that was to have important developments. He met William (later Sir William) Mackenzie, and obtained a timber contract from him. In years to come these two men along with Donald (later Sir Donald) Mann, were associated in railway construction, public utility and other enterprises.

Mr. Holt's reputation as a railroad constructor was firmly established by the Credit Valley contract and when in the middle 80's James Ross, father of J. K. L. Ross, took over the task of building parts of the Prairie and British Columbia sections of the Canadian Pacific Railway, his young superintendent was placed in charge of the work. Mr. Holt later went into the contracting business for himself and under his direction stretches of the C.P.R. in Quebec, Maine and New Brunswick were built. Mr. Holt was one of the group who witnessed the historic ceremony of the driving of the last spike in the C.P.R. transcontinental line by Sir Donald Smith, subsequently Lord Strathcona and Mount Royal.

Mr. Holt also constructed railways in the United States and was a pioneer railroader in South America. He built a line over the Andes, after covering the whole ground with a surveying party on mule back.

He came to Montreal in 1901 and interested himself in the Montreal Gas Company. Then began the series of developments and mergers which resulted in the Montreal Light, Heat and Power Consolidated.

In 1908 Mr. Holt became president of the Royal Bank of Canada, which by absorbing such banks as the Union, the Traders, Northern Crown and Quebec, and acquiring the West Indian branches of the Colonial Bank of England, had widely extended its operations.

Mr. Holt received the honour of knighthood in 1915 for services to Great Britain during the Great War, when he made a survey of the war zone railways in France.

In recent years Sir Herbert had relinquished the presidency of the Montreal Light, Heat and Power Consolidated and of the Royal Bank of Canada, acting in each case as chairman of the board. He was director of a great number of companies as well as a governor of McGill University and president of the Royal Victoria Hospital in Montreal.

Sir Herbert S. Holt, M.E.I.C.

Sir Herbert was one of the senior members of the Institute, having joined as an Associate Member in 1889 and transferred to Member in December of the same year.

Earlier this year he was amongst the eight initial recipients of the Julian C. Smith Medal of the Institute granted "for achievement in the development of Canada." It had not been possible for Sir Herbert to be present at the annual meeting of the Institute last winter in Hamilton when these medals were presented, and it had been hoped that a special presentation could have been arranged this fall.

It may be appropriate to recall the citation which was read by the late General Sir Arthur Currie when he conferred upon Sir Herbert the honorary degree of LL.D., in 1927: "A leader endowed with strength for great responsibilities; clear sighted guide of many nationally important undertakings, who has devoted his organizing talents to Canadian industry; a believer in word and deed in Canadian capital for Canadian development; a citizen of firm faith in Canada's resources who has administered with broad vision a great many Canadian enterprises."

Robert Fitzgerald Uniacke, M.E.I.C., died suddenly at Toronto on August 25th, 1941. He was born at Sydney, Cape Breton, on April 10th, 1858, and obtained his education at King's College, now affiliated with Dalhousie University. He began his engineering career in 1880 when he was employed by the Nova Scotia Government on the construction of the Western Counties Railway. The same year he went to the United States to work on the location and construction of New York West Shore and Buffalo Railroad. From January, 1881, to October, 1883, he acted as assistant engineer on the construction of the Genesee Company division near Buffalo. He then returned to Canada and was engaged by the Nova Scotia Government as resident engineer on the Nova Scotia and Atlantic Railroad. A few years later he was employed with the Dominion Bridge Company in Montreal and the King Bridge Company in Cleveland. In 1904 he returned from Cleveland to become bridge engineer with the old National Transcontinental Railway and, during his ten years' association with the railroad, was responsible for all its bridges east of Winnipeg. Severing his connection with the railway in 1914, he was appointed chief penitentiaries engineer in the Department of Justice at Ottawa, and remained in this position until his retirement in 1926.

Two years before his retirement, he was awarded the Gzowski medal by the Institute in recognition of a paper he had prepared on the Salmon River viaduct in Quebec. During recent years he had lived abroad, returning to Canada in 1940.

Mr. Uniacke was one of the oldest members of the Institute, having joined as a Member the year of its incorporation as the Canadian Society of Civil Engineers in 1887. He acted as chairman of the Ottawa Branch for several years and was a councillor of the Institute from 1914 to 1916. He had been made a Life Member in 1926.

News of the Branches

Activities of the Twenty-five Branches of the Institute and abstracts of papers presented

QUEBEC BRANCH

Paul Vincent, M.E.I.C. - *Secretary-Treasurer*

Le premier tournoi annuel de golf de la section de Québec, disputé sur les terrains du Royal Quebec Golf Club à Boischatel, le 15 septembre 1941, a été couronné d'un remarquable succès, en dépit de la mauvaise température. Le brillant soleil du début de l'après-midi fit place, vers les 4 heures, à une pluie torrentielle qui cependant ne réussit pas à décourager les joueurs. Les dames en particulier, qui avaient été invitées à prendre part au tournoi, firent preuve d'un excellent esprit sportif, et continuèrent la partie jusqu'à la fin.

Entre le dix-huitième et le dix-neuvième. M.M. Lionel Bizier, L. C. Dupuis, P.-A. Dupuis, le champion, et Lucien Martin.

La coupe donnée par la maison Geo. T. Davie & Sons, fut gagnée par P. A. Dupuis du Ministère des Travaux Publics qui enregistra le meilleur score brut. Le vainqueur devra défendre avec succès son titre pendant deux autres années consécutives, pour que la coupe emblématique du championnat reste en sa possession définitivement. Le "runner up" fut Lionel Bizier, du Port de Québec, qui enregistra deux coups de plus que le champion.

Pour le meilleur score net, la palme revient à Gustave St-Jacques, de la Régie des Services Publics. Huet Massue, de Montréal, le suivit de près.

Chez les dames, Mademoiselle Charlotte Dupuis, fille du président de la section de Québec de l'Institut, enregistra le meilleur score brut, tandis que le crédit pour le meilleur score net revient à Madame Léo Roy.

De nombreux prix de valeur, gracieusement offerts par différentes maisons de commerce de Québec, furent distribués aux vainqueurs à l'issue des matches.

Au diner qui suivit, dans le chalet du club, le président L. C. Dupuis avait avec lui à la table d'honneur, Hector Cimon, vice-président de l'Institut choisi pour l'an prochain, et Huet Massue, de Montréal, conseiller de l'Institut.

Le diner fut suivi d'une danse dans les salons du club.

Tous ceux qui ont pris part à cette fête, s'accordent pour reconnaître son succès, et se promettent d'y revenir l'an prochain.

Parmi ceux qui ont bravé la pluie, M.M. Edouard Gaudette, Ludger Gagnon, Joachim des Rivières Tessier, Huet Massue et Hector Cimon.

Groupe des golfeurs après le tournoi. Assis de g. à d.: M.M. Huet Massue, de Montréal; L. C. Dupuis, président de la Section de Québec; Louis Trudel, de Montréal; Hector Cimon, Adhémar Laframboise et Paul Vincent, secrétaire de la Section, tous trois de Québec.

News of Other Societies

Items of interest regarding activities of other engineering societies or associations

ECPD ANNOUNCE ANNUAL MEETING IN NEW YORK CITY ON OCTOBER 30, 1941

The annual meeting of the Engineers' Council for Professional Development, although last year held in Pittsburgh, will this fall again return to its customary meeting place in New York City. The date selected, Thursday, October 30, follows immediately the yearly sessions of the National Council of State Boards of Engineering Examiners, which are also scheduled for New York on the three preceding days, October 27-29.

Although these two organizations are not meeting jointly, nevertheless it is expected that there will be a generous overlapping of attendance, and the focus for joint attendance is the annual banquet of the National Council of State Boards of Engineering Examiners on Tuesday evening. Similarly, the annual dinner of ECPD on Thursday evening is expected to attract many of those who are delegates to the earlier convention.

Three sessions of the ECPD meeting are in prospect for Thursday. In the forenoon reports from various committees will be received and discussed. Following lunch there will be an executive session, devoted to accrediting and similar confidential features of the work. At dinner the programme will be attuned to the special professional problems incident to the present national emergency.

The fine work being done by ECPD should be a matter of pride and interest to all engineers. Those interested are encouraged to attend the public meetings including the dinner at the Engineers' Club. Sessions will be held at the Engineering Societies Building. The chairman of ECPD is Robert E. Doherty, president of the Carnegie Institute of Technology, and for 1940-41 George T. Seabury, secretary of the American Society of Civil Engineers, is secretary.

ANNUAL CONVENTION, CANADIAN INSTITUTE OF SEWAGE AND SANITATION

The Annual Convention of the Canadian Institute on Sewage and Sanitation will be held at the Walper House, Kitchener, Ont., on October 16th and 17th. The programme will consist of four written papers and four guided discussions, Municipal plumbing, by-laws, treatment of activated sludge, refuse collection and salvage of wastes, and treatment by sprinkling filters will be among the subjects discussed; while the written papers will deal with sludge disposal, laboratory control in sewage treatment, the Grand River Conservation Project, and the cleaning and maintenance of sewers. A large attendance is expected.

POST-WAR CONSTRUCTION PROGRAMME

The minutes, recently issued, of the annual meeting of the National Construction Council of Canada, held at Toronto on May 29th, carry interesting news to the construction industry. The Council has appointed a standing committee to study and make plans for a post-war programme of construction along the lines of the recommendations made at the Government sponsored Conference of Building Trades Employers and Employees, held at Ottawa last winter. These recommendations are as follows:

1. Extension of the present Federal Housing Act and the broadening of its provisions to include opportunities for those in business to secure the same measures of assistance as other citizens.

2. Re-inauguration of the Home Improvement Plan and the broadening of this measure to include opportunities for small business men to secure assistance for necessary extensions.

3. A slum clearance programme and development of modern housing and town schemes, planning landscaping and garden home plans, and playground and park improvements.

4. Large scale development for the utilization of water power for the creation of electrical energy compatible with increased demands and modern development.

5. Reforestation.

6. Continuation and extension of the Prairie Farm Rehabilitation Scheme.

7. Highway development, to be progressively continued, that access may be provided to the national scenic beauties of Canada with the object of encouraging tourist traffic now recognized to be an important national asset.

8. Diversion and conservation of waters for a greater use of our lakes and rivers as a means of pure water supply.

9. Construction of sewage disposal plants for preventing the contamination of our lakes and rivers.

10. In the interests of health and sanitation, provision should be made to meet the requirements of numerous municipalities in Canada which lack the facilities of procuring a fresh water supply and proper disposal of sewage.

11. Extension to farmers of the advantages of science, by the installation of modern methods of sanitation and electrical energy.

12. Grade crossing elimination.

13. In co-operation with provincial and municipal authorities, undertake a survey of possible requirements of public buildings and schools and the establishment of a system of modernization.

14. To provide measures of protection for health, we suggest extensive development of a system of public baths and swimming pools and other recreation facilities.

SEPTEMBER JOURNALS REQUIRED

There has been an unusual demand for extra copies of the September, 1941, issue of *The Engineering Journal* and it would be appreciated if members who do not retain their copies would return them to Headquarters, at 2050 Mansfield Street, Montreal, Que.

Library Notes

Book notes, Additions to the Library of the Engineering Institute, Reviews of New Books and Publications

ADDITIONS TO THE LIBRARY

TECHNICAL BOOKS

Aerosphere:

Edited by Glenn D. Angle. Including modern aircraft, modern aircraft engines, aircraft statistics, buyer's guide. New York, Aircraft publications, 1941. 8¾ x 11¾ in.

Design of Modern Steel Structures:

By Linton E. Grinter. New York, MacMillan Company, 1941. 6 x 9¼ in. $5.00.

Elements of Engineering Thermodynamics:

By James A. Moyer, J. P. Calderwood and Andrey A. Potter. 6th ed., rewritten. New York, John Wiley & Sons, 1941. 9¼ x 6 in. $2.50.

Experiments upon the Flow of Water in Pipes and Pipe Fittings:

By John R. Freeman. New York, American Society of Mechanical Engineers, 1941. 11¾ x 9¼ in.

Handbook of Chemistry:

Compiled and edited by Norbert A. Lange; a reference volume for all requiring ready access to chemical and physical data used in laboratory work and manufacturing. Sandusky, Handbook Publishers, Inc., 1941. 5½ x 8 in.

Metal Processing:

By Orlan William Boston. New York, John Wiley & Sons, Inc., 1941. 6 x 9¼ in. $5.00.

REPORTS

American Society of Mechanical Engineers:

Sixty-year index to A.S.M.E. technical papers, 1880-1939. New York, 1941.

American Society for Testing Materials:

Symposium on Colour—its specification and use in evaluating the appearance of materials. Philadelphia, American Society for Testing Materials, 1941.

British Standards Institution—Specifications:

Silver solder (grades, A, B and C), revised June, 1941; brass tubes, tubes for screwed glands and screwed glands for condensers, revised February, 1941; Hard drawn phosphor bronze wire, 1941; Naval brass die castings, October, 1940; Brass cravity die-castings, November, 1940; Cast brass bars (suitable for forging) and forgings, March, 1941; Leaded bronze ingots; leaded bronze castings. Nos. 206, 378, 384, 920, 932, 944, 960, 961, 962, 963, 964, 965.

Canada—Dominion Bureau of Statistics:

Libraries in Canada, 1938-40. Ottawa, 1941.

Canadian Engineering Standards Association—Specifications:

Canadian Electrical Code, part 2—Construction and test of all-asbestos and asbestos varnished cambric insulated wires and cables. Ottawa, May, 1941.

Electrochemical Society—Preprints:

Rochelle copper plating; Deposition potentials of cobalt nickel, and copper from chloride and bromide solutions; Contamination and electrolytic and cleaning of cold rolled steel; Solvent effect on semiquinone redox equilibria, effect of forming temperature on lead storage battery anodes; iron deposition; acid zinc plating; insoluble anodes in the electrolysis of zinc sulfate containing chlorine in solution.

National Council of State Boards of Engineering Examiners:

Digest of state laws governing the practice of professional engineering and land surveying. Columbia, April, 1941.

Ontario, Department of Mines

Forty-ninth annual report, volume 49, pt. 1, 1940. Toronto, 1941.

Quebec, Professional Engineers of Quebec:

Official list of members of the Corporation of professional engineers of Quebec, June, 1941.

Quebec, Statistical Year Book:

Statistical year book. Quebec, 1940. Quebec, 1941.

United States Department of the Interior—Bureau of Mines—Bulletin:

Contributions to the data on theoretical metallurgy; Petroleum and natural-gas fields in Wyoming. Bulletins, 434, 418.

United States Department of Commerce—Building Materials and Structures:

Structural and heat-transfer properties of "U.S.S. Panelbilt". Prefabricated sheet-steel constructions for walls, partitions and roofs. BMS74.

PROCEEDINGS

Highway Research Board:

Proceedings twentieth annual meeting, 1940. Washington, 1941.

National Asphalt Conference:

Proceedings of the thirteenth National Asphalt Conference, Dallas, Texas, 1940.

Society for the Promotion of Engineering Education:

Proceedings of the sixth annual meeting of the Allegheny section. Pittsburgh, Carnegie Institute of Technology, 1940.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet the books are not in the Institute Library, but inquiries will be welcomed at headquarters, or may be sent direct to the publishers.

ACCOUNTING FOR ENGINEERS

By J. R. Bangs and C. R. Hanselman. International Textbook Co., Scranton, Pa., 1941. 532 pp., illus., diagrs., charts, tables, 9½ x 6 in., fabrikoid, $4.00.

The subject material of this textbook, which is amplified by many diagrams, tables and examples, is divided into five major sections: theory of debit and credit; procedure at end of fiscal period; accounting practice; accounting applications; and costs. The method of presentation permits the use of the book as a general text in basic accounting principles. Sample financial statements are appended.

(The) AUTOMOBILE INDUSTRY, the the Coming of Age of Capitalism's Favorite Child

By E. D. Kennedy. Reynal & Hitchcock, New York, 1941. 333 pp., tables 9 x 6 in., cloth, $3.50.

Once more the genesis, development and current trends of the automobile industry are presented as a shining example of American industrial progress. Full of facts and figures, the separate chapters picture in strict chronological order the achievements and vicissitudes which have attended the making and selling of automobiles through the last five decades.

BETTER FOREMANSHIP

By G. Gardiner. 2 ed. McGraw-Hill Book Co., New York, 1941. 336 pp., tables, 8 x 5 in., cloth, $2.50.

In a direct, practical question-and-answer treatment this book presents modern industrial management for foremen. The subjects covered were chosen to give the foreman help both with fundamental functions and practices of foremanship and with the new problems resulting from recent changes in working conditions, labor relations and industrial methods.

(The) DESIGN OF MANUFACTURING ENTERPRISES, a Study in Applied Industrial Economics

By W. Rautenstrauch. Pitman Publishing Corp., New York and Chicago, 1941. 298 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $3.50.

Profitable operation of large and small manufacturing businesses is dependent on their efficient economic design. This book makes available the principles and methods of the economics of manufacture taken from practical experience in the designing of new, or the redesigning of existing businesses for improved operating characteristics. The first part of the text deals with business as a whole; the second, with selected problems from both process and mechanical industries.

DESIGN OF MODERN STEEL STRUCTURES

By L. E. Grinter. Macmillan Co., New York, 1941. 452 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $5.00.

This book and Vol. I of the author's "Theory of Modern Steel Structures" are intended to furnish the requisite material for undergraduate courses in statically determinate structures. A somewhat novel arrangement presents first the chapters on riveted, welded and other connections. Then follow chapters on tension and compression members, beams and girders, and stress determinations. Design procedures for roofs, truss bridges, buildings and continuous beams end the book, with the exception of a section giving abbreviated specifications issued by various engineering associations.

DIRECTORY OF MICROFILM SOURCES including Photostat Service,

Compiled by R. C. Cibella. Special Libraries Association, New York, 1941. 56 pp., diagrs., 10 x 7 in., paper, $0.75.

The main section in this timely directory is an alphabetical list of more than two hundred libraries and commercial firms which offer microfilm, photograph and photostat services. Microfilm collections are also indicated, and a geographical index to the list is provided. The reproduction of sample order forms from many of these sources adds a practical touch.

ELECTRO-PLATING AND ANODISING

By J. Rosslyn. Chemical Publishing Co., Brooklyn, N.Y., 1941. 224 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, $2.50.

General principles and industrial processes for gold, silver, nickel, copper, chromium, cadmium and zinc plating are covered. Separate chapters deal with a number of specialized applications of electrodeposition such as in the printing industry, the hardware trade, etc. The final chapter is devoted to anodising and aluminum plating.

EMULSIONS AND FOAMS

By S. Berkman and G. Egloff. Reinhold Publishing Corp., New York, 1941. 591 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $8.50.

The importance of emulsions and foams in many industries, particularly the oil industry, has led to progressive development in their control. This monograph begins with a detailed treatment of the theory of emulsions and foams, continues with several chapters dealing with the practical knowledge and application of these states of matter, and concludes with a description of the laboratory methods used in the examination of emulsions. The bibliographies are extensive.

FRASER AND JONES' MOTOR VEHICLES AND THEIR ENGINES

By N. G. Shidle and T. A. Bissell with the assistance of T. Francis. 5 ed. D. Van Nostrand Co., New York, 1941. 339 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $2.50.

This book is designed to give a clear knowledge of the theory of operation and maintenance of modern automobiles to beginning students. Current design and practice are emphasized, and for practical purposes most chapters contain information on likely troubles, their reasons and common remedies. The descriptive material is confined to examples from the passenger-car field, but a considerable portion of this and the whole final chapter are applicable to motor trucks.

GAS-LIFT PRINCIPLES AND PRACTICES

By S. F. Shaw. Gulf Publishing Co., Houston, Texas, 1939. 156 pp., illus., diagrs., charts, tables, 9 x 5½ in., lea., $3.00.

The first half of this book is devoted to the history, principles and operation of gas-lift and its equipment, including a considerable amount of gas-lift performance data. The later chapters cover compressor plant installations and examples of actual gas-lift practice in various fields both domestic and foreign.

HANDLING AND STOWAGE OF CARGO

By A. G. Ford. International Textbook Co., Scranton, Pa., 1941. 213 pp., illus., diagrs., charts, tables, 8½ x 5 in., cloth, $2.25.

Efficient modern methods for packing and arranging commodities in a vessel for transportation by sea are described for the use of those engaged in directing, handling or arranging for such shipments. Review questions accompany each chapter, and practical arithmetical examples are included.

Imperial Institute, Plant and Animal Products Department

CHICLE, JELUTONG AND ALLIED MATERIALS (reprinted from the Bulletin of the Imperial Institute)

By E. H. G. Smith. Imperial Institute, London, 1940. 22 pp., tables, 9½ x 6 in., paper, 1s. (obtainable from British Library of Information, 620 Fifth Ave., New York, $0.30).

A reprint from the Bulletin of the Imperial Institute, this pamphlet deals with the botany collection and preparation, production and economics of chicle, jelutong and other similar substances used as a base for chewing gum. A list of references to other publications is included.

INTRODUCTION TO GEOLOGY

By E. B. Brenson and W. A. Tarr. 2 ed. McGraw-Hill Book Co., New York and London, 1941. 482 pp., illus., diagrs., charts, maps, tables, 9 x 6 in., cloth, $3.75.

Intended as a general text for students not majoring in geology as well as for those who are, this book avoids technicalities in presenting the outstanding principles of the subject. The fundamentals of both physical and historical geology are covered. Over four hundred photographs, maps and diagrams aid the beginning student in understanding the text.

(The) MANAGERIAL REVOLUTION, What Is Happening in the World

By J. Burnham. John Day Co., New York, 1941. 285 pp., 8½ x 5½ in., cloth, $2.50.

The author submits the thesis that the running of the world is coming under the control of "managers," "managers" being defined as those who direct activities and do not come within either the capitalist-owner or the labor group. Reasons are advanced to show why the capitalist regime is doomed, and why socialism will not be the displacing system.

MATHEMATICAL TABLES

By H. B. Dwight. McGraw-Hill Book Co., New York, 1941. 231 pp., tables, 9½ x 6 in., cloth, $2.50.

The values of both natural functions and logarithms of trigonometric functions are given to four or five places of decimals in hundredths of degrees rather than minutes and seconds. Exponential, hyperbolic and other commonly used functions are also included. Tabular differences are included wherever desirable.

METAL PROCESSING

By O. W. Boston. John Wiley & Sons, New York; Chapman & Hall, London, 1941. 630 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $5.00.

This volume constitutes a revision of the author's "Engineering Shop Practice" consolidated with more recent data. All steps involved in designing for production are covered briefly in the first chapter; manufacturing drawing, analysis and form of material used, operations and equipment desired, and plant layout. Subsequent chapters treat in detail the various classes of machines and processes and other factors dependent upon conditions of quantity and quality. A bibliography accompanies each chapter.

MODERN HIGHER PLANE GEOMETRY

By A. S. Winsor. Christopher Publishing House, Boston, Mass., 1941. 214 pp., diagrs., 8 x 5½ in., cloth, $2.25.

A résumé of some of the more familiar and important ideas in high school geometry is given in the first chapter. The author then presents, in the standard theorem, proof and exercise manner, certain advanced geometrical concepts concerning loci, harmonic ranges, polars, etc. Important features are a complete treatment of analysis and a discussion of the escribed circles of a triangle.

MODERN METALLURGY FOR ENGINEERS

By F. T. Sisco. Pitman Publishing Corp., New York and Chicago, 1941. 426 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $4.50.

This concise study of recent developments in ferrous and non-ferrous metallurgy provides essential data on the engineering properties of metallic materials, the variables affecting these properties, and their significance to engineers. The relation between constitution and structure of materials and properties is briefly shown in an elementary discussion of fundamental modern concepts of physical metallurgy. Review questions and a bibliography are appended.

OIL BOOM, the Story of Spindletop, Burkburnett, Mexia, Smackover, Desdemona, and Ranger

By B. House. Caxton Printers, Caldwell, Idaho, 1941. 194 pp., illus., 9½ x 6 in., cloth, $3.00.

The oil fields of Texas, Oklahoma and Arkansas in their early days presented a frenzied scene. The author has put into his book the personalities, boom town activity, fantastic profits and sad disillusionments which contributed to this brief phase of American history.

(The) PHOTOCHEMISTRY OF GASES (American Chemical Society Monograph No. 86)

By W. A. Noyes and P. A. Leighton. Reinhold Publishing Corp., New York, 1941. 475 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $10.00.

Photochemistry, the study of the effects produced on chemical systems by the action of electromagnetic radiations, is a progressing field. One portion, that of reactions in the gas phase, is considered in this monograph. The early chapters define the work, describe experimental techniques and present a survey of spectroscopy. Photochemical kinetics and the reactions following absorption by various atoms and molecules are discussed. A considerable amount of photochemical data in tabular form is given in appendices, and there is a large bibliography.

PLANE FACTS FOR AIRPLANE AND ENGINE MECHANICS

By B. A. Kutakoff. Military Book Co., New York, 1941. 241 pp., illus., diagrs., charts, tables, 8 x 5 in., cloth, $1.75.

This practical manual for airplane and engine mechanics presents the latest design and manufacturing practice in order to give an understanding of the structure of planes and engines. Maintenance and repair are also covered, and an extensive question and answer system facilitates review. The material conforms to Civil Aeronautics Administration regulations and practices.

PRINCIPLES OF MAGNAFLUX INSPECTION

By F. B. Doane. Magnaflux Corp., Chicago, 1940. 133 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $2.50.

This description of magnaflux inspection methods covers equipment, processes, the inspection medium, detectible defects, demagnetization and the evaluation of indications. There is a separate chapter on weld inspection. Basic physical principles are discussed briefly, and there is a bibliography.

REINFORCED CONCRETE CHIMNEYS

By C. P. Taylor and L. Turner. Concrete Publications, Ltd., London, 1940. 66 pp., illus., diagrs., charts, maps, tables, 9½ x 6 in., cardboard, $3.50 (obtainable from Engineers Book Shop, 168 East 46th St., New York).

This practical manual deals with the design of reinforced concrete chimneys in accordance with modern British practice. Standard types are described, design data are given for all important factors, and there is a chapter dealing with flue openings, linings, bands and other specific features. Special attention is paid to the scientific calculation of the stresses caused by hot gases.

RUNNING A MACHINE SHOP

By F. H. Colvin and F. A. Stanley. McGraw-Hill Book Co., New York and London, 1941. 449 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $3.50.

A practical manual which gives owners and managers of machine shops valuable pointers for more efficient and profitable operation. It covers everything from shop layout to inspection methods—equipment, routing and work handling, estimating, training of workers, etc. Methods and suggestions have been taken from the practice of leading shops of all types and sizes.

SAMPLING AND CHEMICAL ANALYSIS OF CAST FERROUS METALS (Special Publication No. 7, March, 1941)

By E. T. Austin. British Cast Iron Research Association, Birmingham, England. rev. and enl. ed. 140 pp., diagrs., tables, 10 x 6 in., linen, apply.

This manual has been prepared for the use of chemists and metallurgists in works and other laboratories. Sampling procedure and general laboratory technique are described, and detailed directions are given for the analysis of pig iron, plain, malleable and alloy cast irons, and ferro-alloys. Brief references to theory are included.

SCIENCE EXPERIENCES WITH TEN-CENT STORE EQUIPMENT

By C. J. Lynde. International Textbook Co., Scranton, Pa., 1941. 256 pp., illus., diagrs., charts, tables, 8 x 5 in., cloth, $1.60.

As indicated by the title, this small book contains a selection of simple experiments based on scientific principles. This third volume of a series designed primarily for high school classes deals with sound, light, electricity and magnetism. Explanations of the effects are given at the back of the book.

SURFACE TENSION AND THE SPREADING OF LIQUIDS (Cambridge Physical Tracts)

By R. S. Burdon. University Press, Cambridge, England; Macmillan Co., New York, 1940. 85 pp., illus., diagrs., charts, tables, 9½ x 5½ in., paper, $1.75.

This latest addition to a series of authoritative accounts of topical physical subjects discusses the general conditions affecting the spreading of liquids, and gives some account of various investigations based on the phenomena of spreading. In the last chapter dealing with liquids on the surface of solids, certain technical aspects are considered.

TEXTBOOK OF SOUND

By A. B. Wood. Macmillan Co., New York, 1941. 2 rev. ed. 578 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, $6.50.

Subtitled "an account of the physics of vibrations with special reference to recent theoretical and technical developments," this text treats of vibrations of all frequencies, audible or otherwise. Vibrating systems and sources of sound are thoroughly covered, following a section on vibration theory. Sound transmission and the reception, transformation and measurement of sound energy are discussed. The final section deals with various important technical applications.

(The) THEORY OF RATE PROCESSES

By S. Glasstone, K. J. Laidler and H. Eyring. McGraw-Hill Book Co., New York and London, 1941. 611 pp., diagrs., charts, tables, 9 x 6 in., cloth, $6.00.

This book describes the development and application of a general theory of the kinetics of physical and chemical processes, usually known as the "theory of absolute reaction rates." The fundamental bases are explained, and homogeneous and heterogeneous gas reactions, reactions in solution, fiscosity, diffusion, and electrochemical phenomena are considered in terms of the theory.

TRAINING WORKERS AND SUPERVISORS

By C. Reitell. Ronald Press Co., New York, 1941. 182 pp., tables, charts, 8½ x 5½ in., cloth, $1.50.

This volume of training procedures is designed for executives of plant organizations which are undergoing rapid expansion. The first part deals with the principles and methods for selecting men employees. The succeeding sections cover specific training methods for quality and quantity production and the problems of human relations. There is a list of selected references.

AMOS EATON, Scientist and Educator, 1776-1842

By E. M. McAllister. University of Pennsylvania Press, Phila., 1941. 587 pp., illus., 9½ x 6 in., cloth, $5.00.

Amos Eaton, the founder, with the backing of Stephen Van Rensselaer, of what is now Rensselaer Polytechnic Institute, lived an eventful life. This exceedingly well-documented biography describes his early life, his ill-starred business and legal career, his noteworthy ventures into the natural sciences, particularly geology, and his final success as an educator.

AUDELS MACHINISTS AND TOOL MAKERS HANDY BOOK

By F. D. Graham. Theodore Audel & Co., New York, 1941. Section A, 1,126 pp., Section B, 98 pp., Section C, 300 pp., Section D, 42 pp., Section E, 10 pp., illus., diagrs., charts, tables, 7 x 5 in., cloth, $4.00.

The purpose of this book is to provide a complete course of study for those desiring to become machinsts, and to help machinists become tool makers. In considering each machine, the author first explains how it works, then describes its construction, and finally gives detailed instructions for all machining operations. Blueprint reading, shop mathematics and other useful topics are included. The book is profusely illustrated.

AUDELS NEW ELECTRIC SCIENCE DICTIONARY

By F. D. Graham. Theodore Audel & Co., New York, 1933, reprinted 1939. 525 pp., 7 x 5 in., cloth, $2.00.

Over nine thousand words, terms and phrases used in theoretical and applied electricity are defined in this dictionary. Numerous terms in related and independent subjects have been included to increase the utility of the work, and extended explanations are given for the more important entries.

CHEMISTRY OF PULP AND PAPER MAKING

By E. Sutermeister. 3 ed. John Wiley & Sons, New York, 1941. 529 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $6.50.

The important materials and processes in pulp and paper making are discussed with the object of giving all details which the chemist should have to understand the methods of manufacture. The mechanical features are subordinated to the chemical, and common methods of analysis, available elsewhere, are minimized in favor of more specialized material. Separate chapters are devoted to paper testing and printing. There are chapter bibliographies.

CIVIL PROTECTION, the Application of the Civil Defence Act and Other Government Requirements for Air Raid Shelters, etc.

By F. J. Samuely and C. W. Hamann. The Architectural Press, 45 The Avenue, Cheam, Surrey, England, 1939. 168 pp., diagrs., charts, tables, 13 x 9 in., cloth, 8s. 6d.

This practical manual presents an analysis and explanation of the British Government standards for the protection of civilians as required by the Civil Defence Act, and as set out in the publications of the several Ministers. All phases of the design and construction of air-raid precaution works, including the action and effects of bombs, are discussed, with numerous suggestions and recommendations. Architectural details are shown for all construction work.

DEVELOPMENT OF THE SCIENCES, 2nd series

By O. Ore, F. Schlesinger and others, edited by L. L. Woodruff. Yale University Press, New Haven, 1941. 336 pp., woodcuts, diagrs., 9½ x 6 in., cloth, $3.00.

This second series of published lectures (the first series appeared in 1923) comprises discussions by eight Yale scientists representing the fields of mathematics, astronomy, chemistry, physics, geology, biology, psychology and medicine. Each of the first seven lectures traces the development of basic sciences from their beginnings to the most recent results. The last lecture shows the interdependence of these various sciences as illustrated by specific examples in the history of medicine. The chapter bibliographies are brought together at the end of the book.

FIRE-HAZARD PROPERTIES OF CERTAIN FLAMMABLE LIQUIDS GASES AND VOLATILE SOLIDS

Compiled by Committee on Flammable Liquids of the National Fire Protection Association. Revised ed., 1941. National Fire Protection Association, 60 Batterymarch St., Boston. 48 pp., tables, 9 x 6 in., paper, 25c.

Over four hundred flammable liquids, gases and volatile solids are included in the table of data compiled in this pamphlet. In addition to the information upon fire-hazard properties there is also a column indicating the proper extinguishing agent for each material.

MINING ENGINEERS' HANDBOOK, 2 Vols.

By R. Peele, with the collaboration of J. A. Church. 3 ed. John Wiley & Sons, New York, 1941. Paged in sections, diagrs., charts, tables, 9 x 5½ in., lea., $15.00.

The long-awaited new edition of Peele's Mining Engineers' Handbook appears in two volumes, owing to the great expansion of the work. The extensive revision throughout the text includes new sections on petroleum production and geophysical prospecting, and much information concerning new methods and devices in mining practice. The comprehensive character of the book is retained and is evidenced by the large amount of useful data on machinery, power plant, electric transmission, structural design and metallurgy, for which the mining engineer often has need. A bibliography accompanies each section, and both volumes contain the complete index.

PRELIMINARY NOTICE

of Applications for Admission and for Transfer

September 29th, 1941.

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 at the November meeting.

L. Austin Wright, General Secretary.

*The professional requirements are as follows:—

A 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 or 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 attainment 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

FARSTAD—CHARLES, of Grand'Mere, Que. Born at Meskanaw, Sask., Oct. 24th, 1914; Educ.: B.Eng. (Mech.), Univ. of Sask. 1941; 1938 (summer) chainman, rodman and instr'man. on survey for Cons. Mining & Smelting Co. at Kimberley, B.C.; 1940 (summer), constrn. and mtce. of large saw mill at Wynndel, B.C.; May 1941 to date, asst. engr., mech. dept., Laurentide Divn., Consolidated Paper Corpn. Ltd., Grand'Mere, Quebec.

References: I. M. Fraser, C. J. Mackenzie, W. E. Lovell, H. G. Timmis, E. E. Wheatley, V. Jepsen.

FRASER—JOHN HUGH, of Sydney, N.S. Born at Hopewell, N.S.; Sept. 6th, 1881; Educ.: Mech. Engrg., I.C.S.; 1896-1900, machinist apprentice; 1900-02, machinist; with the Dominion Steel & Coal Corporation, Steel Divn., as follows: 1902-04, foreman, coke ovens and coal washer; 1905-15, master mechanic, mills; 1915-20, asst. supt.; 1920-30, mech. supt., and 1930 to date, general supt.

References: W. S. Wilson, I. P. Macnab, I. W. Buckley, S. C. Mifflen, A. P. Theuerkauf.

HARGREAVES—WELSFORD THOMAS, of Hillsboro, N.B. Born at Hillsboro, March 10th, 1909; Educ.: 1927-28, Univ. of N.B., first year elect'l. (not completed); with N.B. Dept. of Highways as follows: 1928-31, rodman, chainman, 1931-32, rodman, chainman and instr'man., 1936-37, rodman and instr'man., 1937-39, instr'man., 1939-40, senior instr'man; 1940-41, asst. engr. and instr'man. on aerodrome constrn.; 1940-41, senior instr'man. on surveys for airport site; at present, asst. engr. and senior instr'man. on constrn. of aerodrome.

References: W. J. Lawson, W. B. Akerley, W. D. G. Stratton.

KEY-JONES—GILBERT, of Calgary, Alta. Born at Bray, Co. Dublin, Ireland, May 25th, 1887; Educ.: 1903-06, Leeds Polytechnic and University. 1907-08, Durham Univ.; private tuition; 1908-12, asst. dftsman., patent engrg. office; 1912-22, elec. and mech. contracting, Kamloops, B.C., incl. design and installn. of irrigation projects, small power projects, trans. lines, city distribution services, etc.; 1922-23, machine shop foreman; 1923-25, contracting in Medicine Hat, Alta.; 1925-28, with International Coal & Coke Co., Coleman, Alta., in complete charge of rebldg. of power house and substation to own design; 1928, East Kootenay Power Co. Ltd., in charge of installn. of arresters and control room equipment at Sentinal; 1928, Western Canadian Collieries, Blairmore, electrifying Bellevue mine; 1928-31, W. R. Halpenny Ltd. (Later Riverside Ironworks), Calgary, in charge of all engrg. work; 1931-33, Calgary Iron & Foundry Ltd.; 1933-36, The Key Agencies; 1936-37, asst. estimator and engr., Precision Machine & Foundry Ltd.; 1937 to date, manager and owner, The Key Agencies, engrg. services and supplies, electrical, mechanical, steam and refrigeration. District Engineer for the Dearborn Chemical Co. Ltd., and the Nilter Mfg. Co., Consltg. Engr. to the United Fur Growers of Canada Ltd.

References: G. H. Thompson, J. S. Neil, H. B. LeBourveau, J. McMillan, J. T. Watson, A. Higgins, J. Haddin.

MANN—NEVILLE WHITNEY DAVIS, of Howland, Me. Born at Strathadam, N.B., March 17th, 1913; Educ.: B.Sc. (C.E.), Univ. of N.B., 1937; 1937-40, instr'man. and junior engr., Dept. of Highways of N.B.; 1940-41, civil dftsman., and at present junior engr., R.C.A.F. works and bldg. divn., Dept. of National Defence, Gander, Nfld.

References: C. L. Kenney, K. R. Chestnut.

McMULLIN, MATTHEW, of 129 Dorchester St., Sydney, N.S. Born at Sydney, Dec. 16th, 1918; Educ.: Passed N.S. Govt. Exam. for Prov. Land Surveyors License, 1939; 1936-39, rodman, chainman and instr'man., Dept. of Highways of N.S.; 1939-40, employed by Dept. of National Defence at Sydney Harbour; April 1940 to Jan. 1941, inspr. on constrn., H.M.S. Dockyard, Sydney, for architects dept., Dept. of Public Works; 1941 (Jan.-June), field engr., Dominion Steel & Coal Company, Sydney, N.S.; June 1941 to date, junior engr., Dept. of National Defence, Gander, Nfld.

References: J. A. MacLeod, W. S. Wilson, F. A. Crawley, K. R. Chetsnut, M. F. Cossitt, S. C. Mifflen, A. B. Blanchard.

McNEIL—JOHN NEWSON, of 172 N. High St., Port Arthur, Ont. Born at Lindsay, Ont., Dec. 12th, 1903; Educ.: B.Sc. (Civil), Univ. of Man., 1927; 1925-26 (summers), instr'man., Chicago, Mil. & No. Shore Rly., and Windes & Marsh, munic. engrs.; 1933-38, constrn. engr., Canada Packers Ltd., Winnipeg and Edmonton; 1938-39, constrn. engr., new Swift plant at Winnipeg, for Bird Constrn. Co.; 1939-40, mech. engr., Swift Canadian Co. Ltd., Winnipeg; 1927-31 and 1940 to date, with C. D. Howe Co. Ltd., Port Arthur, Ont., as field engr. and engr. in charge of various projects incl. Toronto terminal, Canada Steamships Terminal at Kingston, and govt. elevator at Churchill, Man. At present, engr. in charge of field constrn. work on Distress Grain Storage, Port Arthur.

References: J. M. Fleming, B. A. Culpeper, A. L. Pierce, C. V. Antenbring.

WHITELEY—FREDERICK BRYAN, of Belleville, Ont. Born at Georgetown, British Guiana, Feb. 10th, 1902; Educ.: I.C.S., Civil Engr., R.P.E. of Ontario; 1921-24, chainman, rodman, T. & N. O. Rly.; 1924-25, dftsman. and surveyor, Lorrain Con. Mines. South Lorrain, Ont.; 1925-29, chief of party and res. engr., Wayagamack Pulp & Paper Co., Three Rivers, Que., i-c boundary line and topog'l. surveys, road and dam location, supervn. of road, dam and bridge constrn.; 1929-40, instr'man. i-c of surveys, constrn. of roads and bridges, Dept. of Highways of Ontario; 1940 to date, res. engr., i/c airport constrn. and surveys, Dept. of Transport.

References: A. A. Wickenden, F. C. Jewett, W. H. Riehl, F. B. Goedike, A. A. Smith.

WOOD—WELLS ARTHUR, of 139 Brock Ave. South, Montreal West, Que. Born at Victoria, B.C., Sept. 18th, 1910; Educ.: B.A.Sc., Univ. of B.C., 1932; R.P.E. of B.C.; 1934-36, civilian dftsman., Dept. of National Defence, Esquimalt, B.C.; 1937-38, dftsman., and 1938-40, junior engr. and designer, Pumps and Power Ltd., Vancouver, B.C.; 1940-41, mech. dftsman., Defence Industries Ltd., May 1941 to date, engr. in charge of design and of the engrg. dept., Harrington Tool & Die Co. Ltd., Lachine, Que.

References: J. G. D'Aoust, J. C. Oliver, H. P. Archibald, M. C. Nesbitt, A. Peebles, R. Black.

FOR TRANSFER FROM STUDENT

FURANNA—ANTHONY LOUIS, of 732 Wellington St., London, Ont. Born at London, May 17th, 1915; Educ.: B.Sc., Queen's Univ., 1939; 1935-39 (summers), electrician, London Public Utilities Commn.; 1939-40, demonstrator, elec. engrg., Queen's Univ.; April 1941 to date, engrg. dept., London Public Utilities Commission, London, Ont. (St. 1939).

References: E. V. Buchanan, V. A. McKillop, R. W. Garrett, F. C. Ball, D. M. Jemmett.

LAIRD—ALAN DOUGLAS KENNETH, of Winnipeg, Man. Born at Victoria, B.C., Aug. 8th, 1914; Educ.: B.A.Sc. (Mech.), Univ. of B.C., 1940; 1940-41, with Defence Industries Ltd. and Fraser Brace Engrg. Co. Ltd.; at present, material clerk for the latter company at Winnipeg. (St. 1940).

References: J. N. Finlayson, H. J. MacLeod, G. R. Stephen, C. H. Jackson, C. R. Bown, A. Peebles.

LECAVALIER—JEAN PAUL, of 61 St. John Street, Quebec, Que. Born at Montreal, April 12th, 1914; Educ.: B.A.Sc., C.E., Ecole Polytechnique, Montreal, 1937; 1932-37 (summers), geol. surveying, Quebec Bureau of Mines; 1938, demonstrator, Ecole Polytechnique. With Quebec Roads Dept. as follows: 1937, chief of party for locating and constructing; 1938-39, res. engr., 1939 to date, asst. district engr., Eastern Townships District. (St. 1936).

References: E. Gohier, A. Circe, A. Frigon, A. Gratton, A. Morissette.

Employment Service Bureau

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party. Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted upon request after a lapse of one month. All correspondence should be addressed to THE EMPLOYMENT SERVICE BUREAU, THE ENGINEERING INSTITUTE OF CANADA, 2050 Mansfield Street, Montreal.

SITUATIONS VACANT

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JUNIOR CHEMICAL OR METALLURGICAL ENGINEER for work in plant installation and operation. Required immediately. Apply Box No. 2400-V.

STRUCTURAL AND CONCRETE DRAUGHTSMEN for industrial plant design. Apply Box No. 2401-V.

TIME AND MOTION STUDY: Opportunity for man who can prove his ability in setting of wage incentive standards, methods analysis, and plant layout. Give experience in detail. Address reply to Box No. 2439-V.

JUNIOR RESEARCH METALLURGIST required immediately, with one to five years experience. Apply Box No. 2440-V.

MECHANICAL GRADUATE ENGINEER, with machine shop experience, required for work in South America on important war contract. Apply Box No. 2441-V.

SALES ENGINEER with excellent technical or industrial qualifications, for work largely in the electrical industry. This is a splendid opportunity for a good man. Employment will be permanent. State training, experience and other qualifications. Apply Box No. 2451-V.

YOUNG ENGINEER wanted for newly opened Canadian office in Montreal, by a British company of furnace engineers, with headquarters in England and a branch in the U.S.A. Position with good prospects. Essential that applicants be good draughtsmen and desirable that they have shop experience. They must be willing to travel in Canada and the U.S.A. Apply Box No. 2452-V.

SITUATIONS WANTED

ELECTRICAL ENGINEER, B.Sc. in electrical engineering, age 43, married, available on two weeks notice. Fifteen years experience in electrical work. Including electrical installations of all kinds in hydro-electric plants and sub-stations. Maintenance and operation of hydro-electric plants. Electrical maintenance and installations in pulp and paper mill. Considerable experience on relays and meters. At present employed, but desires change. Apply Box No. 636-W.

GRADUATE CIVIL ENGINEER, M.E.I.C., 15 years engineering on this continent and five years overseas. Experienced in design and construction of dams, hydro-electric and industrial plants. Field engineer for construction on dams and transmission lines, considerable experience in concrete work. Desires position preferably as field engineer or construction superintendent. Apply Box No. 1527-W.

ELECTRICAL ENGINEER, Age 32 with the following experience—Eight years field work in general construction, supervision, estimating and ordering materials. At present employed in general construction but wants to enter the electrical field. Apply Box No. 1992-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, married. Two years city engineer, five years experience in highway work, including surveying, location, construction, estimating and inspection. Apply Box No. 2409-W.

ELECTRICAL ENGINEER, B.E., in electrical engineering, McGill University, Age 24, married, available on two weeks notice. Undergraduate experience, cable testing and cathode ray oscillography. Since graduation, five months on construction of large and small electrical equipment in plant and sub-station. One year operating electrical engineer in medium size central steam station paralleled with large Hydro system. At present employed, but is interested in research or teaching. Associate member of the American Institute of Electrical Engineers. Apply to Box No. 2419-W.

FOR SALE

Transit, Buff and Buff Mfg. Five-inch circle, brass telescope and sliding leg tripod. One nick in the vertical half-circle, but no other damage. Thirty-year old instrument, but not much used. Would sell for $225.00. Apply Box No. 45-S.

RESEARCH IN WOOD AIDING WAR EFFORT

Research on wood products is playing an important part in Canada's war effort, reports the Forest Products Laboratories of the Department of Mines and Resources. Ordinarily the manufacture and use of wood are associated with peacetime activities rather than with destructive warfare, but research work carried out in the past two years reveal that wood is a vital material for a wide range of war purposes.

Many and varied are the uses to which wood is being put during the present conflict, and technical problems in connection with its utilization have involved extensive laboratory investigation. The facilities of the laboratories have been utilized in planning the construction of wooden aerodromes and military camps; in the fire-retardant treatment of wood and plywood for military and naval requirements, and in the preservative treatment of timbers. Research has made possible amendments to United Kingdom specifications for wood used in war equipment built in Canada so as to permit using Canadian species as far as practicable instead of imported timber.

Problems relating to the design and testing of shipping containers of wood, fibreboard, corrugated board, and plywood for the consignment of munitions, foodstuffs and equipment, and the use of Canadian species of wood and plywood in the construction of aircraft, pontoons, life-rafts, and boats have been dealt with. Investigations have been made of types of glue required for different purposes, such as waterproof resin glues used in plywood for house siding, concrete forms, collapsible boats, ships' sheathing, aeroplane covering, and other exposed uses. The seasoning of timber for specific purposes calling for accurate control of moisture, as in the case of wooden airscrews, and the use of resinbonded, compressed plywood to replace metal for certain structural parts of war equipment have also received attention.

Wood is also used in the manufacture of pulp for cartridge wrappers and of gun cotton, smokeless powders, photographic film, collodion and celluloid plastics. Wood flour is used in the manufacture of dynamite for construction and demolition work. Producer-gas from wood or charcoal may be used as a fuel for internal combustion engines to curtail importation of gasoline and diesel oil. Charcoal from Canadian hardwoods is being used extensively in the manufacture of certain alloys used principally in the construction of aircraft.

Wood is being put to numerous other uses to serve the war effort, and many of the lessons learned from the present emergency indicate important fields for further exploration under more favourable circumstances.

SHEET GLASS NOW MADE IN CANADA

When the German hammer smashed at the Lowlands, the glass industry—like many others—became a refugee. The glassmakers sailed to Canada, bringing with them their ancient heritage, and European skill was wedded to the Dominion's resources to create a new industry in this country. Early this summer the only glass factory in the Dominion at present producing window and heavy drawn glass in sheet form was opened by the Industrial Glass Works Company Limited in the Town of St. Laurent on the outskirts of Montreal.

The actual process of manufacturing glass is as strange and wonderful as any tale of mediaeval alchemists searching for gold in bubling cauldrons. A group of raw materials, such as silica sand, salt cake, soda ash, limestone and cullet (broken or waste glass), is transformed from a molten mass into a thin, transparent sheet which withstands the corrosive effects of the elements and at the same time permits the passage of light. Patient research and chemical analysis in the control of processes and raw materials have made possible the mass production of modern window glass, virtually free from flaws and distortion, according to an article by Vic Baker in the September issue of C-I-L *Oval*.

In view of the fact that before the war Canada imported more than seventy per cent. of its window glass from Belgium, the transfer of this industry is a distinct gain for Canadian industry as a whole. Two hundred Canadian workers—all trained in the past few months by skilled Belgian craftsmen—will contribute much in their production output to the wartime domestic needs of Canadian homes, factories and the construction trade in general.

Industrial News

Industrial development — new products — changes in personnel — special events — trade literature

SURGE ABSORBERS

Presenting a comprehensive description of Ferranti Surge Absorbers and "Ferr-Anti-Surge" Transformers, bulletin No. 704, issued by Ferranti Electric Limited, Mount Dennis, Toronto, 9, Ont., contains 13 pages devoted to the presentation of details and oscillograms of a series of tests made with the "Ferranti Surge Generator." The application of this equipment is described and a great deal of other valuable information is included together with numerous installation and other illustrations.

VENTILATING EQUIPMENT

Catalogue, Form No. A 30029C, 40 pp., entitled "New Modern Ventilation and Comfort Cooling," was recently issued by Canadian General Electric Co., Ltd., Toronto, Ont. Divided into two parts: 1, Catalogue Section, and 2, Application Guide Section; this book features commercial, industrial and residential equipment manufactured by Canadian Sirocco Co. Ltd., and distributed by the above company. A wide variety of equipment is illustrated and described, accompanied by dimensional drawings and tables of capacities.

PLANT ENLARGEMENT

Seiberling Rubber Co. of Canada Ltd., is building a large modern addition to its plant in Toronto. The addition will incorporate many innovations in factory design and will be used to manufacture tires, tubes, and various other rubber items for consumer and defense demands.

NEW CHEMICAL PROJECT

A new division of Dominion Rubber Company, to be known as Naugatuck Chemicals Ltd., is announced by Paul C. Jones, President of the Company. The project will occupy enlarged and renovated buildings at the former site of the Elmira rubber factory in Elmira, Ont., a few miles north of Kitchener. Operating in liaison with the parent organization, the Naugatuck Chemicals Division of United States Rubber Co., the new company will produce aniline oil, required in the war effort, and accelerators and other chemicals important to the industry, which, Mr. Jones points out, will make Canada virtually independent of the importation of vital and strategic chemicals for the rubber industry.

SYRENS AND SOUND INSTRUMENTS

Burlec Limited, Toronto 13, Ont., has been appointed by Carters of Nelson, Lancashire, England, to manufacture their complete line of Syrens and Sound Instruments, including both horizontal and vertical types in a wide range from 2 to 10 h.p., and in 25- and 60-cycle units. This line of syrens, which has been approved by the Minister of Home Security in England, will soon be in production in Canada.

B.C. REPRESENTATIVE APPOINTED

Horton Steel Works Limited, Fort Erie, Ont., has announced the appointment of Gordon N. Russell, Pacific Bldg., Vancouver, B.C., as representative in British Columbia. The Company manufactures tanks and steel plate work and has sales offices in Toronto and Montreal and has been represented in the Middle West for many years by Mumford-Medland Limited at Winnipeg, Man.

PLANT EXTENSION AND NEW BRANCH OFFICE

An extension to the factory of Chatham Malleable & Steel Products Limited, in Chatham, Ont., which will cover a considerable area, will provide facilities to meet increasing production demands for the Company's products among which are the "Chatco Heat-Speed Unit Heaters" and "Chatco Heat-Speed Convectors" for apartments, offices, and homes, and a wide range of steel stampings. The Company has also opened a branch office at 901 Royal Bank Bldg., Winnipeg, Man.

BLOWERS

Ilg Electric Ventilating Co., Chicago, Ill., has issued a 64-page "Catalogue and Engineering Data Book," which features Ilg's four lines of direct-connected and belted blowers, plus the two lines of volume blowers—the construction of the Ilg-built motor—advantages of the Ilg-patented "variable air controller and floated drive"—and the complete group of marine blowers. Uses of each type, characteristic curves, dimensions and performance data are included. This is supplemented by fan performance laws, an altitide table, air friction and duct graphs, sample specifications and a chart of universal discharge arrangements.

CONTROLLER FOR TEMPERATURES AND PRESSURES

A folder No. 77-3-25, entitled "Busy Hands do not Always Indicate Efficiency," has been issued by Minneapolis-Honeywell Regulator Co. Ltd. Toronto, Ont. It describes the "Brown Non-Indicating Controller for Temperatures and Pressures," with photos and descriptive sectional drawing illustrating the principal features. Details of installation and a list of typical applications are given.

DEAERATORS

A new deaeration catalogue, Publication No. 3005, 36 pages, recently issued by the Cochrane Corp., Philadelphia, Pa., presents a comprehensive treatment of tray-type daearators, atomizing deaerators, deaerating hot water generators, and cold water deaerators in one publication. A section devoted to flow diagrams, photographs of the actual units described, and an appendix on corrosion control and pH control are included. Also included are line diagrams of operating features and cross-sectional photographs which sections are devoted to special designs, metering deaerators, recording systems and accessory equipment.

DUST COLLECTORS

Pangborn Corporation, Hagerstown, Md., has issued a 6-page bulletin No. 907. Under the title "Unit Type Dust Collectors," the company's new line of this type of collector is thoroughly described and illustrated. Details of construction and recommended applications are given. Designated as Type "CD-1," there are 4 sizes of these units.

HOISTING EQUIPMENT

The Yale & Towne Mfg. Co., Canadian Div., St. Catharines, Ont., has issued a 44-page catalogue No. 25-C. This comprehensive illustrated catalogue of Yale hoisting equipment—differential screw gear and spur-gear chain hoists, and electric hoists—contains detailed descriptions, illustrations and specifications. Dimensional drawings and tables of dimensions, information and prices are also included.

INSULATING MATERIALS SPECIFICATIONS

"Specifications for Donnacona Insulation in All Types of Construction," is the title of a 68-page book recently issued by Alexander Murray & Co. Ltd. Montreal, Que., which contains specifications, detail drawings and photographs covering the many applications of Donnacona insulating materials. These are segregated into four main classifications—panel board, plaster base, roof insulation, and decorative specialties. The specialties include sound absorbing tile, "Hardboard" and "Modernite" products. A final section is devoted to painting specifications.

ENLARGEMENT OF LEASIDE PLANT

Canadian Aircraft Instruments and Accessories Ltd., Leaside (Toronto), are erecting additions to their present plant. This company is manufacturing lines in association with Self-Priming Pump and Engineering Co. Ltd., Slough, England, and Korect Depth Gauge Co. Ltd., Croydon, England.

HEAD OFFICE MOVED TO TORONTO

Dairy Corporation of Canada Limited has moved the head office of the company from Winnipeg to Toronto where the address is now 80 King St. West.

MAGNETIC CHUCK WITH POWER PACK

A 2-page leaflet issued by Osborne Electric Co. Ltd., Toronto, Ont., describes, with illustrations, the Osborne "Magnetic Chuck," and "Hole Magnetic Chuck," designed to speed up production in the machine shop or tool room. Each is supplied with a "Power Pack" to convert A.C. to D.C., so that it can be plugged into any 110-v., A.C., lighting circuit. The "Hole Chuck" is especially designed for grinding punches and dies.

MAGNETIC PULLEYS AND SEPARATOR UNITS

The 16-page catalogue of The Stearns Magnetic Mfg. Co., Milwaukee, Wis., provides a comprehensive reference on the subject of magnetic pulleys and magnetic pulley separator units, with descriptive matter, illustrations, specifications, applications and other data.

NEW CARBOLOY PLANT IN TORONTO

Moving into a new four-storey factory on Lansdowne Ave., Toronto, The Carboloy Div. of Canadian General Electric Co., Limited, has now completed its expansion programme designed to appreciably increase production capacity. This plant is devoted entirely to the manufacture of Carboloy which was previously manufactured at the company's Ward Street Works. Carboloy is being used for machining shells, gun parts and other munitions at greatly increased machining speeds. An interesting feature of the new plant is the installation of fluorescent lighting throughout.

UNIT HEATERS

The advantages of unit heaters over radiators and steam coils for heating the "vital zone" where people work, shop or play, are presented in a colourful manner by the Ilg Electric Ventilating Co., Chicago, Ill., in their 36-page catalogue No. 141. The construction of these heaters is fully illustrated and described, followed by illustrations and data on Ilg's four lines of unit heater models. Engineering data, illustrations showing the proper location of units in various types of buildings, piping diagrams, etc., are also included, together with a "check-chart" comparing the Ilg product with other unit heaters on the basis of eleven essential features.

VIBRO-INSULATORS

A 12-page booklet, Catalogue Section 7900, issued by The B. F. Goodrich Rubber Co., Akron, Ohio, features the company's Vibro-Insulators, devices of metal and rubber for the isolating of vibration in machinery. Illustrated with installation pictures and engineer's drawings, it gives all pertinent information about each type. The selection of mountings and their application to various equipment; methods of mounting, and other fundamental data, are included.

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PROPERTIES OF HEAT INSULATING MATERIALS

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SUMMARY—A discussion of the character of heat insulating materials, the difficulties in determining their relative value experimentally, the effect of air spaces and surface resistance and the possibility of saving fuel by taking advantage of solar radiation and heat stored in the structure of the building itself. Mr. Hamly contributes an appendix describing his microscopic examination of a number of insulating materials.

Although insulating materials have been commonly used for many years on hot and cold surfaces such as those of steam piping and refrigerators, only recently has considerable attention been paid to the advantages of insulation in building construction. This change has been due, largely, to the ever rising cost of fuel, which has made the saving to the average consumer commensurate with the extra capital cost of the installation. As the more easily accessible sources of fuel supply become exhausted, the cost of working the remainder will continue to rise, and it is therefore probable that the tendency toward the use of heat insulation will increase correspondingly. The cost of insulating materials, their useful life, or rate of depreciation, and the expense of placing and maintaining economic quantities of them in the most advantageous positions, must inevitably become more important as time goes on, and therefore it is pertinent at this stage to give some consideration to the physical and thermal properties of those materials that are now used or are likely to become available for this purpose. This, of course, is a large subject and much of it has been, or is being dealt with elsewhere; the present paper is but a brief outline of some of its aspects, indicating more particularly some of the work done at the University of Toronto. Attempts have been made to ascertain the effects produced by variables, either in the materials themselves or in the conditions under which they operate, for the purpose of indicating what characteristics are desirable and how they may best be combined to form effective heat barriers.

Physical Structure

In most insulating materials the primary object is to make the most efficient use of still air. The latter is the real insulator because its conductivity is relatively low, ($k = 0.17$)

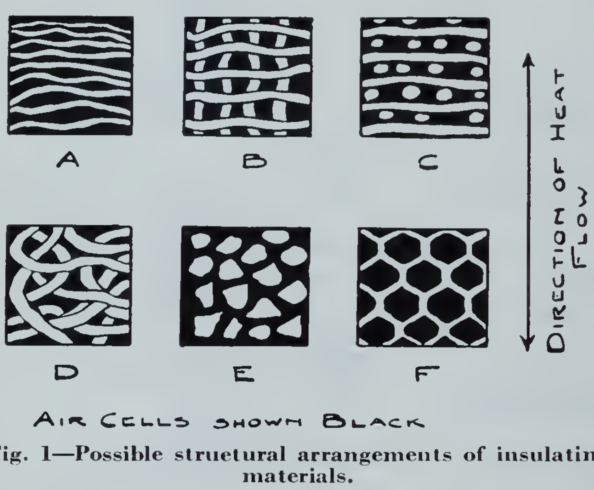

Fig. 1—Possible structural arrangements of insulating materials.

as compared with that of the associated substances which are employed to prevent air motion and to reduce radiation losses. The spaces between the fibres or granules are air cells which may or may not be inter-connected, and therefore the arrangement of the solid material relative to the air is important. In metallurgical work, the micro and macro-structure of metals indicate definite physical properties, and it is reasonable to suppose that a study of the structure of heat insulating materials along similar lines may produce comparable results. As a first approach, certain typical arrangements of material might be classified roughly as follows:—

(A) Fibrous materials with the fibres arranged at right angles to the direction of heat flow. Variables, diameter and length of fibres, density and uniformity of structure. (Fig. 1A).

(B) Fibrous materials in which some of the fibres lie parallel to the direction of heat flow, so that a considerable proportion of the heat is conducted along the fibres. Variables as in (A) and orientation of fibres. (Fig. 1B).

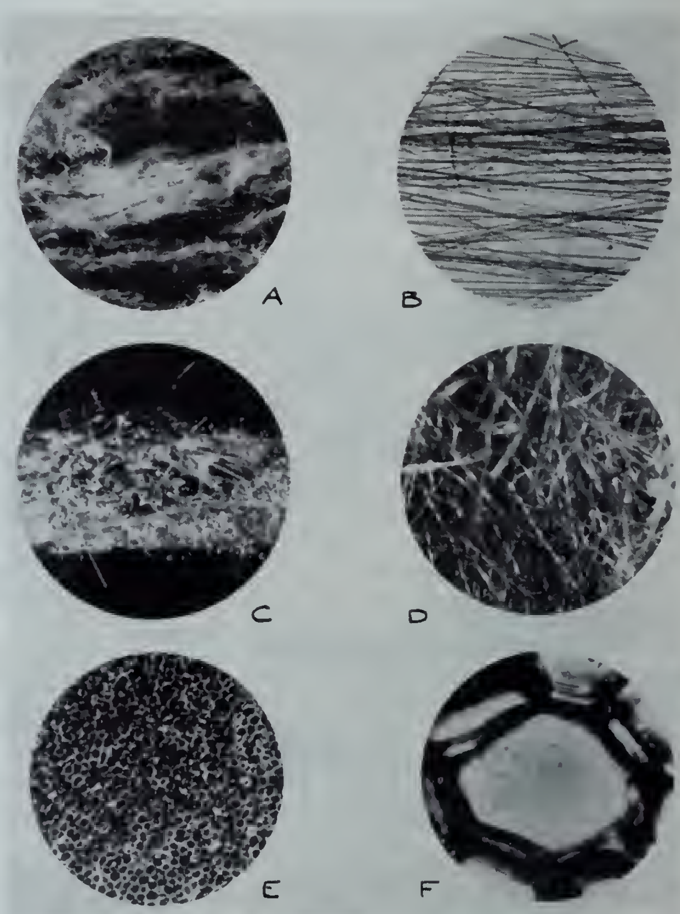

Fig. 2—Actual structure microscopically enlarged. A—Sectional view of fibre board showing laminar structure; B—Individual fibres of rock wool (parallel arrangement); C—Section of rock wool batt taken across fibres; D—Fibres of wood bark (random arrangement); E—Section of cork (cellular arrangement); F—Enlarged view of cork cell.

(C) Fibrous materials with fibres arranged in "lattice" form, so that the transmission of heat is facilitated by the existence of numerous points of contact where the fibres cross. Variables as in (A). (Fig. 1C).

(D) Fibrous materials with fibres arranged in a haphazard or random manner. Variables as in (B). (Fig. 1D).

(E) Granular materials with air surrounding solid granules. Variables, size, weight and form of granules, relative volumes occupied by air and solid. (Fig. 1E).

(F) Cellular materials where the air cells are not connected together but are surrounded by a solid sheath. Variables, size and shape of air cells, thickness of solid barrier. (Fig. 1F).

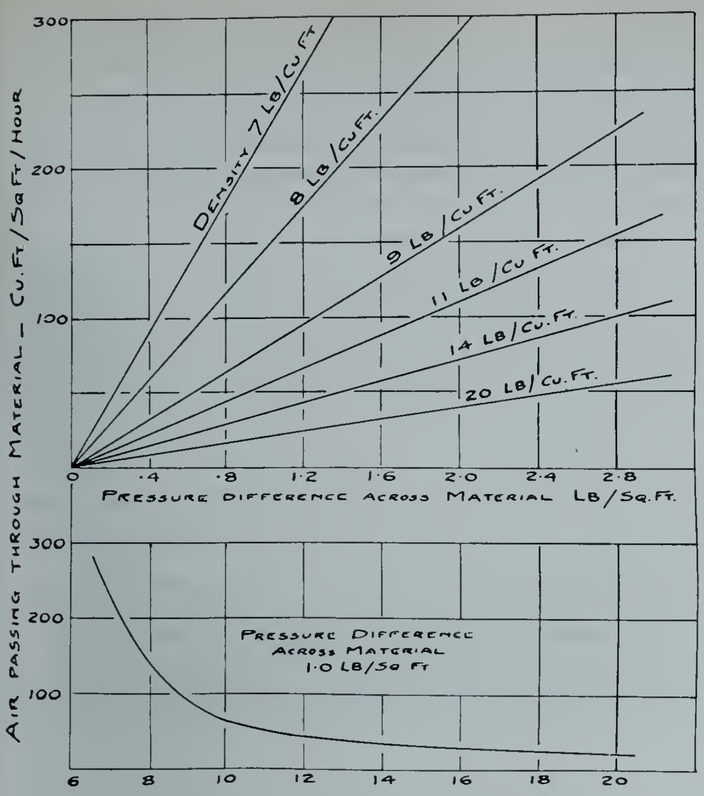

Fig. 3—Leakage of air through rock wool 4 inches thick.

In all of the above, the conductivity of the solid material concerned is a controlling factor, and in some instances its emissivity and specific heat may also be important. Common examples of these structures are glass wool or rock wool batts and fibre boards (Type A), loose rock wool (Type D) and cork (Type F), of which photographs are given in Fig. 2.

In structures A to E, air can either pass through the material or can circulate within it, and the amount of heat transmitted in this manner from the hot to the cold side of the material depends on the number of air cells present, their sizes and their inter-connections. This factor was investigated by passing air through specimens of various materials of different thicknesses and measuring the volume of air passing through the material at each pressure difference.[1] A characteristic example is given in Fig. 3, which refers to rock wool, four inches thick and packed to different densities. The air leakage through this and all other samples of loose fibrous materials was found to be directly proportional to the pressure difference across the specimen, and to fall rapidly with increasing density over the range of densities generally used in practice. Figure 4 consists of a set of similar curves for fibreboards of different densities and thicknesses. This shows that the thickness of such boards has little or no influence on their permeability, as the curves arrange themselves in order of density. It is probable, therefore, that the resistance offered by the surfaces of the material to air penetration is greater than that of the interior. This difference also appears to have some influence on the temperature gradient through the material[2] The application of a thin sheet of aluminium foil to one surface makes the fibreboard impenetrable at air pressures up to 35 lb. per sq. ft., and has the additional advantage of reducing the emissivity of the surface. Some protection also, is given by applying two or three coats of aluminium paint to one surface, the air leakage being then reduced to about 25 per cent of that for the bare board.[1]

A further observation is the greater "conductivity" of large specimens of packed fibrous materials as compared with small ones of the same density. It is possible that these differences may be produced by the circulation of air through the air cells and communicating channels, and in that event, such differences should be definitely related to the structural arrangement of the material. Experiments made on large specimens, sub-divided horizontally and vertically by thin partitions, gave substantial reductions of heat transmission as compared with the individual specimens, and thus provided some evidence confirmatory of this theory.[2] Also, cellular structures (Type F) in which there is little or no connection between the air cells, seem to be free from this "scale effect."

A microscopic study of some of the common fibrous materials used for insulating purposes was made by Dr. D. H. Hamly, and the results are analysed in Appendix I and Figs. 14 and 15. There is evidently a very wide variation in fibre diameters and in their distribution. Thus, the curve for loose rock wool (B) is tall and thin, indicating small fibres of relatively uniform diameters, while that for spun rock wool (C) shows large diameters with a wide range of variation. The term "mode" (Fig. 14) refers to the most frequently recurring diameter, while "median" is the average diameter. "Limits" are the smallest and largest diameters of 75 per cent of the fibres.

An experimental study of heat transfer was also made with the apparatus illustrated in Fig. 5. This consisted of two hollow glass cells, each 8 inches square with walls about ¼ inch thick, which could be evacuated and tested for heat transmission in a guarded hot plate. Tests were made with different vacua inside the cells down to a minimum absolute pressure of 0.2 inches of mercury. The results obtained were consistent down to a pressure of 1.5 inches of mercury, and then became somewhat scattered at lower pressures, probably indicating some variation in convection at low air densities. The tests were then repeated with sheets of thin aluminium foil on the hot and cold sides of the air cell to cut off about 95 per cent of the radiant heat loss, and the results are shown diagrammatically in Fig. 6. The lines "A" and "B" refer to the results obtained with and without the radiant heat shields, and therefore the difference between them probably indicates the amount of radiant heat that travels across the cell when its hot and cold sides are at 115 and 65 deg. F., respectively. Curves C, D, E and F were obtained when the tests were repeated under the same conditions with the hollow spaces filled, successively, with the following materials:—

Curve	*Material*	*Density lb./cu. ft.*	*Conductivity B.T.U./sq. ft/°F/ inch per hour*
C	Exfoliated vermiculite.........	8.5	0.47
D	Puffed wheat...............	3.6	....
E	Expanding blanket...........	3.1	0.29
F	Nodulated rock wool..........	8.0	0.27

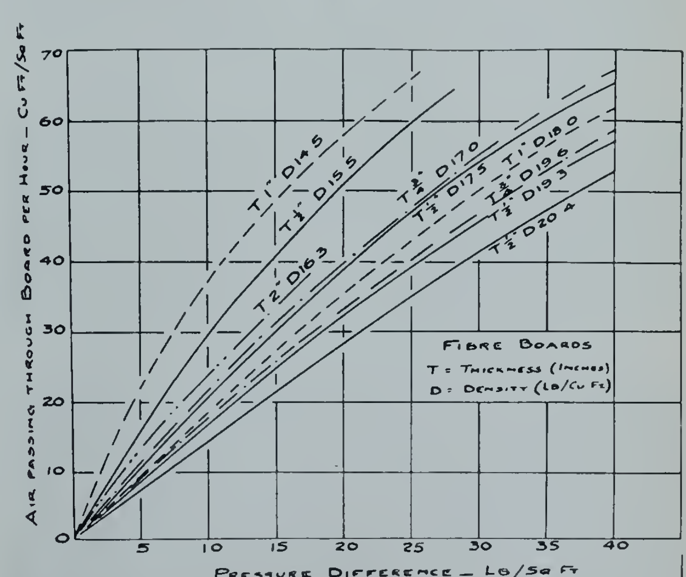

Fig. 4—Leakage of air through fibreboards of different densities and thicknesses.

Similar experiements were also made on glass wool at a density of 3 lb. per cubic foot, but the results obtained were somewhat erratic. The other materials give no indication of change in heat transmission as the air density is decreased, and therefore it is reasonable to infer that there is very little heat transmitted by convection in specimens of this

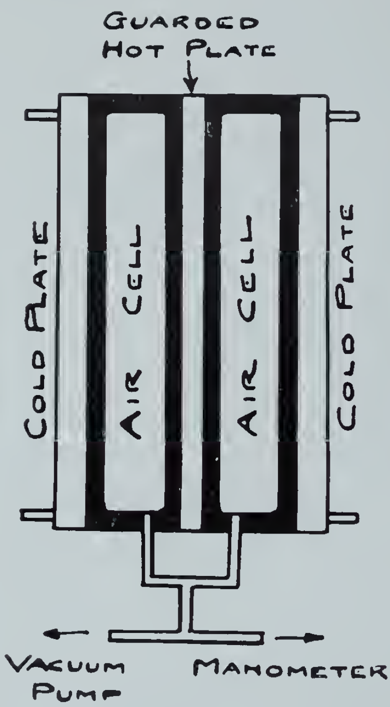

Fig. 5—Hollow glass cells for studying methods of heat transfer.

size. Experiments made on these materials with and without radiant heat shields gave the same results, and therefore radiation also is apparently negligible, so that conduction seems to be the only active agent concerned. The slope of curves A and B indicates the increasing importance of convection inside the cells as the air density increases.

Conductivity and Conductance

For practical purposes, the insulating values of the different materials are compared by means of their respective "conductivities." These are generally obtained by measuring the heat transmitted from the hot to the cold surface in a guarded hot plate, and calculating therefrom, the conductance (C), which is the heat transmitted through one square foot of the material, per degree temperature difference per hour. The conductance is multiplied by the thickness of the material to give the "conductivity" (k) per inch, and the procedure implies that neither the thickness nor the temperature difference across the specimen affect the value of the "conductivity" obtained in this manner. If this were the true conductivity, the above assumptions would be correct, as the true conductivity is a property of the material and is independent of its size and shape. In the author's experience, however, conductivities obtained from test results on thick and thin specimens, respectively, may differ considerably. A series of tests made on thin fibreboards (½ inch thick) varying both the areas of the specimens and the temperature difference between the hot and cold sides, gave both a constant value for the "conductivity" at a fixed mean temperature, and the same rate of increase as the mean temperature was raised. When these tests were repeated on thicker samples, however, it was found that the "conductivity" increased both with the temperature difference and with the thickness.[3]

Temperature gradients were obtained by placing thermocouples inside some of the materials, and, while these ultimately indicated a straight line relationship, there was, in some instances, an abrupt change of temperature at each of the surfaces. Thus, in Fig. 7, the temperature gradient would be $t_1\ t_3\ t_4\ t_2$ instead of the assumed line $t_1\ t_2$. The true conductivity is represented by $\frac{t_3-t_4}{X}$ instead of the value $\frac{t_1-t_2}{X}$ obtained from the hot plate test made in the usual way. In one material, having an apparent conductivity of 1.0, the temperature changes at the two surfaces were each found to be about 3 deg. F. Therefore, if t_1-t_2 is 40 deg. F., the true conductivity would be $1.0 \times \frac{40}{34} = 1.175$.

This superficial resistance, which has already been remarked in connection with air infiltration, is important when the variation of "conductivity" at different thicknesses is being investigated. Consider two specimens of thicknesses X and Y, respectively, (Fig. 7) and let the true conductivities of the two materials be the same. Then $\frac{t_3-t_4}{X} = \frac{t_3^1-t_4^1}{Y}$. But the apparent temperature gradients obtained from the hot plate tests will be, respectively, $\frac{t_1-t_2}{X}$ and $\frac{t_1^1-t_2^1}{Y}$, and if the surface resistances in both cases are equal, it is evident that the temperature gradient for the thin specimens will be greater than that for the thick specimens. That is, the measured "conductivities" of the two specimens of the same material will be different.

Results of this kind obtained on fibreboards were reported independently by four different laboratories, and it was found that when the resistances ($R = \frac{1}{C}$) were plotted against thicknesses (Material "A" Fig. 8) a straight line was obtained which did not pass through the origin. This implies the existence of a resistance when the thickness is zero, which can only be due to surface resistance. The "conductivities" calculated from this curve vary from 0.37 for half-inch boards to 0.44 for two-inch boards, a difference of 16 per cent. A similar pair of curves for a high tempera-

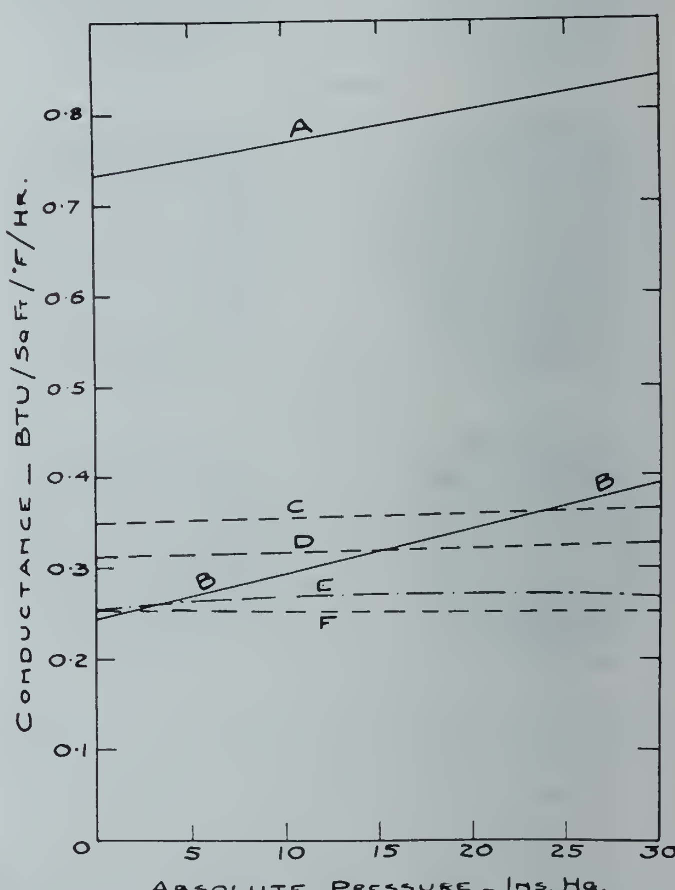

Fig. 6—Heat transmission through various materials with varying vacua.

ture insulation (Material B) is also given in Fig. 8 and shows still greater differences. It seems evident that the property described as $k = C \times thickness$ is not the true conductivity of the material, that it does not remain constant and therefore that it should be discarded in favour of "conductance," as the latter must be used in any case, for the calculation of heat transmission. Alternatively, a different

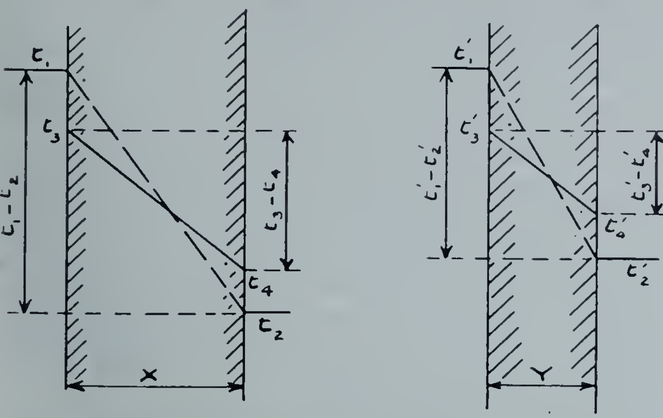

Fig. 7—Influence of thickness on temperature gradient through material.

and less misleading name might be adopted for "k", possibly "apparent conductivity."

Density

Some aspects of this property have already been considered, and the following refers only to its influence on heat transmission. In general, the lower the density, the greater is the percentage of air present, and therefore the lower the "conductivity" will be. This, however, is only partially true, as, if the density of fibrous materials is decreased below a certain value, the rate of heat transmission will again increase.[3] This is illustrated by the curves in Fig. 9. It has been suggested that the increased heat transmission at reduced densities is due to the greater influence of radiation, but the author's investigations do not confirm this, indicating rather that the higher loss is due to increased inter-communication between the air cells as the density decreases. This factor may be important with materials such as glass wool, which are sometimes used at very low densities (1.5 to 3 lb. per cu. ft.). The influence of density on air infiltration is very marked and it seems likely that the increased mobility of the air within the material has an appreciable effect on the transmission of heat, particularly in large specimens.

The fact that glass and mineral wools, which are composed of similar fibres, similarly arranged (but of different diameters) give substantially the same "conductivities" at widely differing densities, was somewhat difficult to understand until the influence of "shot" was taken into account. Table 3 in Appendix I indicates that, in the samples examined, "shot" or beads of siliceous material, account for 23.9 to 54.1 per cent of the weight of rock or slag wools, and only 1.5 per cent of the weight of glass wool. These beads or nodules (Fig. 10) are included in the weights from which the densities are calculated, but probably have no appreciable influence on heat transfer. Consequently, the weights of actual fibrous material present in the two kinds of material are not necessarily so widely divergent as their respective densities suggest. The amount of "shot" present also may be quite important in transportation work where useless weight must be kept at a minimum value. It is not claimed that the figures given above are average values, but they are an approximate indication of the nature of the differences between these two materials.

Another physical factor, allied to density, is the compressibility of the material. Fluffy materials can be compressed almost to any desired extent for transportation, inspection and testing purposes and, whatever method may be employed for measuring the thickness of the material, some slight degree of compression must be used in the measuring process. Another aspect of compressibility is the packing of powdered or other material into an enclosed space where the weight of superincumbent material compressed the lower layers and causes voids to form elsewhere, which may seriously affect the heat flow. The tests illustrated by Fig. 11 and summarized in Table 1 were made with a constant weight of each material which was compressed progressively and tested for heat transmission at each thickness. The conductance, "conductivity" and density are indicated by C, k, and D, respectively.

TABLE 1

Thickness ins.......		1.5	1.25	1.0	.75	.5		.215
Blanket	C	.195	.235	.305	.472	.785	BTU/sq.ft./°F/hr.	
Material	k	.292	.294	.305	.336	.392	BTU/sq.ft./°F/in/hr.	
	D	2.97	3.56	4.45	5.94	8.91	lbs./cu.ft.	
Rock	C	....	.214	.241	.330	.525		.....
Wool	k	....	.267	.241	.248	.262		.....
	D	....	4.92	6.15	8.2	12.3		.....
Glass	C	.206	.222	.271	.330	.514		1.269
Wool	k	.309	.278	.271	.247	.257		.273
	D	1.63	1.95	2.44	3.26	4.89		11.38

Referring again to Fig. 9, the heavier constructional materials have "conductivities" which increase in a fairly uniform manner with density and, in most cases, are reasonably consistent with the properties of the lighter materials.[4]

Figure 12 is a compilation of test results obtained in different laboratories for concretes of varying compositions

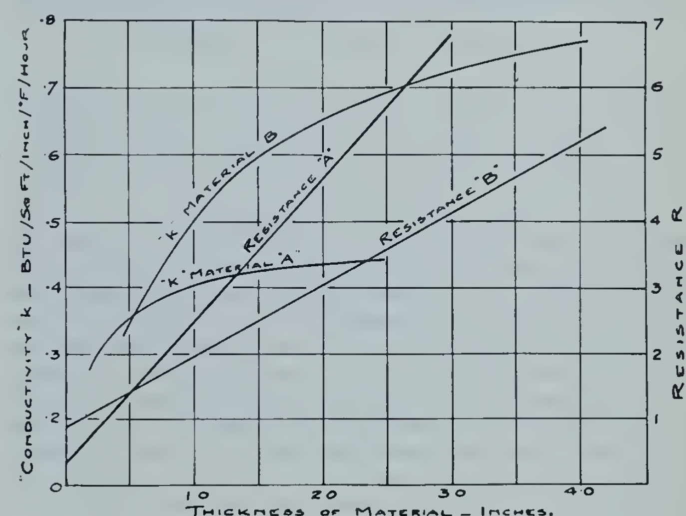

Fig. 8—Influence of thickness on resistance and "conductivity"

and their "conductivities" are apparently grouped round the dotted line shown. Most of the tabulations of conductivity in papers and books of references[5] give a characteristic "conductivity" of 12 B.T.U. per sq. ft. per deg. F. per inch per hour for a typical concrete weighing 140 lb. per cu. ft. This is a value considerably higher than any obtained by the author, and from the curve it would appear that a figure of 6 to 8 would be more reasonable.

Moisture Absorption

It is generally assumed that the conductance of insulating material varies directly with the percentage of moisture present, though this is difficult to prove because, in the process of testing, moisture is driven away from the hot side and toward the cold side of the specimen. This factor was investigated by testing a specimen 3½ inches thick, composed of 2 inch and 1½ inch fibre boards arranged in series. The mean density of the sample remained practically constant during the test, but the boards nearest the hot plate lost weight and those nearest the cold plate gained weight. This effect would not have been detected if the specimen had been made in one piece, as is usually the case.

Some materials such as cork, glass wool and mineral wools, absorb little or no water, but others, such as fibre boards, are hygroscopic. Experiments made on fibre boards of various thicknesses indicated that, with geometrically similar specimens exposed to air at 65 deg. F. and a relative

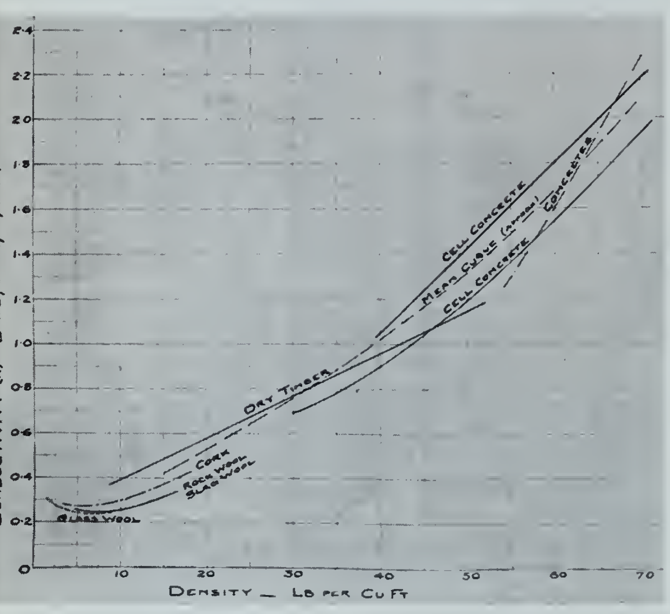

Fig. 9—Influence of density on "conductivity"

humidity of 85-90 per cent, the weight of moisture absorbed per cubic inch was practically constant for all thicknesses.[3] The moisture content was raised from an initial value of 4-6 per cent to a final value of 15-19 per cent by weight.

Whether the solid substance is hygroscopic or not, any material containing voids to which the air has access by infiltration, may be cooled below the dew point, and excess moisture will then be deposited, causing considerable loss and inconvenience, particularly if the temperature is below 32 deg. F., so that the water freezes inside the material. In such circumstances, it is submitted that the criterion of the permeability of the material is not difference of vapour pressure only, as is generally assumed, but is the total difference of pressure on the two sides of the material. Such infiltration should be prevented, wherever possible, by placing an impermeable barrier on the warm side of the insulation.[6][7]

Air Spaces and Surface Resistance

The small air cells that provide most of the insulating value of fibrous and other similar materials may be supplemented or replaced by hollow forms of construction. The effectiveness of the air spaces thus formed, depends on their dimensions and upon whether or not the parallel spaces through which the heat passes are protected from radiation by coverings or coatings of low emissivity, such as aluminium, copper or iron. The properties of these air spaces have been investigated by Rowley,[8] Queer,[9] Wilkes[10] and others, and their observations will not be repeated here, but some results obtained at Toronto may be of interest.

Tables giving the conductances of air spaces are usually based on the Minnesota experiments,[8] which gave a constant conductance at constant mean temperature for spaces more than one inch wide. Some experiments made by the author on air spaces 24 inches square and 3½ inches wide, give considerably lower conductances than those obtained on similar air spaces one inch wide, when tested under the same conditions. It appears that there may possibly be some exceptions to the general assumption.

The advantage of filling hollow tiles with finely divided material is illustrated by tests made on wall sections 5 feet high by 4 feet wide, in which the heat transmitted (air to air) through 8 inch hollow concrete blocks, was reduced by 15 to 30 per cent when the air spaces inside the blocks were filled with gravel or sawdust. Similar experiments made on a 4-inch hollow tile in a 24-inch hot plate, gave a conductance of 0.447 B.T.U., but when the centre was filled with sand the conductance was 0.376 B.T.U., a reduction of about 16 per cent. Large air spaces may be relatively poor insulators, but they are economical in material.

The reduction of heat transmission across air spaces by using coverings of low emissivity is well known, amounting to about 58 per cent with air spaces more than one inch wide. Where this method of protection is impracticable, metallic paint may be used with advantage. A roof slab, one inch thick, was tested in conjunction with an air space two inches wide, the conductance being 0.77 B.T.U. When the surface of the slab next to the air was painted with aluminium paint, the conductance was 0.545 B.T.U., a reduction of nearly 30 per cent.

The effectiveness of bright metallic surfaces as inulsators depends on the retention of their initial emissivity. Tests made by Wilkes[11] and Edwards[12] indicate that, in the case of aluminium, this is not seriously increased by ordinary conditions of use or by very thin protective coatings of lacquer. On the other hand, if the surface is exposed to dust or corrosion, considerable increases of heat transmission may result. A test made at Toronto on an air space divided vertically by a partition having one bright side, gave an increased conductance of 13 per cent when the bright surface was obscured by a very thin dust film. It was also found that a slightly better result was obtained with the

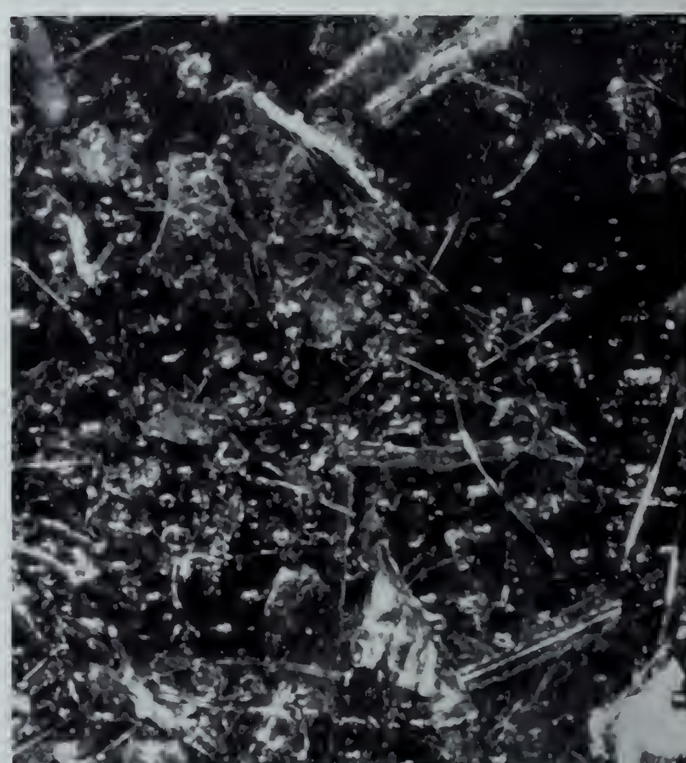

Fig. 10—Photograph of "shot" found in mineral wool

metal foil facing the hot side of the apparatus than when facing the cold side.

Thin air spaces can sometimes be employed advantageously. Some difficulties were experienced with condensation of moisture on the outside of tanks made of plastic material having a conductance of 3.59 B.T.U. per sq. ft. per deg. F. per hour. The addition of an air space 1/16 inch thick, faced

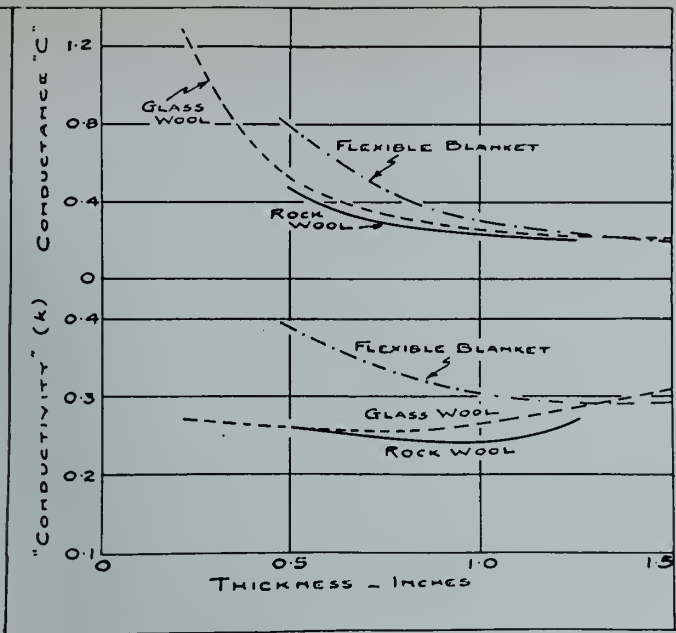

Fig. 11—Conductances and "conductivities" of materials when progressively compressed

by a bright metallic wall, gave a conductance of 1.50 B.T.U., a reduction of 58 per cent. The thickness of the air space was then increased to ⅛ inch and this arrangement gave a conductance of 1.10 B.T.U., being a reduction of 69 per cent from the original value.

The amount of heat lost from a steam pipe depends on the quantity of heat that is transmitted to the air from the outer surface of the insulation, and this factor has also received some preliminary study. The apparatus used is shown diagrammatically in Fig. 13. Temperature readings were taken by thermocouples at various points on the circumference both of the metal and of the insulation, and the results given in Table 2 are averages for each material and set of conditions. These figures are approximate only, as the work is incomplete at the time of writing, but they

TABLE 2

Material	*Temperatures °F.* Outside Surface of Pipe	Outside Surface of Insulation	Difference between Surface and Air	BTU lost per hour per sq. ft. Pipe Surface	Wind Velocity miles per hour	Percentage Increase of Heat Loss due to Wind
85% Magnesia	430	127	40	106	0	8½
with	432	92	12	115	20	
Canvas	520	142	58	145	0	
Covering.	519	103	16	156	15	7½
Thickness 1½ ins.	640	160	76	196	0	
	640	108	22	212	15	8
85% Magnesia	499	167	79	119	0	
with	490	99	15	138	15	16
Metallic	623	200	105	164	0	
Foil Covering.	617	108	18	187	15	14
Thickness	950	285	188	350	0	
1½ ins.	946	118	34	388	15	11
Spun	628	131	56	157	0	
Rock Wool	630	85	9	163	15	4
Iron Cover	829	183	100	258	0	
with Aluminium	829	87	17	274	15	6
Paint.	980	200	132	370	0	
Thickness 2 ins.	981	98	21	384	15	4

indicate that the heat losses from an 8-inch steam pipe, insulated in various ways to give an outside diameter of 11 inches, are increased from 4 to 16 per cent by exposure to a wind of 15 to 20 miles per hour. Covering the outside of the 1½ inch magnesia lagging by metallic foil reduced the heat loss in still air by about 12 per cent, and in a 15 m.p.h. wind by about 6 per cent, with pipe temperatures between 500 and 600 deg. F. Both copper and aluminium coverings were tried and the same results were obtained for each of these metals.

Heat Transmission Calculations

The kind and thickness of insulation required for pipes or structures are calculated from the conductances of the various materials. Unfortunately, the methods of testing, sizes and thicknesses of specimens and temperatures to be used have not, as yet, been standardized, although this

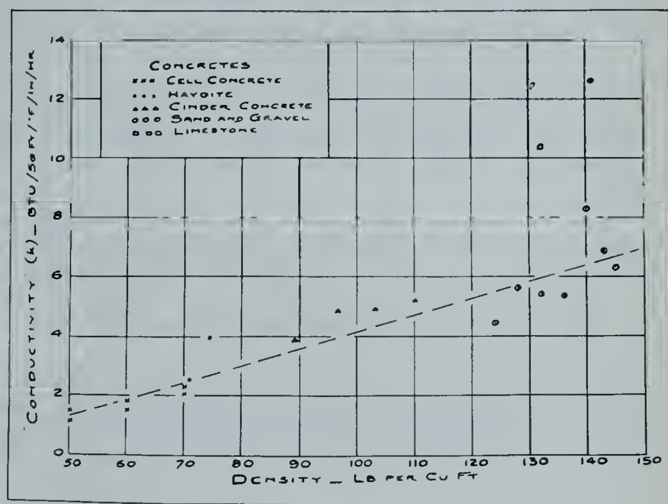

Fig. 12—"Conductivities" of concretes of various densities

question is now being considered by a committee of the American Society for Testing Materials. There is some hope, therefore, that figures comparable with each other will ultimately be obtained for the different materials that are now available. In the meantime, invalid comparisons are continually being made in advertising literature, sales letters and technical books, in which the fact is not disclosed that the figures quoted were obtained with different test conditions. The difficulty of applying such figures in practice is increased when thick sections are used and when

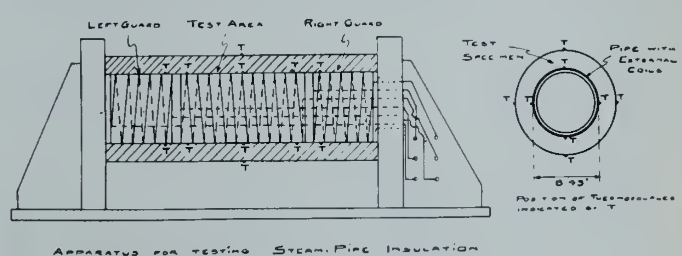

Fig. 13—Diagram of apparatus for testing steam pipe insulation

the material is exposed to variable temperatures. The inside of a building may be kept at a fairly constant temperature but, in the heating season, the outside is subjected to temperature changes between night and day, and also to those due to the action of the sun and wind. As a consequence of these fluctuations, the actual temperature gradient through the wall section is never straight, and therefore the assumptions upon which the heat transmission calculations are made may be quite different from the actual operating conditions. Tests made both at Illinois[13] and Toronto show that thermal equilibrium is seldom obtained in the wall of an average building, and therefore considerable discrepancies are liable to exist between the calculated and measured rates of heat transfer.

This "time lag" may be usefully employed, however, in evening out the temperature curve and in the alternate storing and returning of heat,[14] thus producing the effect of a "thermal flywheel." For this purpose, considerable thicknesses of material are used and their thermal capacities may then be as important as their heat transmissive properties. Several buildings have been designed and erected in Canada which incorporate this principle. These include a hospital in Prince Edward Island, where the thickness of insulation was 10 inches, and capacity of the heating plant provided was less than half of that required for similar hospitals using ordinary construction. This installation was a forced hot water system and the actual temperature of the water, which had been estimated to be 200-220 deg. F., with an outside temperature of 20 deg. F., below zero, was only 130 deg. F., under those conditions. The water temperature during most of the winter 1933-34 was 110-112 deg. F. A study of solar radiation enabled substantial reductions to be made in the size of radiators on the south-east side of the building, and it was found that the time lag between the atmospheric temperature change, and the corresponding change of water temperature, was 3 to 4 days.

Several unheated packing sheds and other buildings for storage purposes have been built by a Toronto architect, Mr. James Govan, in which temperatures above 30 deg. F. have been maintained consistently, in spite of the fact that the outdoor temperatures frequently fall to zero or lower.[15]

A more recent case is the new pavilion of the Toronto Western Hospital, which is described in Appendix III. This consists of an addition of 1,300,000 cu. ft. of new building to an existing hospital having a volume of 1,800,000 cu. ft.

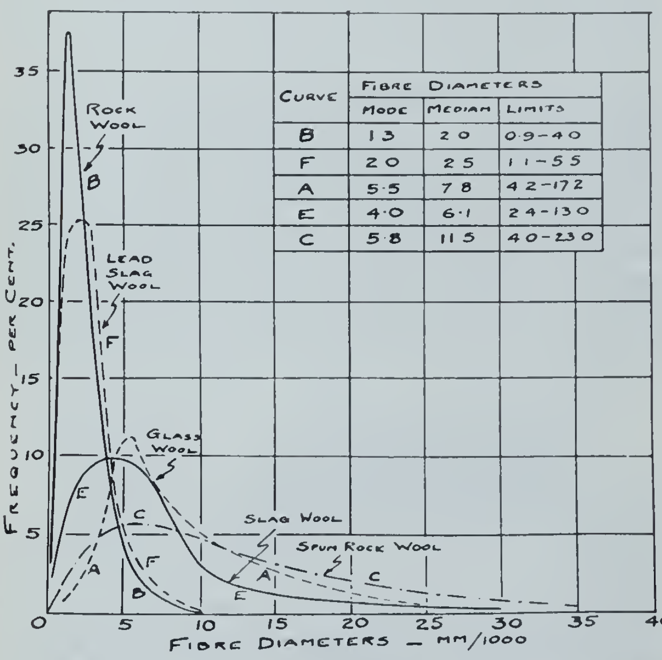

Fig. 14—Frequency curves for fibrous insulating materials

New heating boilers were installed having efficiencies of about 70 per cent, as compared with about 55 per cent for the original installation. The thickness of insulation employed was approximately 10 inches and the records show that the additional 1,300,000 cu. ft. of space is apparently being heated with little or no addition to the coal consumption.

These examples of practical application indicate that much more could be done, than is generally being done, in the matter of reducing heating costs.

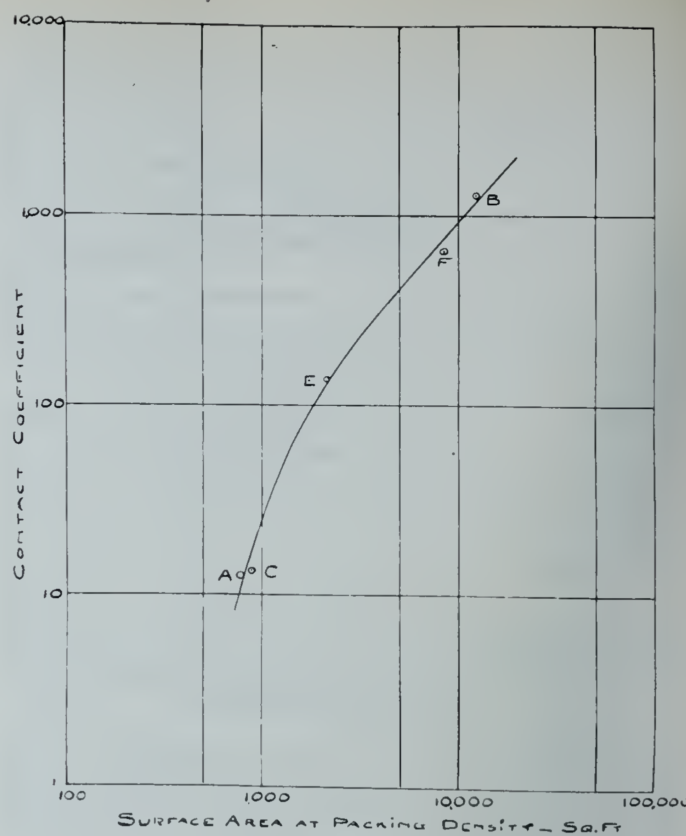

Fig. 15—Contact coefficients and surface areas

Acknowledgment

The author wishes to acknowledge the assistance given during these investigations by Messrs. D. H. Hamly, PH.D., F. G. Ewens, M.A.SC., R. J. Birss, B.A.SC., and W. A. Wallace, B.A.SC., all of whom took part in the experimental work at various times.

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APPENDIX I

MICROSCOPIC MENSURATION OF FIBROUS MATERIALS

By D. H. HAMLY

The volume of air moving at low rates varies approximately in inverse proportion to the area of the surfaces in contact with the air, as shown by experiments with capillary tubes of various lengths. An estimate of the surface area of fibrous materials can be obtained by calculation from the fibre diameters on the assumption that in a sample of suitable size both the diameters and the relative numbers of the various diameters will be fairly represented. Variations in fibre characteristics, such as changes in diameter along a length, or shape, or fibre twinning occur, but these are of little consequence and no statistical record was made of them. Variations in fibre length also occur within a sample, but these differences did not appear to be of sufficient importance to invalidate the calculations for a given sample. However great differences of length appeared in the insulating wools made by different manufacturers, there appeared to be no relationship between fibre length and conductivity other than that lower packing densities are possible with the longer fibred wools.

The method employed to determine the area constant for different insulating wools was as follows. After the scale of the microscope ocular had been calibrated for objects in air, ten small samples were selected from different parts of an approximately one lb. mass of bulk fibre chosen as representative of the material. The small samples were carefully spread out on microscopic slides and held in place with cover slips. Ten fibres from each slide were measured using a 45x (Leitz No. 7) objective and a 6x (Spencer scaled) ocular. Each fibre was chosen deliberately and without prejudice from a new part of the field. Thus, one hundred measurements were made from each kind of material, and tabulated as shown in Table 3, where the measurements and calculations for ten fibres from one sample are shown.

From the diameter dimensions obtained for 100 fibres, a frequency table (Table 4) was constructed.

Table 5 shows the total surface areas reported for materials A, B, C, D, E and F, obtained according to the above plan.

Figure 14 shows the frequency curves for diameters of the same materials. From these curves were obtained both the mode diameter, a dimension which indicates the fineness and the packing capacity of the material, and the median diameter for 75 per cent of the fibres, disregarding 12.5 per cent of the smallest and 12.5 per cent of the largest fibres, indicating the texture and general appearance of the material.

Specific Gravity, Packing Density and Shot Percentage

In making use of the surface area values obtained from the foregoing work, several factors have to be taken into consideration, chiefly specific gravity, packing density, and shot percentage.

Specific Gravity must be used in calculating the other values, and was determined according to the following method. Xylol was used for immersion, since much of the material is slightly oily and not readily wetted with water.

(a) The specific gravity of a quantity of xylol was determined, using a 100 cc. volumetric flask at 72 deg. F. This temperature was used in all determinations of volume and weight.

TABLE 3 (Material F, Lot 5)

Fibre No.	Readings		Difference	*MOcK* 0.0324	Diameter in micra
	High	Low			
1	175	7	168	0.0324	5.6
2	97	40	57	"	1.8
3	89	65	24	"	0.8
4	239	25	214	"	7.0
5	349	34	315	"	10.2
6	65	20	45	"	1.5
7	74	13	63	"	2.0
8	104	88	16	"	0.5
9	128	81	41	"	1.3
10	170	90	80	"	2.6

MOcK = Ocular calibration constant.

(b) The net weight of a mass of bulk fibre placed in the volumetric flask was obtained.

(c) Xylol was added to cover the fibre. The air originally trapped in the interstices of the fibre was removed by repeated use of reduced pressure and by holding the flask at 122 deg. F. for some hours with the stopper in place.

(d) The temperature was then reduced to 72 deg. F. and volume adjusted to 100 cc. The total weight of this quantity of fibre and xylol was then obtained.

(e) The specific gravity of the fibre was then calculated in terms of xylol and of water. The results are given in Table 5.

Packing Density governs the surface area per unit volume, but the presence of shot reduced the $\frac{\text{surface}}{\text{volume}}$ ratio in the bulk fibre and thus its efficiency as an insulator. Shot, prematurely solidified masses, are shown by the microscope to vary greatly in shape; horseshoes or hairpins of very heavy fibres, dumbbells of various sizes, spelterlike masses,

TABLE 4 (Material F)

Class Diameter $d+0.5$	Frequency f	Fibre End Area		Length $\frac{V}{af} = L$	Surface Area Factors per Pound		Total Surface Area $Lxcf = a_{ts}$
		Area a	Class Area af		Circumference c	Class Circumference cf	
1	2	3	4	5	6	7	8
1	32	0.78	24.9	1.425×10^2	3.14	101.8	1.84×10^7
2	25	3.14	79.5	7.74×10^{-6}	6.28	157.0	x
3	23	7.07	163.0		9.42	216.5	8.19×10^{-2}
4	6	12.6	75.6		12.56	75.4	
5	7	19.6	137.2	1.84×10^7	15.70	109.9	1.46×10^6
6	4	28.3	113.2	cm.	18.84	75.3	sq. cm.
7	1	38.7	38.7		22.3	22.2	
8	0	50.2	0.0		25.4	0 0	1.46×10^6
9	1	63.7	63.7		28.6	28.6	9.29×10^2
10	1	78.5	78.5		31.4	31.4	1.57×10^3
			Σ cf 774.3		cf	Σ cf 818.1	sq. ft.

Dimensions in columns 1, 6 and 7 in micra, and in columns 3 and 4 in sq. micra.

TABLE 5—CHARACTERISTICS OF CERTAIN INSULATING WOOLS

Material		Properties				Air	Shot		Fibre						Bulk Fibre			
											Size—Micra				Surface Area			
Type	Description	Colour	Refractive Index	Specific Gravity	Wgt. per cu. ft. in lbs.	Volume Ratio at Packing Density	Shape	% Present	% Present	Mode	Median	Limits for 75%	Contact Coefficient	Surface Area in sq. ft. per lb.	in sq. ft. per lb.	Packing Density lb./cu. ft.	in sq. ft. per cu. ft.	Conductivity (k)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Glass Wool	A Long, clean, white fibres, springy to the touch	Transparent	1.53	2.42	151	0.990	Hair-pins	1.5	98.5	5.5	7.8	4.2–17.2	12.6	519	512	1.5	768	0.27
Rock Wool	B Very soft greyish masses—shot conspicuous	Translucent to grey	1.62	2.71	169	0.942	Hairy shot	54.1	45.9	1.3	2.0	0.9– 4.0	1270.0	26900	1235	10.0	12350	0.27
Rock Wool	C Long, clean, decidedly greenish masses of stiffish fibres	Transparent to green	1.62	2.86	179	0.983	Coarse, hairy to chain shot	23.9	76.1	5.8	11.5	4.0–23.0	13.3	3830	291	3.0	873	0.25
Rock Wool	D Very soft, greyish-green masses with conspicuous shot	Translucent to grey	1.63	2.68	166	0.940	Coarse, hairy to chain shot	46.5	53.5	..	...	...	...	...	...	...	..	...
Slag Wool	E Soft masses of dirty to dark grey fibres. Shot conspicuous	Translucent to dark grey	1.63	2.71	169	0.942	Hairy to chain shot	47.1	52.9	4.0	6.1	2.4–13.0	137.0	410	217	10.0	2170	0.27
Slag Wool	F Very dark fibres soft to touch. Shot conspicuous	Dark grey	1.70	3.14	196	0.960	Hairy to chain shot	32.6	67.4	2.0	2.5	1.1– 5.5	652.0	1570	1060	8.0	8480	0.27

and more or less globular shapes with many projections from which fibres have been broken, may be seen in photomicrographs (Fig. 10). To determine the surface area in a sample of material, it is necessary to determine the relative amount of shot present.

Shot percentage determination is practical, for there are few fibres larger in diameter than 50 μ, and relatively few shot which will pass through a Tyler screen with spaces of 88 μ between the wires. However, the use of screens for shot separation is difficult and slow, because the shot projections catch in the wires of the screen. Water separation proved satisfactory and rapid when the fibre was first broken down by rubbing between pieces of cork carpet.

A mass of about 80 cc. of bulk fibre was weighed in a tared beaker, rubbed to a powder between cork, carefully transferred to a 300 cc. beaker and wetted with 95 per cent alcohol to insure thorough wetting with water. The beaker was then placed in a 2 by 10 by 12 in. tray and the mixture vigorously stirred with water flowing from a small rubber hose. A rapid overflow of water from the beaker was allowed as long as the fine broken fibre appeared to wash over without carrying shot with it. In the meantime the tray filled with water and with carried over material. Most of the fine fibre washed away, leaving the coarser fibre and shot, which was then separated by careful panning, checked by microscopic examination. The shot from the tray was then added to that in the beaker, and the whole carefully washed with distilled water. This was poured off and replaced with 15 or 20 cc. of 95 per cent alcohol. The operation was completed by pouring off the surplus, evaporating to dryness, and weighing at room temperature.

An estimate of the surface area of shot can be based on the size of the opening through which the shot can pass. By assuming that "the average shot" of various sizes in a material are similar, and that all bear the same surface relationship to the surface of a sphere capable of passing through the same aperture, a series of calculations of $\frac{\text{surface}}{\text{volume}}$ ratios were made for material "F", as shown in Table 6. By assuming further that the ratio of hypothetical shot surface to sphere surface of the same passing diameter is as 1:1, the relative importance of the shot can be determined. The net result of the computation shown is that the shot in this material possesses 1/200 of the surface area of the fibre. However, the ratio is actually smaller, for the surface area of irregularly shaped shot of the same weight is greater than that of spheres of a size capable of passing through the same aperture.

Fibre Arrangement

In evaluating the insulating importance of fibres with particular reference to transference of heat by moving air, some consideration must also be given to the arrangement of surfaces and the amount of conductance present. Table 5 shows that, even after allowance has been made for shot present, the surface area of the finer fibred wools is much greater than that of the coarser. However, the coarser and longer fibred wools permit lower density packing and

TABLE 6

Shot Size and Surface Area of Shot for Material F

Size and Use of Screen (Tyler)	Hypothetical Shot Diameter	Shot Size %	Shot and Fibre % By Weight	Surface/Volume Constant $\frac{4r^2}{4/3r^3} = \frac{3}{r} = \frac{6}{d}$	S/V Const. over % S.S.	Relative Importance %
1	2	3	4	5	6	7
Over 589	900	8	2.8	0.0067	0.02	0.01
" 295	450	33	11.5	0.0134	0.15	0.09
" 147	225	38	13.3	0.027	0.36	0.2
" 88	100	20	7.0	0.60	0.42	0.25
Thro 88	50	1	0.4	0.12	0.05	0.03
Shot		100	35.0			
Fibre			65.0	2.6	169.0	99.42
Bulk Fibre		.	100.0		170.0	100.0

Dimensions in micra.

TABLE 7

Factors Governing Coal Consumption	1933-1934	1939-1940	Remarks
1. Total volume of building	1,813,000 cu. ft.	3,693,000 cu. ft.	
2. Increase in volume of building (1935)		1,880,000 cu. ft.	
3. Coal consumed from October to April inclusive	1,592 tons at 14,400 BTU per lb.	1,922 tons at 14,100 BTU per lb. =1,882 tons at 14,400 BTU per lb.	
4. Increase in equal heat value coal for 7 months period		=290 tons	
5. Patient-days during 7 months	60,789	102,422	
6. Increase in patient-days during 7 months period		41,633	
7. Estimated coal consumed in 1939-40 for heating water, cooking and sterilizing		0.00708 tons per patient-day (calculated)	Checked against July and August consumption and against results at other hospitals.
8. Estimated coal consumed for heating water, cooking and sterilizing in 7 months period due to increase of 41,633 patient-days		295 tons	Calculated on basis of Item 7.
9. Actual increase in coal consumed for all purposes, including heating		290 tons	On basis of BTU value per lb. equal to coal used in 1933-1934
10. Degree-days	7744	7411	

arrangement at right angles to the path of circulating air, as well as to the direction of the radiant heat.

Volume of Circulating Air

Though the transference of heat is directly related to the volume of the air circulating within the space partially filled by the insulating material, the limits imposed are not great even for packing densities of 1.5 to 10 lb. per cubic foot.

For material "A", sp. gr. 2.42 packed 1.5 lb. per cu. ft., the volume of air per cu. ft. is $\frac{62.5 \times 2.42 - 1.5}{62.5 \times 2.42} = 0.990$ cu. ft.

For material "B", sp. gr. 2.71, packed 10 lb. per cu. ft., the volume of air per cu. ft. is $\frac{62.5 \times 2.71 - 10}{62.5 \times 2.71} = 0.942$ cu. ft.

Thus, the circulating air in material "B" is only 5 per cent lower than in material "A", although the mass of the bulk fibre is 730 per cent greater. This factor is of minor importance compared to the changes in the surface area and in the contact constant.

The Contact Coefficient

In the conductance of heat across a space filled with fibrous insulating material the number of points of contact between fibres is the determining factor. The fine fibres of such materials as "B" obviously make far more contacts per unit volume than the much coarser fibres of such materials as "C". It may be assumed that the number of contacts is proportional to the packing density at any space filling density. The "contact coefficient," the relative number of contacts for a given material at a given packing density, is derived as follows:

The number of contacts in a given cross-section of material is proportional to the unit area divided by the cross-sectional area of a single fibre of median diameter, multiplied by the number of contacts per fibre (assumed to be 4), and by the packing density in lb. per cu. ft. (P.D.). In the following expression the unit area is 1 mm².

$$\frac{1mm^2 \times 4 \times P.D.}{\pi \frac{d^2_{med}}{2^2}} = \frac{1 \times 10^6 \times 4}{\pi \frac{d^2_{med}}{2^2}} \times P.D.$$

The constants of the above expression give rather large values and are reduced by 10^4:

$$\frac{16 \times 10^6}{\pi \times 10^4} \times \frac{P.D.}{d^2_{med}} = 509 \times \frac{P.D.}{d^2_{med}}$$

509 = Contact constant

$P.D.$ = Packing density in lb. per cu. ft.

d_{med} = Median fibre diameter in micra. $\left(\frac{m.\ m.}{1000}\right)$

Conclusion

Figure 15 shows clearly that the contact coefficients and the surface area for materials A, B, C, D, E and F are related. This figure was obtained by plotting the values found in columns 14 and 18 of Table 5 on loglog paper. This significant relationship does not appear when values uncorrected for the presence of shot and for packing density are employed.

The variation in the reported conductivity for the insulating materials samples is very small, being 0.27 to 0.25, as shown in Table 5, column 19, and the presumption is that transference and conductance are related, unless it can be shown that there is a significant variation in the other factor, radiation.

APPENDIX II

THE EFFECT OF ADDING LIME TO SAWDUST

Sawdust, being abundant and cheap, has been used extensively in some localities as an insulating material. It is necessary, in many instances, to mix this with about 10 per cent of slaked lime to avoid the effects of moisture and vermin. The following results were obtained on the hot plate apparatus at the University of Toronto, when sawdust made of mixed woods was tested, first alone, and then mixed with lime, in the above proportions. The sawdust was first dried at 215 deg. F., about 50 per cent of the weight being lost in the process. During the test the weight of the sawdust sample increased by 3 per cent, due to the re-absorption of moisture, while that of the sawdust-lime mixture increased by 9 per cent.

Material	Sawdust	Sawdust mixed with 10% lime
Density: lb/cu. ft.	9.03	9.03
Mean Temperature: °F	84.7	82.9
Conductance of Specimen 1 inch thick: BTU/sq. ft/°F/hour	0.309	0.319

The addition of lime, therefore, increases the heat transmission of dry sawdust by about 3 or 4 per cent.

APPENDIX III

THE USE OF THICK INSULATION

The new pavilion and other additions made to the Toronto Western Hospital in 1935 increased the volume to be heated by over 100 per cent. Moreover, the new pavilion is fourteen storeys high and has large exposed surfaces, and also considerable additional steam-using equipment was supplied. Table 7 gives a comparison of coal consumptions for the heating season of 1933-34 and 1939-40, respectively.

Thus, the increase in coal consumed by the additional steam using equipment was estimated to be 295 tons. The total difference in coal consumption (on a B.T.U. basis) was 290 tons, so that the extra cost of heating the additions to the original building and the new pavilion is practically nothing. A considerable error in the above estimate would not materially affect this comparison.

This economy is attributed to:—

(1) The use of new and more efficient heating plant. This might account for about 10 or 15 per cent of the difference.

(2) The use of thick insulation in walls and roof. The walls consisted of a brick or stone veneer (4 to 6 inches thick) backed by 8¼ inches of special Haydite blocks (65 lb. per cu. ft.). Behind this were asphalt and 1½ to 2 inches of cork (3 inches in some places). The roof was a concrete slab, 3 inches thick, topped with 2 inches of cork plus felt and gravel. Below this was an air space and hung ceiling.

(3) Double glazing, weatherstripping and caulking of practically all windows.

(4) The orientation of the new pavilion to get the maximum benefit from winter sunlight.

The use of wood shavings (6 to 8 inches thick), proper orientation and ventilation has enabled hog testing stations for the Dominion Government to be kept at a constant temperature of 50 deg. F. with a very small fuel cost. These buildings are in various parts of Canada from Alberta to Quebec, and the outside temperatures are frequently as low as −50 deg. F. The regulation of temperature is necessary for the elimination of surrounding conditions when measuring the inherited characteristics of pigs, as, when the temperature of the farm building is lowered, it is reasonable to assume that increased food consumption is necessary to maintain body temperature, and therefore the amount of food required to produce 100 lb. of pork varies accordingly. The buildings were, therefore, designed to eliminate this variable and have proved satisfactory for that purpose.

The author is indebted for this information to Mr. James Govan (Toronto architect) and Mr. J. G. Lefebvre of the Department of Agriculture, Dominion of Canada.

SOME PROBLEMS IN AIRCRAFT PRODUCTION

J. I. CARMICHAEL, S.E.I.C.

Paper presented before the Lakehead Branch of the Engineering Institute of Canada, on January 15th, 1941.

An industry exists to make, sell and collect payment for its products; thus its basic problems are to purchase the required material, to find suitable sources of labour, to obtain equipment for production, to develop and maintain the necessary organization, to design and manufacture the product and finally, to market the product and finance the manufacturing operations. At present, the market is boundless, while the production capacity is definitely limited. Thus marketing and financing presents no serious problem to Canada's aircraft industry.

Organizing, designing and manufacturing are internal problems while the remainder are external and are not under the control of the aircraft manufacturer, and for this reason have become critical under the present wartime industrial conditions. It is felt that the secondary industries of supply are not fully aware of their responsibilities to Canada's aircraft manufacturing programme. As the industry is more dependent upon these industries than ever before, some aircraft production problems will be presented so that the development of more efficient relationships may be aided.

Effects Of Design

The requirement that a product be designed for the most efficient performance is, in most industries, less important than its production at lowest cost, usually from standardized materials and processes. In the aircraft industry the opposite condition exists, as the designer must make every effort to obtain highest possible performance and cannot make concessions to cost or ease of production if they affect performance.

Aircraft components must be given special shapes and arrangements in order to obtain highest aerodynamic and operational efficiencies. These involve various design procedures, specialized types of construction, large numbers of parts and special forms of material, which require many difficult manufacturing processes. When the basic design has been established the reduction of weight affords the best opportunity for improving performance. This requires the use of specialized material specifications whose variations must be held within narrow limits; very low manufacturing tolerances and exceptionally high standards of workmanship must be specified; and inspection must be extremely critical to insure strict adherence to these requirements.

The types of construction most commonly used are welded tubular, bolted tube and gusset and semi-monocoque; each has special applications but the choice usually depends upon which is most adaptable to available material and production capacity. Semi-monocoque[1] is the most common type as it allows the use of easier and faster production methods and materials which have been standardized to a much greater extent than for other types.

Much effort is being spent upon the development of a full-monocoque[2] type of construction; when this is accomplished, aircraft will be produced much more rapidly and cheaply than by any method now in use; indeed the present aircraft industry will be revolutionized.

Most designs provide for interchangeability between major components and between many detail parts. This provision does not affect performance and is the most important contribution of the design towards aiding shop fabrication and assembly and maintenance in the field. This is done by specifying low tolerances on common dimensions of matching parts which are to be interchangeable, and by building this accuracy into their jigs, tools and fixtures. The first part is made in conjunction with its tools of which there are usually two or more, and is then offered up to its next assembly to check its inter-

[1] The theory underlying semi-monocoque design is that the stress is all carried in a thin skin, usually light gauge metal, which is internally supported by stringers, bulkheads, etc.

[2] Semi-monocoque construction is the result of limitations imposed upon fiull-monocoque by the lack of satisfactory materials and manufacturing processes. Full-monocoque construction has the skin carry the load free from any internal support. The so-called "plastic" airplane is of this type; the components would be molded in one piece usually with the application of heat and pressure. Materials such as phenolic-resin-bonded plywood have been successful in recent experiments; further progress is limited by the size of the component which can be turned out, the extremely high cost of equipment and also by the fact that research is not yet completed.

changeability. When the tools are thus cross-referenced, parts and components may be placed in production with complete assurance that they will be interchangeable. This is done with as many parts as possible in order that the work of fitting and otherwise completing on assembly may be kept to a minimum. Establishing interchangeabilities is a costly procedure and cannot be done on all parts for practical and economical reasons, but it is a distinct aid to production and thus is developed wherever possible.

The Hawker "Hurricane," now in quantity production at the Fort William Plant of the Canadian Car & Foundry Company, presents unusually difficult production problems because it is a mixture of several types of construction. The wings are of the stressed skin type and require approximately forty per cent. of the total productive man-hours for the aircraft; the remainder of the structure is bolted tube and gusset construction with minor applications of many other types of construction such as welded assemblies, wood fairings, etc. There are about six thousand parts required in quantities of one or more per aircraft; these include six hundred proprietary parts, eight hundred machined parts, three thousand three hundred detail fabricated parts, which are assembled into twelve hundred sub-assemblies and are later incorporated into one hundred main assemblies.

In addition there are three thousand standard details which are required in large quantities, so that the total number of items on the airframe probably exceeds sixty thousand. Machined and detail fabricated parts may be made from one of twenty-five types of construction, from thirty material specifications which are required in ten different forms. During their manufacture these parts undergo several of sixty fabricating processes and are completed by passing through one or more of twenty finishing processes.

From the foregoing it will be seen that the aircraft is composed of numerous intricate parts and that each of these must be designed for highest efficiency; the efforts to reduce weight cause additional complication by requiring great accuracy in design and construction; the designer then has no choice but to treat each problem as a particular case with its own special solution. This latter condition produces a lack of standardization in all details which is a most serious problem from the various view points of material purchasing, labour and equipment supply, plant layout, production control and economy, and speed of manufacture.

There is a growing tendency to give greater consideration to production problems and in many cases changes are being made which have little effect on performance but which greatly aid production. The majority of these problems will not be solved effectively until new methods of design and manufacture are introduced which will permit highest performance and at the same time allow lowest costs and much higher rates of production.

Labour Supply

Rapidity of industrial expansion is limited by the rate at which new personnel can be absorbed, new equipment can be set in operation and material can be procured for production. These are external problems among which the problems of labour supply are most easily solved by the manufacturer, despite the fact that there has been no general industrial training programme in Canada for many years and that today the aircraft industry is confronted by labour shortages.

One of the most important effects of the design is to specify extremely high standards of workmanship over a variety of very difficult fabricating operations. In addition, the numerous types of construction and large number of parts require that each workman be possessed of more than one skill and thus it is impossible to set untrained men and women at producing aircraft parts. Men and women with no industrial background must be given instruction in the fundamentals of aircraft shop practice before they can be put to work. This delays expansion.

Many government-supported industrial training schools are giving assistance but their graduates come to the aircraft factories relatively unskilled. These graduates usually spend another six weeks in company training classes or in the shop under close supervision before they are considered capable of performing simple tasks. After an additional four months they generally develop to a point where they can act with initiative and produce good work.

The possibility of absorbing large numbers of women workers is being explored; while actual numbers are unknown, one manufacturer has been able to employ women to the extent of approximately fifteen per cent of the total staff. It is estimated that this could be increased to thirty per cent. if necessary. This is being done for many reasons; women are not liable for military service; most male workmen are already employed, thus women represent a relatively untapped labour reserve; many tasks are more suitable for women either because of the delicate touch required or the monotony involved. Women are most readily adaptable to tasks such as stamping, welding, sub-assembly, detail inspection, rivetting, etc., but there are few tasks they cannot perform satisfactorily if sufficient traning is provided.

Most factories have been able to cope with the labour situation as outlined above, but their rates of expansion have been limited and production efficiencies have been lowered. If larger contracts were placed, manufacturing procedures could be reduced to their simplest elements and allow the use of less skilled workmen.

Material Supply

The aircraft industry is finding the location and maintenance of adequate sources of raw materials and proprietary articles to be a difficult external problem. The complexity of the design and general market conditions combine to make this so.

Previous to the outbreak of war, nearly all commercial aircraft manufacturers in Canada had experience with the production of American designs and were using material made to American specifications; for this reason little thought was given to the expansion of the production capacities of existing suppliers or to the development of new sources of material to British specifications. Despite the fact that it was difficult for the manufacturers, the first war contracts were given for the production of aircraft of British design. No sources were available in Canada for most of the material required, thus the manufacturers were forced to import their requirements from England. About six months later an export embargo was placed on these items and the development of Canadian sources for these materials became vitally important, in order to avoid stopping the various programmes before they were fairly started.

This situation would not have arisen if a vigorous programme had been previously undertaken to develop the Canadian sources of supply. If this had been done, the supply industries would have had a chance to solve the numerous practical and technical problems of producing these new materials; stocks of basic raw materials would have been accumulated and most important, the capacities of the supply industries would have been surveyed, coordinated and if necessary, developed. This was not done until the manufacturers were forced, for their own protection, to develop their own sources.

These sources were found among industries whose products, experience and equipment indicated that they would be capable of manufacturing and supplying the necessary materials. The purchasing, engineering and planning staffs of the aircraft factories made direct contacts with the key personnel of these supply industries; in this way they transmitted directly the necessary technical data and supervised the operations and progress made. When the supplier proved his ability to produce, the British Air Commission placed him on their approved list; from this time he was responsible to them and was considered to be a standard supplier of the particular item he had developed and was able to supply it to the whole industry.

Sources had to be developed for both raw material and proprietary parts. The former presented many difficulties because the materials were new and their specifications were much more rigid than anything previously produced. In the case of proprietary parts, the difficulties were mainly in the working of such materials. For nuts, bolts, rivets, forgings, castings, etc., the working characteristics of the new materials could be learned only by experience and this caused many unforeseen delays. For example a bolt manufacturer found he could not manipulate a certain alloy steel until he had developed new tools and fabricating procedures; a forging manufacturer had never before produced aluminum alloy forgings and found that he had to procure more powerful presses, redesign his dies, and develop completely new techniques of forging and heat treatment.

There were many items of raw materials and proprietary parts for which sources could not be developed economically in Canada. Such items are special alloy steels, radiators, tie rods, instruments, etc., in these cases American substitutes were readily adaptable or development could be more easily completed by firms working on American equivalents and for this reason they were purchased in the United States.

While this method of development has presented obstacles to Canada's aircraft production, it has advantages in that the direct contact was the best possible condition for rapid development and it ensured that priorities would be established and delivery promises would be met. The great disadvantage was that the industry was unprepared and the manufacturers were often forced to duplicate each others' efforts to develop sources and in many cases entered into competition with one another. This caused the wasteful use of what capacities were available and developed some sources which would have been more effective producing something else.

The continuously expanding aircraft industry will soon absorb the capacities of all sources now developed, and a serious situation will result if additional expansion is not undertaken immediately. There is a lack of co-ordination among the suppliers, particularly in the case of machined parts; this has caused inefficient production but may be eliminated by the setting up of a central control agency which would determine priorities, allocate capacities and control and co-ordinate deliveries.

The existing severe specifications and lack of standardization of material present many problems which can only be solved by considering production as well as performance. If American rather than English types could be produced in Canada, these problems would be less pressing, owing to the fewer materials required and the greater production capacities available.

Subcontracts

The problems of finding extra space and new equipment are also of importance. They are caused by conditions outside the industry and are becoming the major obstacles to rapid expansion. The construction of new buildings and the purchase of new equipment such as salt baths, presses and machine tools are requisites for expanded operation but market conditions present many delays.

The manufacturer finds the only solution is to approach well established industries in other fields and endeavour to make use of their production capacities for the manufacture of aircraft parts or components on a subcontract basis. Such an arrangement is made only when the subcontractor is experienced in the commercial production of parts similar to those required; this is mutually satisfactory, as the manufacturer obtains some additional capacity and the subcontractor has an opportunity to aid the war effort and keep his organization operating efficiently.

Items which may be subcontracted most effectively are machined parts, and wood and sheet metal assemblies and details. Machined parts are most important as they may be put into production immediately in numerous industries whose experience and equipment is readily adaptable; there is much more commercial productive capacity available; their production time is the major part of all work subcontracted; the tooling programme of the manufacturer is relieved considerably when the subcontractor makes his own tools; the existing machine capacity is reserved for the main contractor's tooling programme; and development and control of subcontracted machined parts is easier providing sufficient capacity has been found.

There are relatively few aircraft on which wood details and assemblies involve a large proportion of the work; where these do occur, they may be successfully subcontracted to commercial woodworking firms and thus present few problems. Sheet metal assemblies and details may be successfully subcontracted either to other aircraft manufacturers or to commercial industries which produce similar articles. When parts or components of this type are sublet, the subcontractor must possess experience and equipment which are readily adaptable to their manufacture, after a minimum of instruction; this shortens the development period and assures the success of the undertaking. As there is a relatively small amount of suitable commercial capacity available, this type of work can not be subcontracted as extensively or as successfully as machined parts.

It would be of great assistance to the aircraft industry if suitable sources were available for subcontract work; this is not the case and each manufacturer usually finds that he must undertake the development of his subcontractors in exactly the same way as he developed his sources of raw material, i.e. by personal contact and close supervision of the progress made. An ideal situation would exist if subcontractors could accept orders, drawings and relevant data from the main contractor and then proceed to buy material, develop tools and methods and finally to deliver the parts ordered on the dates specified. This is impossible at present as subcontractors are generally inexperienced with the materials and manufacturing processes required, have not the same access to markets or priorities as the main contractor and do not realize fully their responsibilities to the main programme. Thus the manufacturer must supervise and control all operations and usually must train the subcontractor in fundamental aircraft shop practice; in addition he must supply all material, special tools and manufacturing data and the first parts submitted must be checked very carefully before allowing production to proceed. This is slow and laborious for the manufacturer but when the development period has been completed, the subcontractor usually gives complete satisfaction.

In the case of machined parts these requirements may be relaxed if the subcontractor has sufficient experience, but sheet metal parts and assemblies will always require close attention. If an experienced subcontractor is capable of making and cross-referencing tools and detail parts and can manufacture a complete assembly, the problem is eased considerably as a check need be made only on the assembly and not on its component parts.

It is indispensable that manufacturers and subcontractors realize their mutual obligations. The manufacturer must give all help necessary and must allow a reasonable time before requesting deliveries and during this time he must continue to supply his own needs. This allows the subcontractor to develop his work properly, free from pressure for early deliveries. The subcontractor must realize that all assembly sequences are stopped when one part is lacking; if a promise for delivery of a part is broken, the manufacturer is forced to enter production on it at extremely short notice and often cannot avoid delay. when this happens material must be procured, often tools must be built, and the most expensive manufacturing methods must be employed in an effort to break the jam. This is particularly dangerous in the case of machined parts as they are more difficult to make and often the manufacturers' machine tools are working at full capacity on tooling or some other urgent programme. The danger of delaying the assembly line may usually be avoided if the subcontractor realizes his inability to meet his promise and issues a warning at least one week previous to the delivery date.

It is estimated that at least twenty-five per cent of the total production time may be subcontracted efficiently; thus the successful development and co-ordination of subcontractors is seen to be of vital importance to the expanding industry. The final stage in the development of present subcontractors will be reached in a few months and it would be of great assistance to the industry if an independent agency could be set up to co-ordinate their activities with those of the aircraft manufacturers.

Organization

The problems which have been discussed affect the industry externally but there are two major internal problems which are basically similar in all industries, i.e. departmental organization and manufacture.

There are two groups of departments, one directly, the other indirectly, responsible for the success of the manufacturing programme. The latter group includes the engineering, purchasing and costing departments, which have contact with production problems concerning the development of subcontractors and sources of material. For this reason no direct reference will be made to their responsibilities. The other group includes the inspection, stores, shop and production departments.

The British Air Commission supervises all activities of the inspection department, holding it responsible for seeing that the finished aircraft conforms to drawings in all respects; that standard manufacturing procedures are used and that proper standards of workmanship are maintained. The stores department is divided into two sections,—" finished parts " and " raw material " stores. In the first are received, stored, and issued parts made by the shop and subcontractors; in the second raw material and proprietary parts are received, stored, and issued for fabrication.

The inspection department supervises this department to prevent the issue of improper material and keeps a full set of records on the origin of all materials; in this way parts made from defective material may be traced and replaced.

The shop is primarily responsible for the manufacture and assembly of detail parts into the finished aircraft; secondary responsibilities are the maintenance of discipline and the education of new personnel. There are about thirty departments in most aircraft shops which are classified as detail, processing or assembly departments according to their functions. The detail and assembly departments each comprise about forty-five per cent of the total labour staff, the balance being required for processing departments. The shop is responsible to the inspection department for the standard of workmanship and to the production department for the completion of work on schedule.

The function of the production department is to co-ordinate the activities of the departments directly concerned with production problems, thus it is directly responsible for the success of the manufacturing programme. The project must be planned properly and effective control must be set up to secure this co-ordination. The first of these duties is performed by the planning department which plans the work in all its details and lays the foundation for the production programme; the second is done by the control department which sets the programme in motion and sees that it moves according to schedule.

The planning department has much to do before the project can be placed in production. Preliminary time study estimates and recommendations for necessary changes in personnel, equipment, etc. must be made; detail and master bills of material must be prepared for the use of the shop and purchasing departments; production methods and times must be investigated from which tool designs and department loadings are developed and production schedules are set. The tooling programme and construction of the first aircraft are very closely supervised by this department as they are developments from the primary responsibilities outlined above.

The control department is responsible for the control of material, despatching and recording production orders, routing parts through the various steps in their manufacture, for supervising the progress made and correcting it if necessary. The material control division supervises the distribution of all material and is responsible for the detection of impending shortages. When shortages are foreseen the purchasing department is urged to obtain more material; if the correct specification is unavailable, this group requests the British Air Commission to permit the use of a substitute. Present market conditions prevent the maintenance of satisfactory inventories on some items and under these circumstances effective material control is of vital importance.

Orders for the fabrication and assembly of detail parts are issued to the shop in accordance with the schedule laid down by the planning department. An even flow of orders and work through the shop is necessary for rapid and efficient production. Conditions such as material shortages, incorrect tools or improper department loadings must not exist, as they will impede this flow and cause a loss of control. The progress division routes all parts along their fixed paths from primary fabricating departments, through processing departments and inspection view-rooms to the department which requires them next. If this flow is delayed the progress division must take any corrective action necessary; they may request the use of new or additional tools, enlargement of the department, overtime work, or completion of shortages elsewhere in order that the work may proceed.

The control department is the one most directly affected by the various production problems described and is responsible for the progress made; for this reason it is the central and most important division of the organization. Problems of control arise from the design and are so numerous and complex that it is exceedingly difficult to maintain co-ordination. In spite of continuous efforts, serious conditions often develop and occasionally the control system fails completely; when this happens shortages are found to exist only at the instant the items are required. As any missing part can stop assembly operations completely, this will delay the whole programme; the prime duty of the control department under these circumstances is to ascertain and remove the cause of the delay as quickly as possible without consideration of cost.

Manufacturing Problems

During the development stage, and later when the programme has reached quantity production, the manufacturer is confronted with numerous problems arising from the basic design, the pressure of time under which the work must be completed and the relatively small quantities of aircraft he is allowed to produce. The period for developing a new contract does not end when the first machine flies; many refinements must be made in tooling, production methods, etc., before production " bugs " can be eliminated and full scale production can be entered. About twenty-five aircraft must be completed before this stage may be considered complete; the programme for the " Hawker " Hurricane required about fifteen months and an expenditure of about one million man-hours on tools and parts before the start of quantity production. Due to the dire need for aircraft and their rapid obsolescence, the pressure of time places tremendous obstacles in the way of the successful co-ordination and completion of the development and production programmes.

The first limitations on cost and ease of production are caused by design but nearly as important are those imposed by the quantity to be produced.

Many manufacturing problems are caused by the smallness of the orders placed, which prevents the use of equipment, methods and tools which would allow cheaper and faster production. It has been estimated that unit production costs are decreased by ten per cent each time the quantity to be produced is doubled. This saving is due to the combined effects of being able to use more efficient equipment and manufacturing methods which allow cheaper, faster and more continuous production; and simpler design methods which change forms of material and types of construction to ease production without affecting performance.

In the past, initial contracts usually have been placed for about fifty or one hundred aircraft. On this basis development and production were undertaken, tools and equipment purchased and methods set up to allow economical operation. When the programmes were nearly completed, they were usually extended by placing additional small orders. This necessitated the purchase or manufacture of many new tools, as the old ones were worn out or had to be replaced with different types to maintain economy of production; new methods had to be developed and often additional space had to be procured. This caused duplication of effort, wasted much money originally expended, lost precious time, and, most important, did not allow the manufacturer to set up the best conditions for his programme.

The importance of placing larger contracts may be demonstrated by comparing the estimated results to be obtained from producing an interceptor-type aircraft on contracts for forty and for fifteen hundred. Development of the former could be completed within ten months and production would be complete in another six months; the highest rate of production would be about four per week and production of the last few aircraft would require approximately twenty thousand man-hours. In the latter case, development could not be completed and the first machine flown in less than fourteen months; the programme would require another fourteen months for completion; the highest rate of production would probably exceed sixty per week and production time would drop to less than ten thousand man-hours per aircraft in the latter stages of the programme. Thus an increase of forty times in the size of the contract would reduce the productive effort by fifty per cent, would allow an increase of fifteen times in rate of output while requiring only twice as much elapsed time. The objections to placing much larger orders are that the Canadian aircraft industry has only recently proved its ability to handle such difficult tasks; the extremely high cost of these larger contracts; and the rapid obsolescence of all military aircraft. Under the present dire need for aircraft of all types, these objections are not as important as high rates of production and hence it is felt that the placing of larger contracts should be seriously considered.

It is often recommended that mass production methods be applied to a greater degree in the aircraft industry; for various reasons it has been found impossible to effect any considerable increase in efficiency by these means. Mass production achieves rapid and cheap production by establishing continuous manufacturing operations and material flow; this continuity is prevented by the complexity of aircraft design, which does not favour easy production. Further, the necessity of maintaining economical operation often requires inefficient fabricating methods and prevents the full development of interchangeability.

Conclusion

The more serious aircraft production problems have been presented so that secondary industries may appreciate these difficulties and thus give greater assistance. It has been shown that solutions of most of these do not fall directly within the scope of the manufacturer and require assistance from outside sources. Designers are striving for greater standardization but find it impossible to obtain this while present methods of construction are used and performance is held to be of first importance. Labour supply and organization problems are made more difficult by the design but are not impossible to solve. Sources of supply and subcontract capacities require coordination and further development if the industry is to continue to expand; as previously stated, an independent organization should be set up for this purpose. Manufacturing problems will always be serious particularly under the pressure of time but would be eased considerably if new methods and equipment were made possible either by the adoption of new methods of construction or the production of much larger quantities of present types.

SALT, ITS PRODUCTION AND USES

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The common salt to which we are accustomed, is almost pure sodium chloride. It is the modern, cheap, form of a substance that has not always been readily obtainable, and at times, in some places, has had high intrinsic value. It is so necessary to our lives that it has been closely linked with the history of mankind.

Salt is as old as the earth itself and being water soluble, every stream has, for thousands of centuries, carried its small burden of salt to the ocean. Thus, with evaporation of the water, the saltness of the ocean has gradually increased. It has been estimated that the ocean contains as rock salt, nearly 5 million cubic miles, a bulk 14½ times that of the continent of Europe above high water.

However, there are stores of salt, apart from the ocean. These are the deposits of rock salt and of brine found in many parts of the world, usually quite deep in the earth. The rock salt, or halite as it is known to geologists, is believed to have been deposited from the ocean by evaporation. Large arms of the sea became cut off or partially cut off from the main body and by evaporation, the salt content was deposited. The overlying rock in later ages converted this by pressure into rock salt. If quite pure, it is a clear colourless mineral which breaks into cubical pieces. Usually magnesium and calcium compounds exist as impurities. The thickness of these deposits may be up to two or three thousand feet.

Locally, one bed of the deposit is about 230 ft. thick. This is at a depth of 1400 ft. Thinner beds are located up to the 1000 ft. level. This deposit is part of a vast salt basin formed, it is believed, about 350 million years ago. The Canadian portion of this, roughly, is west of a line between St. Thomas and Kincardine and north of a line between St. Thomas and Amherstburg. The area in this boundary is approximately 3000 square miles so the included quantity of salt has been estimated as sufficient to supply all the needs of the world at the present rate of consumption for 90,000 years. One square mile of the thickest local bed would satisfy all Canada's requirements as at present, for about 800 years. On the Michigan side of the river, this formation is north of a line running west of Wyandotte to Kalamazoo where it turns north west to Muskegon on the shore of Lake Michigan. Thus all northern Michigan is believed to be underlain with salt though at a greater depth than on the Canadian side.

Ages after the salt deposits were formed, when man found a need for salt, he only knew of the ocean, salt lakes and springs. To many inland peoples then, salt was almost unattainable. Therefore, a salt trade was built up and this early had its effect on trade routes and commerce. Desert caravan routes were built up from salt oases. Some ancient sea trade routes started with salt and salt fish. A special road was built by the Romans for salt traffic. This was the Via Salarina from the mouth of the Tiber across the peninsula to the Adriatic.

The economic importance of salt is indicated by the almost universal prevalence in ancient and medieval times and even to the present day in some countries, of salt taxes and government monopolies. In parts of Africa, salt cakes have been used as currency. Marco Polo found that salt was a medium of exchange in Chinese markets and that salt was very important to the financial system of the Mongol emperors.

Because of its necessity, scarcity and properties, salt had its effect on customs and religions. Salt springs were looked upon as a gift of the gods. Salt was early associated with religious offerings and feasts and in this regard, is noted in the Bible. In fact, among ancients, every meal that contained salt was held to have a sacred character so that a certain bond of piety and friendship was believed to exist between host and guest. Out of this arose certain Arab beliefs and phrases such as "There is salt between us" and "To eat a man's salt." Probably an outgrowth of this was the medieval English custom of distinguishing the rank of guests at the table by placing them above or below the salt, this being a large salt cellar on the table. To be above the salt was a mark of distinction and to pass the salt in those days was really an accomplishment.

Our word "salary" comes from the practice in early Roman times of giving the soldiers an allowance of salt. In Imperial times, money was given for this and was called "salarium", hence the word "salary". The phrase "Not worth his salt" therefore means "not worth his salary."

The natural method of salt recovery using sea water, was to evaporate the brine in shallow pools by the heat of the sun. An extension of this method is still employed today in sections having plenty of sunshine and relatively little rainfall. Salt is produced in this way on the shores of San Francisco Bay.

The sea water is first pumped to ponds a few hundred acres in extent where over the period of a year, the evaporation is sufficient to raise the proportion of salt to about 25 per cent., which is about the saturation point. Some impurities, as calcium sulphate, have a slightly lower degree of solubility than the sodium chloride and so most of this crystallizes out. When salt crystals commence to form, the brine is pumped to smaller crystallization ponds. As evaporation goes on, the salt collects to the depth of several inches. The mother liquor is drained off before more highly soluble impurities as calcium or magnesium chlorides or some bromine and potassium salts crystallize out. The salt is then gathered up or "harvested" by shovelling into small dump cars. A more modern method uses a machine to collect the salt and place it in the modern cars. The resulting salt is then drained, washed, and dried, but usually is not of high enough quality for dairy and table use so that often, for this market, it is re-dissolved and re-processed by artificial heat methods.

Another natural method of concentrating weak brines is the freezing method. This is based on the definite manner in which a solution of sodium chloride freezes. If a solution of 23.6 per cent. NaCl and 76.4 per cent. H_2O is cooled, it will freeze as a mass at -22 deg. C. If the solution is weaker than this, ice will crystallize out and continue to do so until the proportions are as noted before. If the salt were in excess of this ratio, its hydrate $NaCl\,2\,H_2O$ would be deposited until equilibrium had been reached. The whole mass would then solidify. This minimum temperature then is a eutectic point above which either salt or water will crystallize out, depending upon which is present in excess of the eutectic ratio. Thus, with a weak brine, the separation of pure ice takes place because the water is in excess and the remaining solution will be correspondingly stronger in sodium chloride.

This method is said to be practised with some degree of success in the northern part of Europe, the ice being removed as fast as it forms. The saturated solution thus obtained is then treated by one of the artificial heat methods of evaporation.

Where it is possible, beds of rock salt may be quarried or mined and this has been done for centuries. Salt mines in northern India were worked before the time of Alexander. In Poland, the great deposits near Cracow have been mined for 800 years. This is the famous mine which contains fine sculptured statues, vast ballrooms, reception halls, chapels, etc., carved out of rock salt. The depth of operations is from 200 to 1000 ft. In Canada, the only salt mine is at Malagash, Nova Scotia, where operations are 200 to 300 ft. below the surface. Nearer at hand, we have a mine in Detroit, which goes to a depth of over 1100 ft.

In mining, the process is one of removal of the rock salt by cutting and blasting and transporting it to the surface. Impurities are usually kept separate as much as possible, and the rock finally crushed and screened to different grades. Often, an artificial heat evaporation plant is operated to take care of fines and waste from the primary hand separation.

By far the largest output of salt is from brine wells. These may tap natural stores of brine or fresh water may be pumped down to dissolve rock salt and be returned to the surface as a saturated brine. Occasionally, a fresh water source tapped by the well at a higher level than the salt can be made to act as a fresh water supply.

The wells are drilled and cased to penetrate to the bottom of the bed. The fresh water is pumped down the casing and the resulting brine flows back up a smaller pipe inside the casing. Owing to the higher specific gravity of the brine, it may be necessary to use deep well pumps to raise it about ⅛ of the well depth. It is possible, after continued use of adjacent wells, to pump the water down one well and bring the brine up another.

The fresh brine is stored in large tanks to settle and is chemically treated to precipitate the impurities.

As another method of producing salt from brine, obviously man early would make use of artificial heat applied to vessels containing brine. This probably was first a kettle over an open fire but later was a flat pan over a fire enclosed in masonry. Then several pans in a row were used. As the salt formed, it was raked out by hand and placed in baskets to drain.

It is interesting to read of the specific directions given for salt making in the few works on the subject some 400 years ago in England. Such things were added to the hot brine as sheep's and cow's blood, beaten white of eggs, or a quart of the best beer or ale obtainable. The object of these peculiar additions seems to have been to remove dirt or, as they believed, " to granulate the salt ".

Of course, the salt from these direct fired pans was not uniform in grade owing to the differences in heat applied to each and therefore they were finally replaced by a single long pan. This somewhat improved the quality obtainable.

It was a short step, though a relatively recent one, to heat a long pan with steam coils and create the method of production now known as the grainer system. Generally, this uses a steel tank over 100 ft. long, about 16 ft. wide and 2 ft. deep, heated by steam coils near the bottom. By regulating the steam temperature, it is possible to control the grade of salt produced, thus better salt is produced with brine at 192 deg. F. and coarse salt at 175 deg. F.

The salt is removed by a continuous endless chain drag or a reciprocating rake. The latter has the advantage that it is not so exposed to the air to create rust. It is operated by a hydraulic cylinder at one end of the grainer and on the forward stroke pushes the salt ahead along the bottom but on the return stroke it rides above the salt. Thus, the salt is gradually and continuously pushed to one end of the grainer where it falls to a trough to be pumped to a filter.

As salt production is an evaporating process, it is natural that multiple effect evaporators should be widely used though their application is relatively recent. In this use, the evaporators are referred to as pans, though they in no way resemble an object we would recognize by the word " pan ". They are cylindrical at the centre with conical tops and bottoms. The diameter may be 18 ft. and the overall height about 40 ft. At the centre is the steam belt which contains tubes around which either the brine or steam circulates, depending on the design. The pans are connected in series so that the steam produced in one, passes to the steam belt of the next or from the last one to the condenser. The salt collects in the conical bottoms where it is drawn off by a slurry pump.

The principle of operation is the same as in similar evaporators in that a partial vacuum is created by the condensation of the evaporated steam and because of this reduced pressure boiling takes place at a lower temperature than normal. Then by the use of multiple effects, the steam supplied to the first pan precipitates salt in all the pans; thus the system is very efficient. The three-effect system is most popular and with this, it is possible to evaporate over 2½ lb. of water per lb. of low pressure steam supplied. The salt produced has a fine cubical grain that is little different in size due to the different temperatures. Three 18-ft. pans will produce about 22 tons of salt per hour.

The salt from both pans and grainers is usually handled in the same way. Pumps are used to transfer the salt in a brine slurry to a filter or centrifuge where the salt is separated from the brine. A centrifuge is simply a high speed rotating screen cylinder that removes the brine by centrifugal action. This leaves two or three per cent. of moisture in the salt. The filter is usually a slowly rotating horizontal screen cylinder on which the slurry is poured at the top. An exhauster removes the air and brine from the interior of the filter, thus forming a cake of salt on the screen. This is scraped off during the rotation. By enclosing the filter and supplying it with heated air, it is possible to produce moisture-free salt on the one machine. Otherwise, it is necessary to send the moist salt through a rotary dryer. This is merely a rotating cylinder about 30 ft. long and 6 ft. in diameter through which the damp salt passes counter to the direction of flow of hot air from steam coils or an oil furnace. This will remove the last traces of moisture. The hot salt must be cooled either in a similar device supplied with cold air or a water jacketted screw conveyor.

The salt is easily handled by belt, bucket, or screw conveyors and it is thus transported to storage or where required. For grading it is screened to different sizes and stored in special bins. Before packaging any required ingredients are added such as magnesium carbonate which makes the salt free running in damp weather or potassium iodide which is used in iodized salt. The former is added to the extent of 1 per cent. and the latter 0.01 per cent. Automatic machines are used for packaging and bagging. Salt blocks are made from ordinary fine salt pressed to shape in a hydraulic press. Salt tablets as used by the canning industry are made in a small mechanical press.

The uses of salt are numerous as it is a basic mineral necessary for modern civilization. Directly, or indirectly, it is said to have some 1400 uses that vary from seasoning of foods to a raw material in the manufacture of carborundum.

There are the household uses and what may be called a medical use as a vehicle for iodine to prevent goitre. It is a necessity of life, for the human body can exist for only a few hours with entire absence of salt. It is required for digestive purposes and also to prevent evaporation of body fluids and retain the fluid pressure in the cells.

For the same reasons, it is required by animals and so salt blocks are sold to farmers for their livestock. It is, of course, very necessary for butter and cheese manufacture so that special grades of specially purified salt are made for these purposes. In other food industries it is also required. For canning factories, special salt tablets of different sizes are made so that for accurate and easy salting of the product, one tablet is placed in each can by a machine.

In the packing industry, it is used for the curing of meats, a special salt for which is "smoked" salt. Hides and pelts are preserved with salt. An extensive use is in the curing of fish, where purity is of great importance as it affects the quality of the product. In refrigeration, it finds considerable use, as brine is often used as a heat transfer medium.

In transportation, salt is finding uses as a protection against frost. For railways, it prevents heaving of the ties and freezing of switches. On highways and streets, it is used to remove ice, for which it is very effective, as, at sleet forming temperatures one pound of salt will melt almost 50 lb. of ice. When mixed with sand, it greatly aids increased traction by partially melting the ice. If previously mixed with the sand piles, it has the advantage of preventing these from freezing. It is mixed at the rate of about 75 lb. per cu. yd. of sand, and the pile is often capped with more salt equal to another 25 lb. per cubic yard.

Salt is coming into use as a stabilizing material for unpaved roads. For this, it is mixed with aggregate and clay which is rolled on top of a good foundation. The thickness of this stabilized course is about three inches and the amount of salt used is about 15 tons per mile of 20 ft. roadway.

The resulting road surface is harder, more durable, and relatively dust free compared with the same road without salt. The reason for this is that the salt tends to prevent evaporation of the moisture from the road due to the lower surface tension of the salt solution, and so keeps the clay binder in a cohesive condition, and allows better compaction of the aggregate at the surface. The slow evaporation of the moisture leaves salt particles, filling voids in the surface, thus making it denser and reducing the evaporation. It also prevents cracks due to contraction of the clay. When it rains, the surface salt crystals are dissolved. The clay at the surface becomes dispersed in colloidal condition and so stops up the pores and prevents the water from penetrating the road. Drying again repeats the coagulation of the clay and crystallizing of the salt. The loss of salt in these processes is slight.

It is in industry that salt finds its greatest use. It has long been used in the metallurgical industries and the ceramic industry. One use in the former is as a flux and in the latter it improves some clays and gives glaze to some wares. Carborundum has salt as one constituent raw material.

Salt is also required in soap making, textile dyeing and some organic preparations. It is also a basic raw material for some of the newer plastics.

POWER INDUSTRY

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An address delivered at the dinner of the Canadian Electrical Association, at Calgary, Alberta, April 16th, 1941.

My subject is the Power Industry and the War. The question is, are we as an industry and as individuals doing our utmost to further the war effort. Our difficulty is to approach such problems objectively. To illustrate this I will give a simple example.

Some years ago the Elbow River in Calgary was in flood. The rising waters had broken into the basement of the Victoria Park power plant in which are situated the bus bars over which a large section of the City is fed. We had bulkheaded off the room containing these bus bars and had every pump we could lay our hands on at work. At the height of our endeavours we got an impassioned appeal from a man connected with the company to send someone with a pump to unwater his cellar. He was pained when we did not comply with his request and could not understand why we had turned him down. His cellar was uppermost in his mind and he was unable to visualize the situation in its true perspective. Most of us to-day are busying ourselves pumping out our own cellars instead of devoting our energies to the common end.

Our politicians, naturally enough, are inclined to take the line of least resistance. Heavy taxation and conscription of manpower are unpopular, so the politician tends to belittle the menace and to magnify our war effort. He lulls us into a false sense of security by wasting huge sums on home defence, whereas our future will be decided in Europe or in the Far East. Only a military disaster can bring us to our senses. It took Norway to oust the procrastinators.

Let us not underestimate our opponent. Vast resources in manpower and in factories have been made available to him in the conquered countries. The new sources of raw material lessen the effectiveness of our blockade. Germany's power has not yet reached its zenith.

To avoid a stalemate we must organize for a total war. To this end we must devote the utmost of our energies to the war effort and more important still we must see that these energies are applied with maximum effort. We are told that the St. Lawrence Waterway will aid the war effort but actually a man's services flying a bomber over Germany are infinitely more valuable in the defence of our country than those same services used in building the St. Lawrence canal.

We must recognize that our economic morale has been sadly undermined through the infiltration of communist ideas over past years. Constant reiteration has resulted in an unreasoning belief in many of these teachings. I refer particularly to the "soak the rich" view so prevalent today, the baiting of corporations and the idea held by so many Canadians that there is something unmoral about the "profit motive." The demagogue finds them the very thing to rouse the jealousies of the "have nots." Already such propaganda has resulted in discriminatory taxation and other abuses which, if carried to their logical conclusion, would result in a collapse like that of France. To get everybody working wholeheartedly it is indispensable that all be treated alike, each according to his merits, whether at the front on active service or at home in the munitions plant, and that the necessarily heavy taxes be levied justly and impartially.

As regards the despised profit motive we must recognize that it alone provides the necessary incentive to the individual to do his utmost and rugged individualism suitably curbed spells efficiency. In this connection the Mexican Government, when the oil trouble was at its height several years ago, suggested that the oil operators form themselves into a syndicate similar to the labour syndicates. The representative of one of the operators remarked to me that if you were to put the seventeen operators in a room together you could not get any two of them to agree on anything, let alone the whole seventeen. That is where the politician comes in because he has mastered the technique of getting people to work together. What we need in the Ministry of Finance to-day is a Sir Herbert Holt to do the planning and a politician co-operating with him to put it over with the public. I use Sir Herbert Holt as an illustration because he, probably more than any other single man in Canada, is responsible for our present high standard of living. In his promotional activities he made money but only a small part of it was diverted to his own needs. The balance went either into taxes or into further enterprises. These in turn provided employment and more manufactured goods to raise the standard of living. Only the wealthy should invest their money in the riskier ventures and it is to their savings that we owe most of our progress. The "soak the rich" policy may be good politics but it is bad economics. Let us be fair to the Sir Herbert Holts. We need them to-day in our war effort, and fortunately one at least of the Government departments recognizes this—the Department of Munitions and Supply.

Aiming at the destruction of private capital, propaganda has been directed towards exterminating companies through confiscatory taxation, oppressive legislation and unfair competition from governmental agencies. The Canadian public has been only too ready to believe the worst of companies and not without reason in some cases. In England the law makers have recognized the service rendered by companies in the development of the community and companies as such are virtually untaxed, but in Canada, following American precedent, corporate income is taxed as such, and the very same income is taxed again when it passes to the shareholders, whereas in England the income is taxed only once and the tax is collected at the source. Companies after all are merely groups of individuals banded together for a common purpose and it is a manifest injustice to tax the individuals twice over merely because they are so banded together.

So long as the tax was low and was confined to the Dominion this injustice was not very harmful, but with the Provinces invading the field and with the high rates of taxation necessary for war purposes the double taxation becomes devastating. It results in the confiscation of the entire income of certain groups of investors while leaving the income of other groups untouched. Consider the case of a company financed in the ordinary way with bonds, preferred stock and common stock. The minimum Dominion tax on income is 30 per cent including 12 per cent of so called excess profits tax, and it applies on all income after deducting operating expenses, depreciation and interest but not amortization of bond discount or preferred or common dividends. So long as there is enough income left after setting up this amortization to pay the preferred dividends in full the entire tax comes off the income available for the common shareholders. As Dominion and Provincial taxes on income now absorb nearly half the taxable income it becomes next to impossible to pay common dividends in a company with any substantial amount of preferred stock outstanding. Thus, as the rate of tax is increased, the value of the common stock and the value of the preferred stock are in turn destroyed. Apart from the obvious injustice of the double taxation, the junior security holders, whose equity is thus confiscated, are the very ones who take the most risk and who in the interests of further development of the country should receive the most encouragement. The promotion of new enterprises will become impossible and unless the companies can pass the tax on to the consumers in inflated prices, they will become so weakened financially that they can no longer finance the replacement of wornout plant and so will pass out of the picture. To avoid state capitalism our income tax will have to be placed on a sound basis.

One evil arising out of the high income and excess profits taxes is that the Government in contrast to the last war is forced to put up nearly all of the money needed for new plants or extensions to existing plants to make munitions. Were the companies using their own money it would no doubt be spent with greater prudence, but with the profit motive effectively eliminated by the excess profits tax, companies dare not risk capital except with an assured return. Whether after the war these munitions plants will be closed down or will be sold to private companies for a song or will be operated by the Government in competition with private industry remains to be seen, but of one thing we can be sure and that is that had the companies invested their own money in the plants they would not leave a stone unturned to put them to some use.

In contrast to this practice the Government has taken the position, rightly I think, that the supply of power for war industries is the sole responsibility of the public utility operating in the territory. With only two minor exceptions, in so far as I know, the utilities are themselves putting up all the capital necessary other than in some cases the relatively small amount required for the customer's substation and tap. These two exceptions are the Summerside air training school where the Dominion Government provided the town of Summerside with a Diesel engine, and the Dundurn military camp where the Government advanced a substantial sum to the Saskatchewan Power Commission to enable it to carry out an elaborate interconnection scheme, the effect of which is to deprive of income two power companies who are heavy income tax payers.

Not only does the Government insist on the power companies providing any capital required but it expects service at rates comparable to those applicable to firm contracts yielding an assured revenue for a considerable period of years. Industrial rates such as these are highly competitive and do not admit of any substantial amount being applied by way of depreciation to the retirement of capital used for war purposes. Thus power companies, unlike most industries, cannot take advantage to any extent of the provision of the excess profits tax act allowing special rates of depreciation on war facilities. To make matters worse, the excess profits tax precludes the building up of a surplus out of war profits with which to pay the carrying charges on the idle facilities through a post war depression. Any increase in taxable income would almost surely be taxable at the rate of 79½ per cent (including income tax) and when provincial income taxes are added only a trifling sum is left as compared with the financial risks involved. The power companies recognize that a major war means sacrifice for all and they are ready to do their share. All they ask is that existing discrimination be eliminated and that taxes be levied justly and impartially.

This brings up the tax discrimination existing as between privately and publicly owned utilities. This year the power companies will contribute some twenty million dollars to the Federal treasury in income and excess profits tax, whereas the publicly owned utilities pay nothing except indirectly through any power they may happen to purchase from power companies. Were all taxed alike in proportion to the number of customers the Dominion would receive another twenty million dollars at least in this time of need. This is equivalent to a thousand Spitfires a year. To maintain a sound financial position and be able to finance the expanding needs of the public they serve, the power companies have to pass on the tax to their consumers, so that it is the consumers of the privately owned systems who are being discriminated against. The increase in taxation will for the moment have to be absorbed by the power companies but should the high rates of taxation continue it is only a question of time until the disparity in rates becomes excessive or the high standards of service can no longer be maintained. The power companies are not the only ones that are the victims of this discrimination. It applies to all situations where government agencies, wheat pools, co-operatives, etc., compete with private business. While it is recognized that socialistic propaganda has made too much headway for it to be expedient for the Government to subject these to equivalent taxation, the Government could right matters at one stroke by adopting the English system of income tax. The difficulties are not insurmountable and under war conditions rates could be instituted that would yield more tax revenue than now.

As far as the power companies are concerned the public need have no fear of a power shortage. It is only in the electro-metallurgical industry that very large blocks of power are required and so far only three or four of these situations have developed in the whole of Canada. It would be an undue burden on the consuming public for the power companies to maintain reserves of developed power against such remote contingencies. It is better to build power plants specially when the occasion arises. The reserves normally carried by power companies are adequate to cover any ordinary war load as well as the normal increase in customers requirements.

Before turning to what we in our business should do or avoid doing in order to further the war effort, we should realize just what is involved in a war economy. In a highly mechanized country like Canada the supply of manpower normally far exceeds the demand, but under war conditions this no longer holds, and we are rapidly moving into the position where manpower will be the bottleneck limiting our war effort. This means that governments, companies and individuals alike will have to scrimp and save, that the pick of our manhood will have to be released for active service from non essential industries, from agriculture, from the civil service, from commerce, from the so called essential services and even from the munitions industry itself. Where their jobs cannot be eliminated altogether their places will have to be filled by others less fit physically and by women. Every thing we can do without will have to be deferred until after the war.

Money is only a medium whereby goods and resources can be readily exchanged, but the underlying transactions are fundamentally barter. Whenever we make a purchase, we, in a varying degree depending upon its nature, draw on the country's resources in raw materials and manpower, which would otherwise have been available for war purposes, and we must accustom ourselves to thinking not in terms of money but in terms of the use or misuse we are making of these resources. When we build ourselves or somebody else a house we draw heavily on these resources and unless the house is urgently required for housing munition workers we are sabotaging the war effort. If we buy a house, however, it is merely a transfer of a capital asset and the war effort is not affected. We make no contribution whatever to the war effort when we borrow money to buy war bonds or sell other securities for this purpose, as the man we borrow from or sell to could just as well have bought the war bonds himself. *It is the savings that count* and the more we can reduce our current expenditures on such items as involve the use of our manpower or our industrial resources that would otherwise be available for war purpose the better it is for the war effort. It matters not whether these savings are used for the purchase of war bonds or are put in the savings bank or are paid out in life insurance premiums or are used to buy company securities, the money and the use of manpower and industrial facilities it commands are available to the Government just the same.

It may be argued that in the cutting down of our purchases we will throw a large number of men out of employment. This is so to a certain extent but wars cannot be won without somebody getting hurt, and drastic measures are necessary to force men to abandon their accustomed line of activity and enter war work. For example, the prairie farmer in the drought area is clinging desperately to his homestead. A war economy with the majority of the people engaged in war activities means far reaching readjustment. So long as men are required for the Army, the Navy, the Airforce and the munition industry all activities not directly or indirectly connected with the war should be cut to the limit regardless of the temporary unemployment this may create. This applies particularly to civil government which is one of the greatest sources of waste to-day. As yet none of our governments has made a serious effort to retrench.

A war brings about a far reaching redistribution of income. The few in the higher income brackets have their incomes drastically reduced but the great majority are far better off. Many work overtime, those that were casually employed work full time, and such of the unemployed as are employable can find work. Those who for years have been in straightened circumstances, break out in a spending rash as soon as they have some loose cash, and it is not the necessities of life that they buy but the luxuries. Worst of all, they mortgage their income by purchasing automobiles, radios, etc., on the instalment plan. This by creating activity in the non-essential industries diverts manpower and foreign exchange from our war effort. Thus, our war effort tends to defeat itself. Somehow or other *we must combine high industrial activity with a low standard of living for all.* The workers must reconcile themselves in the national interest to deferring the reward of their labours till after the war; that is, they must save till it hurts while the war lasts. When it is over the spending of these savings will create work and so avert a post war depression. With our production capacity greatly incresaed as a result of the war, we have the means of creating much better living conditions for those in the lower income brackets. We all should recognize that it would be a happier world if the great majority could be converted into capitalists as a result of the war. Compulsory saving along the Maynard Keynes plan as now being introduced in England would appear to be the answer.

The implications of this as applied to the power business are far reaching and not very palatable. As the war economy develops we likewise in our expenditures on capital and operating will have to be frugal in the use of manpower and industrial resources. Our revenues will be up and the temptation will be to spend it as fast as it comes in, particularly as our tax laws offer little incentive to thrift. Our aim should be to carry on our operations with the very minimum drain on the country's industrial resources and on manpower, except of course where power for war purposes is required. In the war interest we will have to taper off our promotional and load building activities, to defer maintenance wherever possible, to discourage new connections and to make fuller use of existing facilities at the sacrifice of the quality of the service rendered the public.

Our sphere of influence extends beyond our direct operations and we should make the most of it in aiding the war effort. We can induce our employees to save. It may soon be unpatriotic to encourage extravagant purchasing by customers. We may then have to eliminate time payments; stock only a limited range of "stripped" models and no knick-knacks. In our own purchasing we can standardize the articles we buy and do without the many gadgets that the manufacturers have developed to serve as selling points for their particular products. At least half the number of types and sizes of insulators, pole line hardware, transformers, etc., that are now being manufactured could be dispensed with without any hardship to any one; probably three quarters of these could be spared if we are willing to put up with some inconvenience.

If we could overcome the jealousies of rival manufacturers we might have one size of transformer made in one plant and another size in another. This getting down to the minimum number of stripped war models is a matter that might well be taken up by the Canadian Electrical Association in conjunction with the publicly owned utilities. If approached in a broad way our efforts should result in a great reduction in our demands on manpower and industrial facilities and so we might avoid the imposition of war priorities on our every day requirements with its consequent hampering of our operations. War priorities and control may speed up the production of certain articles but it is at the expense of production as a whole. Our aim should be to simplify our needs, and we should be broad enough not to chisel the manufacturer in the process. We will be far better off if we can anticipate changes before they are forced upon us.

We should recognize that this is one war that we cannot be half in and half out of. Governments, companies and individuals alike will have to scrimp and save. Companies and individuals will not flinch from the heavy taxation indispensable to victory so long as the taxation is just and impartial and the proceeds are used solely for *bona fide* war purposes.

STRESSES IN DRILL STEEL

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The following analysis was made of the theoretical magnitude of stresses that occur in a length of drill steel during the drilling process, in order to investigate the possibility of decreasing the stress below the fatigue limit of the steel or raising the fatigue limit of the steel (by heat treatment or the addition of alloys) above the value of stresses encountered.

In operation, the drill steel is given a series of blows in rapid succession by the action of a piston in the air drill. At each blow, the cutting edge of the steel advances approximately 1/20 in. into the rock, a distance varying of course with the hardness of the rock and the sharpness of the bit. If the energy of the blow is considered as compressing the steel like a spring between the rock face and the piston or anvil block in the drill, the stress in the steel is found to be comparatively small. Actually, all parts of the steel are not stressed to the same degree at the same time, but, instead, a wave of stress travels back and forth along the steel with the velocity of sound, the stress at any point being at times much greater than the resultant stress would be if the piston energy were absorbed slowly by the steel.

Fig. 1—Curve showing variation, with respect to time, of stress at shank end for a 5′, 1″ quarter octagon rod and 80 ft. lb. blow.

On account of the small movement of the bit end, the actual condition in the steel is somewhere between that of a free rod being struck longitudinally on the end, and a rod with one end fixed being struck on the other end. The fixed end rod approaches more nearly the actual conditions and produces the higher stress and so is considered here; but it should be mentioned that as regards fatigue there is not as big a difference between the two cases as might be imagined since in the free rod almost complete reversals of stresses are encountered. The fatigue limit for a stress ranging from zero to maximum in the same direction is approximately 1½ times the fatigue limit for a stress undergoing complete reversal.

The relations between stress and velocity in a rod may be represented by the following partial differential equations:

1. $$\frac{\partial P}{\partial X} = -\rho \frac{\partial v}{\partial t}$$

2. $$\frac{\partial v}{\partial x} = -\frac{1}{E} \cdot \frac{\partial P}{\partial t}$$

Where P = stress
v = velocity
x = distance measured along the rod from bit end
t = time
ρ = density of steel
E = Young's modulus

Solving these equations by means of Heaviside's operational calculus with the proper boundary conditions gives the equations listed below for the stress in the rod:—

Symbols used:

P = stress in rod at point rL—poundals per sq. ft.
V = velocity of mass striking rod—ft. per second
ρ = density of steel in drill rod—lb. per cu. ft.
e = base of Napierian logarithms
c = velocity of sound in steel—ft. per second
m = weight of drill rod, lb.
M = weight of mass striking rod, lb.
L = length of drill rod, ft.
t = time measured from moment of impact, seconds
r = variable from 0 to 1. Point "rL" in rod is measured from bit end.

1. When $0 < t < \frac{L - rL}{c}$

$P = 0$

2. When $\frac{L - rL}{c} < t < \frac{L + rL}{c}$

$$P = V\rho c \cdot e^{-\frac{m}{M}\frac{c}{L}\left(t - \frac{L - rL}{c}\right)}$$

This is a maximum when t is a minimum, or

P max. $= V\rho c$

3. When $\frac{L + rL}{c} < t < \frac{3L - rL}{c}$

$$P = V\rho\, c. \left[e^{-\frac{m}{M}\frac{c}{L}\left(t - \frac{L-rL}{c}\right)} + e^{-\frac{m}{M}\frac{c}{M}\left(t - \frac{L+rL}{c}\right)} \right]$$

and P max. $= V\rho c \left(1 + e^{-2\frac{rm}{M}} \right)$

4. When $\frac{3L - rL}{c} < t < \frac{3L + rL}{c}$

$$P = V\rho\, c \left[e^{-\frac{m}{M}\frac{c}{L}\left(t - \frac{L-rL}{c}\right)} + e^{-\frac{m}{M}\frac{c}{L}\left(t - \frac{L+rL}{c}\right)} + e^{-\frac{m}{M}\frac{c}{L}\left(t - \frac{3L-rL}{c}\right)} - 2\frac{m}{M}\frac{c}{L}\left(t - \frac{3L-rL}{c}\right) . e^{-\frac{m}{M}\frac{c}{L}\left(t - \frac{3L-rL}{c}\right)} \right]$$

or P max. $= Vp\, c \left(1 + e^{\frac{-2m}{M}} + e^{\frac{-2m(1-r)}{M}} \right)$

5. When $\frac{3L + rL}{c} < t < \frac{5L - rL}{c}$

$$P = V\rho\, c \left[e^{-\frac{m}{M}\frac{c}{L}\left(t - \frac{L-rL}{c}\right)} + e^{-\frac{m}{M}\frac{c}{L}\left(t - \frac{L+rL}{c}\right)} + e^{-\frac{m}{M}\frac{c}{L}\left(t - \frac{3L-rL}{c}\right)} - \frac{2m}{M}\frac{c}{L}\left(t - \frac{3L-rL}{c}\right) . e^{-\frac{m}{M}\frac{c}{L}\left(t - \frac{3L-rL}{c}\right)} + e^{-\frac{m}{M}\frac{c}{L}\left(t - \frac{3L+rL}{c}\right)} - \frac{2m}{M}\frac{c}{L}\left(t - \frac{3L+rL.}{c}\right) . e^{-\frac{m}{M}\frac{c}{L}\left(t - \frac{3L+rL}{c}\right)} \right]$$

$$\text{or } P \text{ max.} = V\rho\, c \left[e^{\frac{-2m(1+r)}{M}} + e^{\frac{-2m}{M}} + e^{\frac{-2mr}{M}} - \frac{2mr}{M} . e^{\frac{-2mr}{M}} + 1 \right]$$

For all practical values of $\frac{m}{M}$, that is for all drill rods over 1½ ft. long, it can be shown from the stress equations that the maximum stress is reached during the first three passages of the wave of stress along the drill rod. Figure 1 shows the variation of stress at the shank end with time, while Fig. 2 shows the maximum stress reached at different points along the length of the rod. These curves have been worked out for a 5-ft,. quarter octagon drill steel being struck an 80 ft.-lb. blow with an 8½ lb. piston. In Fig. 1, the negative stress shown does not occur in practice at the shank end as there can be no tension between the end of the steel and the striking body.

It will be seen from the maximum stress curve that the steel should fail from fatigue near the bit or shank end. In a test against a manganese steel plate, the failure would probably take place just behind the bit as the shank heat-treatment usually extends a little further along the steel and raises the fatigue limits in this section. In actual drilling

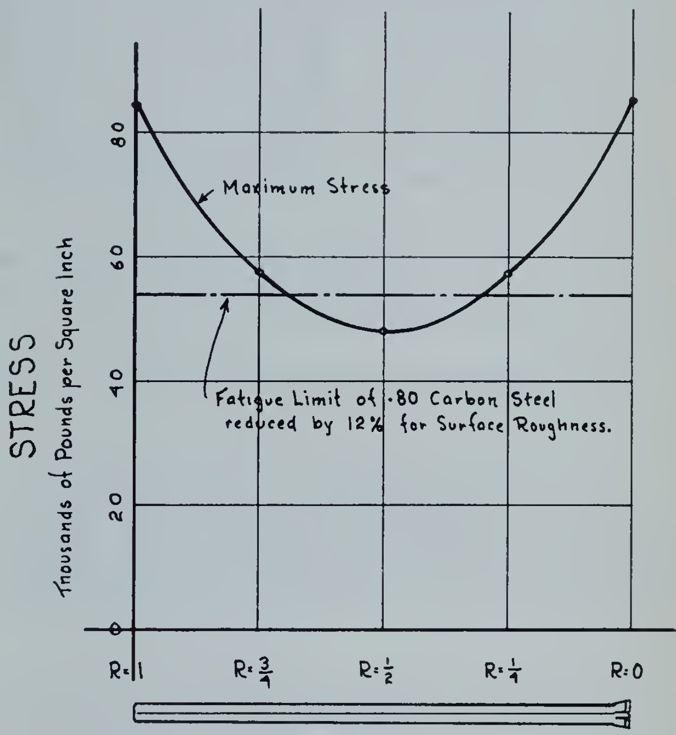

Fig. 2—Curve showing maximum stress in steel for a 5′ 1″ quarter octagon rod and 80 ft. lb. blow.

the breaks should probably be close to the shank end where the steel is unsupported and consequently the compression stress is raised slightly by bending stresses.

The stress equations show that the stresses depend mostly on the velocity with which the rod is struck, since in the expression $V\rho c$, the factors ρ and c are constants and the values of terms of the form $e^{-\frac{m}{M}}$ are very small. A lower striking velocity could be obtained by using lower air pressures, by using a heavier piston or by shortening the piston stroke so that a greater number of blows could be struck with a lower velocity. The advantage of any of these methods would have to be determined by experiment.

ALTERNATIVES FOR ALUMINUM PAINT

JOHN GRIEVE, M.E.I.C.
The Imperial Varnish and Color Company Limited, Toronto, Ontario.

The Government has found it necessary during this war period to control for specific war purposes, the available supply of aluminum. All stocks of aluminum powder are therefore being recorded and the sale of aluminum is restricted to war contracts under priority release.

This action by the Government practically takes aluminum powder, as a paint pigment, off the market for upkeep painting and forces the use of some alternative.

There is a natural and popular inclination towards aluminum as a bright clean wearing finish for up-keep painting, and this has been widely and well fostered by the attractive advertising campaigns during the past ten or twelve years.

The weakness of aluminum paint however, is that it has always been advertised as " aluminum " with little or no stress on the importance of the specific vehicles required when aluminum is recommended or used for special exposures.

The result is that because of this lack of information about the vehicle, aluminum paints have in many instances been recommended and used wrongly or extravagantly.

The following alternatives for aluminum for special exposures may be of interest.

Hot Surfaces (smoke stacks, retorts, etc.)

For these exposures aluminum has outstanding value and is difficult to replace because of the adhesive and non-burning nature of the bright aluminum powder. The best alternative is either a natural black amorphous graphite in a suitable vehicle or one of the heat-resisting bituminous blacks.

Structural Steel (bridges, roofs or steel exposed to weather)

Aluminum paint should never be recommended as a paint to be directly applied on steel for weather exposure; for this purpose it should always be used over a suitable anti-corrosive primer and only as a finish coat. The life wearing quality of black or dark coloured paints is at least equal to that of aluminum, and the cost is somewhat less than that of aluminum paint. Well formulated light gray paint will wear, as a field coat, almost as long as aluminum and cost about the same per coat, at existing prices.

For use where the heat reflecting value (i.e. roofs, tanks, etc.) is important, white or light coloured paints have an efficiency equal to or greater than aluminum paint.

Structural Steel (tanks)

The attractive appearance of aluminum on storage tanks is accountable for its general use. Aluminum powder in a good weather and moisture resisting vehicle does not chalk under weather exposure and therefore does not show dirty streaks from rain washing from the plate laps, as do white or light coloured paints. But the wearing value of aluminum paint is no better than that of well formulated light gray paint, and for evaporation loss, where volatile liquids are stored, white paint shows an economy of 3 or 4 per cent over aluminum paint.

Structural Steel (interior)

Aluminum has been used on many exposed structural steel frames for the interior of buildings. For this service, white or light gray will give equal service at less cost and at considerably increased light reflective value.

The light reflective value of aluminum is approximately 50 to 55 per cent. light gray 55 to 65 per cent. and white 85 to 90 per cent.

Radiators

Aluminum has been used as a popular radiator paint. For general heating systems, however, where radiators give off heat by convection, flat black paint will give off heat at from 15 to 20 per cent. increase over the aluminum paint. For general hot water or exhaust steam radiator installations, (metal surface not exceeding 200 deg. F.), well formulated dull finish, light coloured paints will give efficient service, equal to aluminum.

Repainting Asphalt or Bituminous Coated Metal

Some of the better resin and water-emulsion paints may be applied over the " Robertson " type sheeting or other asphaltic surface building siding, to prevent bleeding of the asphalt and allow light coloured paints to be used as a finish.

Priming Exterior Wood-work

The general run of aluminum paint in a varnish vehicle is too short to act as a good primer on wood. For this service a specially long oil vehicle mixed with the aluminum powder is necessary. The regular white wood primers formulated for two coat work or those recommended for refinishing old and perished wood surfaces, will give results equal to aluminum and at no increase at existing costs. These white primers also overcome any tendency to " grin-through."

Sealing Knots

The general formula for aluminum paint will not stop the bleeding of live knots and (because it becomes a dark gray when painted over) has a tendency to " grin through " when used as a knot sealer. White two-coat wood primer over a light coat of shellac will overcome this difficulty.

Interior Surfaces (brick, plaster or wood)

A great deal of research work has been done in the paint laboratories to develop light reflecting paints suitable for all structural surfaces.

Aluminum has a reflective value of approximately 55 per cent. while most of the whites can now be supplied in a cone-coat type which will give over 85 per cent. light reflective value and cost no more per square foot of area, than the aluminum, at existing prices.

To sum up:—while the Government restrictions on the use of aluminum powder may disappoint many users in the popular selection of aluminum paint until the war situation changes, it should be kept in mind that:—

(A) Aluminum powder is not specially suited as a paint pigment for universal use but must be formulated in proper proportions and with a suitable vehicle for each special exposure.

(B) It is possible, until the supply of aluminum is cleared by the Government after the war, and until the cost becomes more normal, to furnish coloured paints which have past records of service and may therefore be of real interest.

DISCUSSION OF GAUGES FOR MASS PRODUCTION

Paper by Dr. C. A. Robb, M.E.I.C.[1], published in *The Engineering Journal*, April, 1941

K. R. Ayer[2]

I would like to express my appreciation of the able manner in which Dr. Robb has condensed such a large subject, yet managing to bring out the essentials.

Gauges are the special instruments that allow speed of inspection. They must measure sufficiently accurately but not too accurately, as the more accuracy the less speed and speed is the essence of all mass production.

Gauges have a two-fold purpose:

1. To make measurements where they will increase the speed of inspection.

2. To make measurements that cannot be made with standard instruments.

Yet, there are certain cases where gauges should not be used:

1. Where not sufficient quantities of a part are being made to warrant their use.

2. Where the inspection can be done more quickly with a standard instrument.

3. Where the accuracy of the dimension to be measured is so fine that other means than gauges must be used.

Accuracy—Perfect accuracy of measurement is unattainable and unnecessary in mass production. Therefore, care must be taken to allow the utmost manufacturing tolerance that safety will permit. Nevertheless, ability to measure to the closest practical limit is essential in the gauge industry. An axiom that every gauge manufacturer should constantly remember is, "You can only manufacture accurately what you can measure."

Thread Gauges—Perhaps the least understood are thread gauges, especially those of British Whitworth standard, which have seven elements where errors may occur, usually with a cumulative effect; i.e., (1) Major diameter; (2) Minor diameter; (3) Effective diameter; (4) Pitch; (5) Angle; (6) Radius of crest; (7) Radius of root.

Male thread gauges can be measured with proper inspection equipment, but female thread gauges cannot be so measured. Check gauges must be utilized to ascertain if they fall within allowable limits of measurement. The minimum requirements to inspect a female thread gauge are: (1) A full form check gauge; (2) An effective diameter (only) Not Go check gauge; (3) A major diameter (only) Not Go check gauge; (4) A plain plug Not Go check gauge for the minor diameter if such is too small to be accurately measured with an instrument; (5) Examination of a cast in a 50 to 1 magnification projection apparatus.

Some manufacturers of gauges use seven check gauges: (1) A Go effective diameter (only); (2) Not Go effective diameter (only); (3) Go major diameter (only); (4) Not Go major diameter (only); (5) Go minor diameter (only) plain plug; (6) Not Go minor diameter (only) plain plug; (7) Go full form check gauge; and a cast to examine the radii of the crests and roots.

Effective diameter (only) check gauges have the radius at the crest completely removed, and the radius at the core cleared away. Major diameter check gauges have an accurate radius at the crest, but the angle of the flanks is reduced by five or more degrees.

Check gauges for the examination of threads should always be made by the same manufacturer as the gauges to be checked. This is necessary because the errors of the various elements may be cumulative, thus a check gauge with very minor errors on each element may have a cumulative error in one direction sufficient to reject perfectly good gauges with minor errors in the opposite direction.

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It is recommended that any one interested in accurate thread gauges should obtain "Notes on Screw Gauges," issued by the National Physical Laboratory, Metrology Department, Teddington, England; Fourth Edition September, 1938; published by His Majesty's Stationery Office, York House, London, W.C.2. These Notes cover very fully the methods of inspection and the allowable tolerances on all British Standard thread gauges.

Machine Tools—Engineers not familiar with the manufacture of gauges are apt to be surprised that the standard "cutting" machine tools are of much less importance, both as to accuracy and quantity, in gauge manufacturing plant than grinding machine tools.

One idea of the minimum machine tool requirements needed for a complete installation suitable for the manufacture of gauges is as follows:

"Cutting" Machine Tools
- 1—Power Saw
- 1—Do-All Profiler
- 1—High Class Engine Lathe (complete)
- 1—Bench Lathe (complete)
- 1—Universal Milling Machine
- 1—Small Vertical Milling Machine (complete)
- 1—Shaper
- 3—Bench Drill Presses
- 1—Jig Borer (complete)

Grinding Machine Tools
- 3—Surface Grinders
- 1—Rotary Surface Grinder (wet)
- 1—External Cylindrical Grinder (wet)
- 1—Internal Cylindrical Grinder (wet)
- 1—Thread Grinder complete with internal attachment
- 1—Radius and Angle Dresser
- 2—Magna Sine Chucks
- 1—Lapping Machine
- 1—Tool Grinder
- 1—Etching Machine

Inspection Equipment
- 3—Sets Johansson Blocks
- 2—Comparators (reading 1/10,000)
- 1—Super Micrometer
- 2—Projection Apparatus (50-1 Mag.)
- 1—Pitch Measuring Machine
- 1—2 Wire Measuring Machine
- 1—Magna Sine Plate
- 2—Surface Plates
- 1—Height Gauge
- 1—Depth Gauge
- 1—Hardness Tester

Complete sets of outside and inside micrometers, Vee blocks, parallels and indicators.

Such machine tools, with necessary small tools and the proper personnel, should be able to produce even the most complex gauges.

Not nearly enough has been written in Canada on the subject of gauges, and it is to be hoped that Dr. Robb's paper may bring out many of the highlights of gauge production that are important to those who are concerned with precision work.

W. G. Blakey[3]

I have read Dr. Robb's paper, "Gauges for Mass Production" with great interest and find that he has covered a considerable amount of ground, any part of which could be enlarged upon with advantage.

Others, much more capable than myself, will, no doubt, discuss the technical problems.

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Mass Production—What does that term bring to mind? We think of a huge factory with many machines and innumerable workmen. We cannot help but marvel at the wonder of it all. What is the secret of this almost phenomenal accomplishment? It is the high degree of accuracy and the perfection of the production of gauges which, to-day, makes possible "MASS PRODUCTION" as we understand it.

And can the gauges also be produced according to the same system? They are simple enough looking bits of metal, but actually every gauge requires the individual and personal attention of the toolmaker, without whom there would be no gauges. His pride in his work is great. He looks upon a measurement of one one thousandth of an inch as the ordinary man looks upon a foot. He measures with certainty to one ten thousandth of an inch and is always willing to back his judgment as to measurement against all the measuring devices which are used in the inspection laboratories.

Doctor Robb refers to the number of manufacturers now engaged in gauge production in Canada and mentions that some years ago the annual import was valued at about $290,000. To-day in Canada, orders are being placed for "Inspection" gauges only at the rate of about $300,000 per month and at a rough estimate "Shop" gauges are being bought to at least a comparable amount.

Naturally this has meant the development of gauge manufacturing shops of which there were none, as such, before the war. The toolrooms of manufacturing establishments have co-operated exceedingly well and real gauge producing capacity has been built up in Canada by encouraging the management of these toolrooms to enlarge their capacity for fine gauge work by persuading them to install precision inspection and measuring devices, precision machine tools and the like.

This effort of the toolmakers and manufacturers has not been appreciated by the general public and it would appear that the Institute might take steps to remedy this.

R. H. Field, M.E.I.C.[4]

Canadian engineers were confronted with many problems when the manufacture of munitions was undertaken in the Dominion just prior to the outbreak of the present war. The provision of gauges was one. In the great bulk of military material, particularly in ammunition, interchangeability of pieces is of great importance. A fuse machined in one part of the world must be fitted, at a critical moment, into a shell made thousands of miles away. A cartridge case or shell jamming in a gun may have fatal results for the crew, or mean the loss of a position in battle. For reasons of this kind certainty in interchangeability is much more necessary than in ordinary manufacturing, where an occasional defective dimension usually results in little worse than delay.

The use of gauges, as understood to-day, really came to the fore in the war of 1914-18. Before that time limit machining was not widely practised and in munitions much reliance was placed on the "sealed sample," to which products must conform. In the later stages of that war, and in the subsequent period, gauges became of greater importance in manufacturing, and contributed to the cheapness of machined parts made in quantity. Steels were developed, precision grinding and finishing tools produced, measuring devices designed and, as a result of the labours of committees and individuals—e.g., The Gauge Committee of the A.S.M.E. in the U.S.A., and the National Physical Laboratory, working in conjunction with the B.S.I. in England, gauge constants were decided upon and tabulated.

It followed that much less spade-work was required in the matter of devising gauges and the means of producing gauges when Canadian engineers prepared to transfer their attention from pruning hooks to spears. On the other hand, as Dr. Robb points out, previous to the present war, few gauges were made in Canada (outside, possibly, the large automobile shops), and there was very little control service available. Thus, in the early days of the present war Dr. Robb was greatly handicapped in his endeavour to make mechanical engineers and others "gauge conscious." He must be given credit for his pioneer work in this connection, which has resulted in many Canadian shops co-operating in producing a supply of gauges, and in the acquisition of the special machine tools and other necessary aids.

For reasons already indicated munitions gauges must conform to national standard measures—it is impracticable to have a set of master reference gauges for each item. Fortunately the widespread use of Johansson type, or slip gauges, has simplified the standardization problems both of the manufacturer and of the metrologist. Besides the ease with which length intervals in steps of 0.0001 inch, or even finer, can be built up, these blocks have the advantage that they can be measured absolutely in the laboratory by the application of optical interferometry. Before the introduction of these blocks lengths were obtained by studying the sub-divisions of a standard rule of one metre or one yard, which in turn had been compared with a reference length derived from the ultimate standard. This was a laborious operation, to which had to be added the almost equally laborious calibration of the micrometer screw used for obtaining fractions of the established length. To-day, in a few hours, it is possible by interferometry to measure the length of a set of slip gauges which, in combination, will permit lengths in minute steps to be used with a knowledge of the errors to something of the order of 0.00001 inch, or even finer if special precautions are taken.

As adjuncts to Johansson, or slip gauges, various sensitive comparators of simple design have been developed—for example, the Sheffield Comparator,—which permit the toolmaker or gauge inspector to make measurements beyond the precision of the machinist's micrometer. Measuring machines which, up to the last war, had hardly progressed beyond the creation of Whitworth, are now fitted with sensitive indicators and less reliance need be placed on the screw. Comparators have even been constructed which permit differences being determined to two millionths of an inch, or less. In these cases, too, slip gauges replace micrometer screws, and the measuring machine is only called upon to determine a difference of a few thousandths, or less.

Thread gauges, which Dr. Robb rightly lists as difficult to produce without adequate equipment, can now be measured quickly and accurately, especially by the use of the well-designed apparatus originating in the National Physical Laboratory, and so widely used in England. Most trouble in the laboratory arises from gauges of types that do not lend themselves to measurement by direct methods, and which require special fixtures or set-ups.

Despite the improvement in manufacturing technique the relative positions of metrologist, gauge maker, and machinist does not seem to have changed. Improved machine tools permit, and modern mechanical engineering demands, much finer limits in finished parts. This, in turn, necessitates closer tolerances for the gauges; but the toolmaker is assisted by improved grinding machines, abrasives and measuring tools. The metrologist, who undertakes the responsibility of certifying the gauges as conforming to standard dimensions, is also assisted by improved laboratory technique and appliances. Hence, beyond the effect of an increased complication, it is doubtful if any of us have more headaches than our predecessors of 1914-1918 and we all endeavour to make the Dominion's contribution in the present need exceed, relatively, that given during the former.

In conclusion, I must express my appreciation of Dr. Robb's paper, particularly in his ability to compress his subject, which could fill several papers. His account should be of special interest to those engineers who do not come into contact with actual gauge making and measurement.

[4] Metrologist, National Research Council, Ottawa, Ont.

H. F. Gorth[5]

In the making of gauges to the close tolerances demanded by present day gauging standards there are four essentials that must be taken care of before good results can be expected.

First: We must have all the necessary machine tools, lathes, milling machines, shapers, grinders, etc., and all must be in good condition.

Second: The gauge makers must be the best type of tool makers, possessing not only skill but unlimited patience if good results are to be obtained.

Third: Usually the hardest essential to obtain is an even or uniform temperature all through the gauge room, so that all gauges, tools, etc., can be maintained at the same temperature. This is imperative if the gauges being worked on are of any considerable size.

Fourth: The inspection equipment and tools must be of the best, as they not only have to check against the work done in the shop but the work they pass must be acceptable to the inspection departments of the company the gauges are being made for.

In the making of these gauges the most important machine of course is the finishing machine. In most cases these are precision grinders, divided into three types: external cylindrical for circular outside grinding and internal cylindrical for inside or hole grinding, with the surface grinder taking care of all flat surfaces.

Along with the machines and equally important are the necessary precision measuring tools, surface plates to give a plane surface to check from, height gauges, indicators reading in ten thousandths, etc., and most important of all the precision gauge blocks, commonly known as Johansson blocks. These blocks when new are supplied in three grades: A laboratory set accurate to two millionths of an inch, an inspection set accurate to four millionths and the working set accurate to eight millionths. These working gauges are the blocks most commonly used in the shop and are used both for taking actual measurements and as a master for size and a comparison made from them to the point being worked on by the use of ten thousandth indicators.

The actual use of these blocks inevitably affects their accuracy, as it is only by wringing these blocks together in their various sizes that we obtain any desired size. This wringing together causes wear and consequently reduction in size of the gauge blocks. It is therefore necessary either to buy new sets of blocks or to find some method whereby we can check our blocks for wear and post the size of each individual block, so that the user of the blocks can allow for the errors when building up to the desired size.

In a plant using a number of sets of blocks, continually buying new sets would mean a very large outlay. To eliminate this we use an inspection set of blocks as a master set and a comparator measuring direct to twenty-five millionths of an inch but easily divided to eight millionths. By comparison with our master set we can check and chart each block to the accuracy they originally had.

The types of gauges being made to-day can be classified in general as:

Plug gauges for the gauging of holes; these are generally double ended, one end to the high tolerance and the other to the low.

Ring gauges for gauging over male forms, these usually being made in pairs, one to the high and the other to the low tolerance.

Thread gauges are designed in general the same as plug and ring gauges but are much more difficult to make, requiring special and very costly machinery to grind the threads of the gauges and for each size of gauge masters and laps must also be made.

Profile gauges cover almost every variety of shape and form and in general are not held to as fine tolerances as other gauges, being for the most part gauges for visual inspection.

Snap gauges are made in a number of styles. Some are made with a forged or cast frame with inserted hardened and ground points set for high and low dimension. These are adjustable for wear and when the points become deformed too badly for use new points can be inserted. This type of gauge is generally used only for dimensions greater than one inch. The other type used is made from flat plate hardened and ground and when the tolerance is very small hand lapped. This type is not adjustable and when the wear allowance has been reached the gauge must be scrapped or in some cases reground for a slightly larger size. These gauges are in most cases made double for gauging on two sides, one to the high and the other the low tolerance.

The so called fixture gauges are the most difficult of all to make. These are built up of a number of pieces. Each gauge of this type usually controls a large number of dimensions all held to close tolerances, and as the relationships of one part to another require the same close tolerances, the difficulty in making is obvious.

It is on these gauges particularly that good or bad design can make all the difference between a satisfactory or a poor gauge. Many gauges are being designed to-day by men with no conception of how the gauge can be made as designed or whether it will stand up under use after it is made. The cost of providing gauges can only be held to a minimum if the designer is familiar with gauge making technique; designs his gauges with the question continually before him: Can the gauge be made any easier way and how will it stand up under use ?

In addition to a tool room with all the necessary machine tools and measuring instruments the gauge shop must own and maintain an inspection department for this work alone equipped with many types of precision inspection equipment.

In the inspection room it is also necessary to duplicate all the small tools in use in the shop. All tools here must be of the highest quality and kept in the best of condition.

Colonel G. B. Howard[6]

There is little to add to Dr. Robb's excellent paper on Gauges for Mass Production.

If it is not outside the scope of the paper, it is thought that some mention might be made of the essential differences between "production gauges" and "acceptance inspection gauges."

Production gauges are required to ensure that the product or component will pass inspection when completed; consequently the tolerances they permit are normally well within the drawing tolerances. For this reason, extreme accuracy in the manufacture of production gauges is not so essential, and greater wear may be permitted. They are also designed differently, since they are used at the machines or after each operation, while acceptance inspection gauges are used to gauge completed articles and components.

Acceptance gauges are so designed to permit the maximum tolerances allowed on the drawing, to ensure the acceptance of all articles within drawing limits. To ensure rejection of all articles outside drawing limits, acceptance gauges must be made to very accurate dimensions and relatively little wear is permissible.

Some mention might be made also of the trend, in industry, towards the use of mechanical and electrical comparators instead of limit gauges. This practice permits change of dimensions or design without provision of new gauges, since comparators are adjustable over wide limits. Wear also may be neglected. Such gauging methods are also advantageous when selective assembly is required.

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Chester B. Hamilton, Jr.m.e.i.c.[7]

I have read this article carefully and think Dr. Robb has done a very good job, though a few points might have been stressed more. The weak points in the gauge programme in Canada were (1) lack of advance planning, and (2) ordering gauges in lots too small to permit efficient production.

Dr. Robb does not make it clear that the accuracy requirement for the gauge has a direct relation to that for the part being measured, usually about one eighth or one tenth the tolerance. A wide tolerance on the gauge cheapens gauge production, but increases cost of part production because it narrows the part tolerance by that much.

In regard to thread gauges, Dr. Robb does not mention a very important class,—the truncated thread gauges. These have straight line profiles, the top and bottom being cut straight across omitting all the curves of the Whitworth tip and root. The straight flanks also may be, in some cases, shortened to less than the straight part of the Whitworth. Thus only a band above and below the pitch line is measured, but it gives all the necessary information for a good working fit on production inspection. This type of gauge is far cheaper to make and accuracy is more easily attained than the full Whitworth. Its use, of course, would not be right for establishing and checking the threading tools, or the first part produced, but in parts production it checks axial pitch, thread thickness, pitch diameter and pressure angle, which is all that can be required, once the original tools have been proved.

As a design element, the sacred Whitworth thread is probably one of the most hampering things to which our enemy could wish to see us tied.

Owen W. Ellis, m.e.i.c.[8]

As Dr. Robb has pointed out "nitrided steel has a very hard surface." According to the type of steel nitrided the hardness may vary from somewhere below 1,000 to somewhere above 1,100 Vickers Diamond Penetration Number. Certain Nitralloy steels are slightly harder immediately below the nitrided surface than on the nitrided surface, so that removal of 0.001 inch from the surface of a nitrided article may actually result in an increase in its hardness. Since an increase in diameter of 0.002 inch in material having a case depth of 0.030 inch serves as a fair example of the growth which takes place on nitriding, it will be appreciated that the effect of bringing a gauge back to size after nitriding may be to leave it with a harder surface than that produced by the nitriding operations per se.

One of the objections that has been put forward to the use of nitrided steels in the manufacture of gauges is that they are not easy steels to finish perfectly to a hundred thousandth or a millionth of an inch. Nitrided steel slip blocks have been found extremely difficult to wring and the use of nitrided steels in this connection has, on this account, been discontinued. There does not seem to be much doubt that the difficulty of wringing these steels is related to the difficulty of finishing them satisfactorily. The question of finishing would not of necessity loom large in all gauges, but is one that cannot be overlooked. It is not impossible that new nitriding steels will be developed which, after nitriding, will have satisfactory finishing qualities.

Paul V. Miller[9]

In the opinion of the writer Dr. Robb's paper covers the subject of gauges thoroughly, and there is little that the writer could add unless he were to go into greater detail as to the design or manufacture of one or more of the types discussed.

There is, however, one point which might well be mentioned in a discussion of the production of gauges, and that is the matter of standardization of gauge blanks which, at a time like this, is really of vital importance. Some sixteen years ago work was started on this subject and several different edition of a subsequently developed Standard have been printed. The most recent edition is entitled, "Commercial Standard CS8-41" published by the United States Printing Office, and it gives complete dimensional data regarding recommendations for gauge blanks of various types. Before the present War broke out in Europe some progress was made in England toward the adoption of certain parts of this standard, and the writer understands that some gauge manufacturers in England are now using the dimensions recommended for plug gauges and snap gauges.

The writer is enclosing a copy of this American Standard covering Gauge Blanks, and would suggest that some mention of this be made in the discussion of Dr. Robb's paper, for, no doubt most of the gauges which Canada is purchasing from manufacturers in the United States will be made to these dimensions, and it would probably result in some saving and economy if Canadian manufacturers were to adhere to these dimensions where practical.

Colonel A. Theriault[10]

I have read this article with much interest and believe there is very little that we can add.

In connection with the last sentence under the heading "The Gauging Surface," in which Dr. Robb says that internal grinders are available for diameters as low as ¾ of an inch, it may be of interest to know that we are presently grinding internally here down to diameters of 0.308 of an inch in the regular course of our work, and we have ground as small as 0.208 of an inch.

Regarding the paragraph on Special Machines, I wish to say that we are the proud possessors of a Swiss Jig Boring and Measuring Machine on which the table can be located to within .0003 of an inch for any position of the table, horizontally in two directions and vertically, by direct reading dials and verniers.

The Author

In his discussion Mr. Ayer has stressed the dearth of scientific literature on gauges. In peace time the lack of demand for such books may be accounted for by the fact that the whole question of gauging has rested lightly on many types of manufacturing. However, Mr. F. H. Rolt, Metrologist, National Physical Laboratory, has ably presented the fundamentals in " Gauges and Fine Measurements " published in two volumes by Macmillan & Co., London, 1929. The machine tools and inspection equipment required by the gauge manufacturer depend upon the type or types of gauges which he can deliver at a satisfactory price.

While quick dissemination and application of information on novel developments and ideas on gauge production and inspection problems during war save time and expense, the secrecy may require that these be not published but be reserved for the benefit of the gauge and munitions manufacturers, the gauge inspection laboratories and the inspectorate.

Mr. Blakey has aptly described the special part which the competent tool maker and precision machine operator plays in the production of munitions gauges.

In creating the gauges for the inspector and in dealing with production troubles, " the perversity of inanimate things " frequently places a severe strain on the tool maker's sense of humour. Like the artist, his reward is largely in the appreciation of his splendid creations.

Mr. Field has outlined the role of the metrologist and his equipment in certifying the gauges as conforming to

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[10] Chief Superintendent of Arsenals, Dominion Arsenal, Quebec, Que.

standard dimensions. With characteristic modesty he has omitted to state the indispensable function which the metrologist and his laboratory perform in connection with the educational efforts of gauge production representatives, who have to encourage suitable manufacturers to undertake the production of gauges. In many cases, the gauge laboratory provides the first opportunity for the manufacturer to observe the equipment for gauge inspection, to become familiar with the standards of quality which are required and learn about the technique of the metrologist in making precise measurements. The gauge laboratory is the arena in which gauge production troubles are diagnosed and recommendations for their correction given. It provides fertile ground for new ideas and novel applications of some all but forgotten tricks of the craftsman. It was largely due to the provision of this service, quickly organized by Mr. Field and his associates of the National Research Council, that Canadian manufacturers were enabled to reach a monthly output of inspection gauges by mid-July, 1940, equal to that received in Canada from all sources of supply on this continent during the month of November, 1917.

Mr. Gorth has stated the case for the manufacturer. Other reviewers have covered certain points raised in this discussion.

Tool makers will second his appeal to the designer for consideration of the question, " Can the gauge be made in any easier way ? "

It sometimes happens that the tool maker is able, without disturbing the fundamental design, to construct the gauge in a manner which greatly facilitates its inspection.

Colonel Howard's explanation of the difference between " production gauges " and " acceptance gauges " is timely. A third group of so-called " master inspection gauges " find a very limited application, although during the last war they were much in evidence. Gauge and munitions manufacturers will appreciate Colonel Howard's interpretation of the trends in industry.

Mr. Hamilton has expressed the relation of the gauge tolerance to that of the part to be measured and to the cost of production. It may be added that, when time and quantity schedules are known, the objective to be attained is a minimum cost per unit manufactured, the expense for gauges being included in the total.

Truncated thread gauges have interesting possibilities for quality control and were reported during the autumn of 1939 as in use elsewhere. However, in Canada this service has generally been included in the function of other types of gauges.

Mr. Ellis' contribution on nitrided steel acceptably fills one of the gaps in the gauge story, and Canadian engineers will welcome his report on this development, which has been the subject of investigation in his laboratory during recent years.

Mr. Miller's discussion on standardization of gauge blanks and his reference to the recent publication of the United States Printing Office, " C S 8—41 " (For sale by the Superintendent of Documents, Washington, D.C. — Price 15 cents) will be appreciated by gauge designers. It is noted that some gauge manufacturers in England are using the dimensions recommended for certain types of gauges.

" Armament Production Policies "—1941, from the press of the Reinhold Publishing Corp. New York (Price $1.00), contains brief references to gauges.

Colonel Thériault's report on developments in internal grinding serves to report a further achievement of the Dominion Arsenal at Quebec.

Abstracts of Current Literature

Abstracts of articles appearing in the current technical periodicals

THE ACOUSTIC MINE

From *The Engineer* (London), September 19th, 1941

In the course of his recent review of the war in the House of Commons, Mr. Winston Churchill, the Prime Minister, made reference to the anti-mining service. Almost every night, he said, thirty to forty enemy aeroplanes were casting destructive mines, with all their ingenious variations, in the most likely spots to catch our shipping. The attack was begun with the ordinary moored mine, but it has been continued with the magnetic mine and the acoustic mine. It was now being continued, said Mr. Churchill, with the acoustic mine as well as the magnetic mine in many dangerous combinations. The acoustic mine, like the magnetic mine, does not depend on actual contact with a ship in order to detonate it, and it can therefore be dropped from aircraft in the shallow waters of harbours and narrow channels. The mine contains an electrical relay, which is adjusted to fire the charge when the ship's propeller is near enough for the ship to be blown up. It is known that our minesweepers are now equipped to deal with both magnetic and acoustic mines or their combinations. This means an added complication to their equipments, but they are continuing to discharge their task of keeping our harbours and channels clear with complete efficiency. Mr. Churchill stated that 20,000 men and 1,000 ships toiled ceaselessly to clear our ports and channels every morning. Thanks, he said, to the resources of British science and British organization, the menace had been largely mastered. Reference was also made by the Prime Minister to the work of the salvage service, which, he said, had recovered since the beginning of the war in every circumstance of storm and difficulty, considerably upwards of 1,000,000 tons of shipping which would otherwise have been cast away.

CONTROL OF CIVIL ENGINEERING

From *Civil Engineering and Public Works Review* (London), September, 1941

The British people have always regarded their personal rights as sacrosanct, something that must never be interfered with by others. The fundamental basis that lies at the bottom of the present war is the struggle to maintain personal freedom of thought and religion and the freedom of action, provided it is not to the detriment of others. In a struggle between such mighty forces there is little chance for survival if there is a lack of cohesion and of co-operation. To fight tyranny organized for war and dragooned to the sternest forms of discipline and self-sacrifice, it is necessary that the forces of freedom must steel themselves to the same, or even greater sacrifices. The clear-sighted men of the nation have realized this from the beginning of the struggle, but in a nation where freedom of thought and action holds such a grip on the public mind, the people of Britain have been slow to recognize the necessities of the hour. This characteristic may be a weakness, but if it is a weakness it is also a source of great strength and forms the stabilizing influence which prevents hasty experimentation and action without mature thought.

As the war has progressed, "right" after "right" has been surrendered by the nation and dictatorial powers have been bestowed upon the Prime Minister and his Government. No one of standing has challenged the wisdom of the surrender of those rights, though many have declared that the organization of the nation has proceeded far too tardily. As each problem has arisen, it has been dealt with in its turn and the national needs have been met, when it has been proved necessary, by the surrender of personal liberty of action and the placing in the hands of the Government an increase in power over the individual citizen, his business, and his wealth.

The development of the war in the air has produced a problem which the nation has to face. The destruction of buildings and works of public utility has created a situation that has compelled the Government to review the position of those industries and professions immediately concerned. The problem is complicated by the demands for Government work on the construction of new factories, aerodromes and suchlike essential war work.

There are many professional men, civil engineers, surveyors, and others who are intimately connected with this problem. Besides these there are the trade unions and the manufacturers and producers of raw materials such as bricks, gravel and cement. Again, there are the many reinforced concrete firms, plant manufacturers and plant hirers.

At present there is no central organization representative either of all these varied interests and of builders, contractors and the operatives. The number of workers engaged in peace time in the building industry and the civil engineering industry was about 1,400,000. Already more than half this number have been diverted to the main war construction and building industry, A proper co-ordination of this great force of professional and skilled labour is essential. At present the Minister of Works deals with many individual industries. The Minister has decided that there shall be a proper co-ordination of the many ramifications of the industry and for this purpose the Building Industries National Council has been expanded to bring in other interests not yet represented, thus furnishing him with a council to help in the administration of the various powers and responsibilities.

Membership of the Council is confined to those interests most directly and immediately concerned—employers and operatives, with a few professional and independent members. The members have been chosen by the Minister and are not delegates of sectional interests.

The chairman of this new Works and Buildings Council is Mr. Hugh Beaver, M.Inst.C.E., M.I.Chem.E., M. Inst.T., Director-General Works and Buildings and previously a partner in Sir Alexander Gibb and Partners, Consulting Engineers, and the secretary is Mr. E. J. Rimmer, B.Sc., M.Eng., A.M.Inst.C.E.

The Minister will look to the Council for advice on all matters affecting the building and civil engineering industry. The Council has, however, the right of initiative and may make representations on any matters affecting the two industries.

The steps taken by the Minister will, without doubt, be welcomed as a move in the right direction, as it will assist in a proper control of the industry and help to direct the civil engineering and building effort of the country into channels most conducive to the benefit of the nation's war effort. It will tend to an allocation of tasks to the firms most suited to their performance. A central body such as has been created must bring about a smoother co-operation between the various branches of the industries and greatly increase their efficiency. This gain in national efficiency will certainly more than offset any advantage the civil engineer might have possessed without the compulsory co-ordination, and will thus, we are confident, be welcomed by all members of the profession.

THE SHORT STIRLING BOMBER

From *Trade and Engineering*, September, 1941

Limited details may now be published concerning the Short Stirling, the R.A.F.'s latest four-engined bomber which has already taken part in a number of successful daylight and night raids and has proved itself a first-class machine in every way. Its most noticeable feature is its size. It is 87 ft. 3 in. in length, 22 ft. 9 in. in height, and has the tremendous wing-span of 99 ft., which is 4 ft. shorter than the U.S. Flying Fortress. A midwing monoplane, it has wings set well back from the nose, with a noticeable dihedral. The trailing edge tapers sharply to the tip, which is rounded to meet the leading edge. The root, where the wings are swept into the fuselage, is markedly thick.

Power is derived from four radial engines, either Bristol Hercules 14-cylinder air-cooled of 1,400 h.p. each, or Wright Cyclone double-row 14-cylinder air-cooled motors. The outer engines are mounted mid-wing and the inner are underslung and set forward of the outer pair. The fuselage is rectangular. The cockpit is well over the nose, some distance forward of the engines, and the bomb aimer's position has been set immediately under the forward gun turret. The depth of the fuselage permits easy access to the rear gun turret. The top line of the fuselage runs back straight and level to the tail, the lower line being swept up to the tail well back from the wings. The fin and single rudder are high and narrow. The tail planes are of extremely wide span, with the leading edge well tapered and set level with the fin. Details of the armament remain secret, but, as may easily be imagined from the presence of turrets fore and aft, it is extremely powerful.

The Stirling contains several special features. The wheels of the undercarriage, which retract into the nacelles of the inner engines, are more than 5 ft. in diameter, and their tips show under the nacelles when retracted. A novel feature is the fitting of twin tail-wheels, which retract into a compartment with flush-fitting doors. Glass which is faired into the sides of the fuselage ensures a well-lighted interior the whole length of the fuselage. Another detail which cannot yet be mentioned is the bomb load, but the fact that the bomb doors extend to approximately half the length of the fuselage shows that it is exceptionally heavy.

Pilots and crews who have taken part in operations in the Stirling say that it has exceedingly good flying qualities. Some of the features, noticeably the tail, proclaim the relationship of the Stirling to another famous Short product, the Sunderland flying-boat, which continues to give excellent service with the R.A.F. Coastal Command.

FATIGUE RESISTANCE OF AUTOMOTIVE BEARINGS

Abstracted from *S.A.E. Journal*, August, 1941

Any metallic bearing, if run under completely ideal conditions and if run long enough, eventually will fail due to fatigue, provided the load exceeds the endurance limit of that particular metal or alloy. It might be said that the bearing dies of old age.

With respect to fatigue, we can rate bearing alloys in the following order:

1. Copper-lead
2. Cadmium Alloys
3. Tin-base and Lead-base Alloys (Conventional Type).

The evidence of fatigue is the presence of numerous fine cracks in the bearing metal. These cracks invariably start at the bearing surface. The first phase may be considered as the birth of the crack. In the second phase, the crack works inwardly toward the bond line, its actual path being influenced greatly by the location of the grain boundaries in the bearing metal. The third phase is quite astounding and is very probably the immediate cause of most bearing failures. Here the crack turns at right angles when it has proceeded to within a very short distance of the bond line. The crack will then run in a plane somewhat parallel to the interface between bearing metal and backing metal. When this crack meets another crack which has worked down from the surface, the effect is to produce a small section of loose bearing material. The disastrous results of a number of these small loose pieces can readily be visualized.

From the foregoing explanation on the mechanism of fatigue, it can be seen why the performance of the thin-layer bearings should be far superior to the conventional type bearing. The manufacture of thin-layer bearings of the Trimetal and Micro type requires a precision and a technique not thought possible just a few years ago. However, there are many millions of both of these types of bearings in successful operation today.

Corrosion Resistance

With respect to resistance to corrosion by acids formed in the oxidation of oil, the four general alloys group themselves somewhat differently. Here the tin-base and lead-base alloys are practically immune to any type of corrosion so far encountered in the field. On the other hand, the cadmium alloys and copper-lead are definitely susceptible to attack if corrosive conditions are allowed to exist.

Future Bearings

It is quite evident that the trend of future bearing developments is toward a very thin lining of a recognized bearing material backed by steel or steel and an intermediate layer of bronze. As production methods with respect to bearings and engines are improved, we may expect even thinner linings than are in use at the present time. In closing, it may be of interest to mention that "Micro" and "Trimetal" bearings have been produced by laboratory methods which have successfully sustained mean unit pressures in excess of 10,000 psi.

ENGINEERS' EARNINGS

From *Engineering* (London), September 26th, 1941

In normal times, professors of engineering give considerable time to efforts enabling graduates of their colleges to make a start on a technical career. Frequently they are helped in this activity by appointment boards, which now operate in connection with most universities, while assistance may also be rendered by the professional institution of which any particular graduate may be a student member. The whole of this type of activity is now in a state of suspension. No graduate whose technical attainments make it desirable that he should be employed in some phase of war industry, rather than pass into one of the Services, finds any difficulty in obtaining an appointment. This state of affairs is not likely to endure after the war, except possibly during a period of hurried reconstruction, and in due course engineering graduates will again be faced by the old problem.

The particular branch of engineering to which a young man passes after leaving college is frequently determined by chance; he takes whatever job is offered. In some cases, however, selection is possible. In that case his choice will be largely determined by the course of training which has been followed, and to some extent by the particular interests and enthusiasms of the teaching staff to which he has been subjected. There is also a fashion in these things. At one time, a majority of young engineers were attracted by electrical work, due possibly to the remarkable progress that particular branch of engineering made in the course of some twenty years. More recently, the internal-combustion engine, in its various phases, has proved one of the major attractions. The proportion of graduates entering any particular branch of engineering is necessarily affected by the arrangements which that branch makes to receive it, and the institution of graduate-apprentice courses by some of the large electrical firms enabled them, at one time to take the pick of the graduate available. Various other branches of engineering have now realized the value of building up their technical staffs by facilitating the entry of selected graduates into their works, and matters are not so one-sided as they were.

Probably few young men to whom a choice between various branches of engineering is offered base their selection on a consideration of which is likely ultimately to provide them with the largest salary, although the immediate emolument offered is often a factor not to be ignored. The late Dr. Rosenhain once told us that, when he was interviewing candidates for a post at the National Physical Laboratory, one young man, asked if research work was of particular interest to him, replied that his real interest was to obtain a job which would furnish him with a salary of 1,000£ a year, as soon as possible. It was suggested that in that case he had come to the wrong shop. The point of view of this particular candidate is, we think, unusual. Most young men do not speculate whether electrical or mechanical work is likely ultimately to be more profitable. Even if they did, they generally have no data on which to base a conclusion. The graduate who chooses a particular line of work because of family or other connections, which will ultimately place him in a good position, is, of course, a special case.

It is no one's business to determine whether an engineering graduate, who joins a firm of contractors and specializes on tunnel work, is, on the average, likely ultimately to make more money than one who joins a firm of electrical engineers, or devotes himself to radio transmission. As a result, co-ordinated statistics on the matter are not available. A recent publication by the United States Department of Labour, with one aspect of which we dealt in our issue of August 22, does, however, contain some incidental information on the subject. This publication, entitled *Employment and Earnings in the Engineering Profession, 1929 to 1934*, was prepared at the request of the American Engineering Council in order to determine the effect of the business depression of 1930-1934 on professional engineers. The figures of earnings which it quotes, as they refer to American practice during a special period of stress, have no direct application to this country. It is possible, however, that the relative earning value of different types of activity which is disclosed may have some bearing on British conditions.

The figures in the report were collected and are considered from the point of view of the effect of the depression on engineering earnings, and the relative position occupied by different types of occupation was not quite the same at the beginning of the period studied as at the end. In general terms, however, it was found that, in private employment, mining and metallurgical engineers were paid the highest rates, followed by those engaged in chemical and ceramic engineering, mechanical and industrial engineering, civil engineering and electrical engineering, in that order. In public employment, civil, electrical and mechanical engineers earned less than in private, except for civil engineers engaged on new construction. The particular section of any of the main branches of engineering on which a man was engaged had considerable influence on salary, and it is stated that "engineers engaged in general administration make from half again to twice as much as those engaged in design, construction or operation." Consulting, teaching and sales averaged less than administration, but more than design, construction and operation.

These figures were obtained by means of a questionnaire which brought in 52,589 effective replies. Of these 3,900 were from chemical and ceramic engineers and 19,981 from civil engineers. Whether these two figures fairly represent the proportionate numbers of the two types of engineer in the United States we do not know, but the higher position in the salary scale occupied by the chemical engineers can partly at least be explained by the fact that a smaller proportion of them than of any other class was engaged in public employment. With civil engineers the position was reversed and in most fields earnings in public employment were less than in private industry. An inquiry in this country might disclose the same thing, but in our case public employment usually carries pension rights, which are, in effect, equivalent to an addition to salary. This apparently does not hold in the United States. "The degree of economic security among professional engineers, as evidenced by possession of an employment contract covering some period of time, or by pension privileges, was negligible."

The leading position found to be occupied by chemical engineers is possibly to be explained by the fact that they are engaged in an industry which has greatly extended in recent years, particularly in the plastics branch. As the number of men who have taken a degree in chemical engineering is certainly much smaller than those who have done the same thing in, say, electrical engineering, and expanding industry, competing for the supply available, might tend to raise the standard of salary offered. A condition of this kind however, would not necessarily be permanent. There is a further factor which may have had an influence on the matter. The proportion of first-degree engineering graduates found in the ranks of ceramic engineers, a branch of the chemical engineers, was, at 77.3 per cent. higher than in any other sphere. The higher standard of education marked by the possession of a degree was, in fact, found to influence earnings.

The inquiry revealed that, although non-graduate engineers had an advantage in the early years, owing to the fact that they were establishing themselves in industry while the graduates were at college, they lost their lead at a time corresponding to five years after graduation. Even two years after graduation the difference in earnings between the two groups was very small. After this initial period the graduates drew ahead, and advancing age showed a considerable advantage in their favour, indicating that, in general, they tended to obtain the better-paid posts. The returns, as a whole, showed wide variations, as might have been expected, and many important positions were occupied by non-graduate engineers. On the average, however, the graduates tended to show the larger earnings in the long run, their emoluments continuing to increase for several years beyond the point of maximum earning capacity of non-graduate engineers. In the case of the latter, the average condition was found to be that their salaries either remained stable, or declined, after the age of 53 years.

NEW SWISS GRINDING AND MILLING MACHINES

By Alfred Rickenmann

From *Schweizerische Bauzeitung*, April 1941.

Abstracted by *The Engineers' Digest* (London), July, 1941.

At the 1940 Basle Fair some new thread grinding and milling machines were introduced by the Swiss firm, Reishauer-Werkzeuge A.G., which are subsequently described.

Owing to its great versatility, the universal thread grinding machine, type NRK, can be used for grinding threads of all descriptions, such as right and left hand, internal and external threads with a pitch of about 0.4 to 0.8 mm. The grinding wheel is adjustable from both sides up to about 25 deg. helix angle. The machine can work with a single or a multi profile grinding wheel of 40 mm. maximum width. With a single profile grinding wheel it makes use of the longitudinal traverse grinding method, while with a multi-profile wheel it operates by the plunge-cut method. The first method is used for spindles, worm gears, long screw taps, and thread gauges, that is whenever the length of the thread exceeds 40 mm., or when it would not pay to prepare a multi profile wheel. For short taps, or for grinding threads on bolts, screws, etc., made of high quality steel the second method is advantageous. It eliminates rough machining of the thread, and hence the adjustment of the grinding wheel in the rough thread.

The single profile wheel is formed by means of a diamond, while for the multi profile wheel crushing rolls are used which are pressed against the wheel. For precision work the machine is fitted with a hardened and ground grinding spindle and a special pitch correcting, change speed, gear. For easy setting of the grinding wheel in rough machined threads, a telescope with a revolving graticule is provided. The electrical machinery consists of four motors, all controlled by press buttons. The reversing of the slide is hydraulically operated, and so is the relief grinding motion of the slide.

Another new model introduced by the same firm is the R. 1. This machine is a combined Internal, Thread and Hole Grinder with provision for dealing with parallel or taper holes. Thread grinding is always performed with multi-profile grinding wheels.

Since the speed of travel for thread and plain hole grinding is different, provision is made for a quick change over from one type of work to another. For this purpose two table slides are provided, one above the other, the lower oen for the fast traverse when hole grinding is being hydraulically operated, and the other for thread grinding operated through gearing.

The speed of the machine can be steplessly varied between wide limits. Three internal spindles are provided with a range of speeds from 4,000 to 28,000 r.p.m. to amply cover the various grinding wheel diameters that will be required for the range of work of which the machine is capable. A tachometer indicates the spindle speed. Work speeds are variable from 0.5 to 256 r.p.m. in 32 steps.

The short thread milling machine, Type KBH, is principally a thread groove milling machine. The work spindle provides the longitudinal and transverse motion for the pitch and the depth of thread. After the work is finished the spindle is brought automatically to its original position. Operation of the machine consists only of feeding the work to the machine and starting the motor. All other work is automatically performed.

The machine is especially suitable for cutting short internal and external threads. The following operations are hydraulically controlled; clamping and releasing of the work, advancing and returning the work slide, fixing the slide into position, and automatic operation of a milling cutter protection cover during changing of work.

THE CHANNEL TUNNEL

By Rolt Hammond, A.C.G.I.

From *The Central* (London), June, 1941

There are few projects about which so much has been written and debated for nearly a century and a half than the Channel Tunnel. Ideas, fantastic and practical, have been put forward during that period in profusion, and a very brief history of these may be of interest at the present time.

It is generally believed that the first idea was put forward in 1802 by the French mining engineer, Mathieu, when he presented his plans to the Emperor Napoleon, during the First Consulship. The Emperor welcomed the scheme, which even found favour with the eminent British statesman, Charles James Fox; Mathieu's plans were exhibited at the Luxembourg and at other galleries in Paris, but it is unfortunate that no trace of them can now be found.

De Gamond was another French engineer who devoted a vast amount of time and energy to the solution of this problem. For more than forty years he studied various schemes, and considered in turn a submerged tube, a submerged concrete roadway, a train ferry and finally a tunnel. For building the submerged roadway he proposed to use forty submarine boats of his own invention; with these, and with the aid of 1,500 sailors and navvies, for a sum of £10,000,000 he guaranteed to provide a Channel crossing lasting thirty-three minutes.

The Great Exhibition of 1851 gave rise to a crop of suggestions, most of which were fantastic and smacked more of the romances of Jules Verne than of practical engineering projects. In 1856 we find De Gamond once more on the warpath, this time with a proposal for a tunnel. He planned to build thirteen islands in the Channel, through which he would sink shafts to *terra firma*; from these shafts he proposed to drive tunnels east and west until the different sections met one another. At that time this was the only known method of driving long tunnels, for by such means it was possible to divide the work into sections of manageable length. The obvious objection to his scheme was the permanent obstruction which would be caused by the islands in the Channel, and it was therefore not surprising that the idea was rejected by Napoloen III and Queen Victoria, to whom it was presented simultaneously.

Undaunted by his failure to produce a workable scheme, De Gamond then turned his attention to the idea of a bridge, which he proposed to construct between East Ness Corner and Calais. This again would have entailed great obstruction to navigation, and any bridge project has the further disadvantage of being extremely vulnerable.

It is interesting from an historical point of view to mention that the bridge project put forward by Schneider and Hersant in 1889 received the support of such well-known bridge engineers as Sir John Fowler and Sir Benjamin Baker; details of the bridge were given at a meeting of the Iron and Steel Institute in Paris. Crossing the Channel from Cap Gris Nez to Folkestone, the longest spans were to be 1,638 ft. in length (as compared with 1,640 ft. in the case of the Forth bridge), while the shortest was to be 320 ft. The columns of this huge structure were to rest on masonry supports, each 130 ft. high, providing a minimum height of 180 ft. above water level.

In the 'sixties and 'seventies of last century many suggestions were again put forward, one in particular creating considerable interest. This was due to James Chalmers, who published a book in 1861 in which he described his proposal for a submerged tube to be laid on the bed of the Channel, and to be ventilated by three huge towers rearing their heads above the sea. Obviously any form of submerged tube has grave disadvantages, for it would affect tides and currents very considerably, and probably cause considerable silting.

The year 1867 may be considered as the most momentous in Channel Tunnel history, for in that year William Low, M.Inst.C.E., conceived a plan of attack which has never been bettered, and he was the first engineer to put forward a scheme based on thoroughly sound engineering practice. Low was one of the best-known civil and mining engineers of his day, and carried out a large amount of railway and tunnel work. His scheme for the Channel Tunnel provided for twin tunnels, each 18 ft. in diameter and 33 miles long, the submarine portion having a length of 24 miles. These two tubes were to be connected by transverse galleries at intervals of about 110 yards to help ventilation and the tunnel was to be located about 150 ft. below the Channel bed.

Detailed plans for this scheme were presented by Low and G. F. Thomas to Napoleon II, in the same year, the Emperor being greatly intrigued by the ventilation possibilities of the twin tunnels. With typical Gallic wit he remarked: "I see perfectly; you give us English air through one tunnel and we shall send you French air through the other."

The formation of the Channel Tunnel Company in 1872 was followed in 1875 by a concession being obtained by the French Channel Tunnel Company from their Government, and a shaft was sunk at Sangatte, near Calais. From this shaft they subsequently drove a heading about 1½ miles in length and in the same year the South-Eastern Railway voted £20,000 for research. The Channel Tunnel Company also obtained powers to make trials at St. Margaret's Bay, near Dover. Low's plan for a railway tunnel was adopted by the railway company in 1881 and two shafts were sunk, one at Shakespeare's Cliff and one at Abbot's Cliff; from the former a 7-ft. heading was driven for about 2,000 yards, and from the latter a similar heading 880 yards long.

From all this it would seem that the great project was at last launched upon its course when, like a bolt from the blue, came a permanent injunction, sponsored by Mr. Joseph Chamberlain in 1882. Matters of national defence and high policy intervened to stop the venture.

Since that time the matter has been thrashed out from every conceivable point of view, but the author considers that there is only time to deal with the technical side of the problem, itself a fascinating study. Geologists have proved that the grey or Rouen chalk extends in a thick continuous bed across the Channel, and it is believed that there should be no insuperable difficulty in tunnelling through this material.

The Channel Tunnel Committee Report, presented to Parliament in 1930, is an extremely interesting document and worthy of close study. The Committee were assisted by three well-known firms of consulting engineers, who reached the conclusion that a pilot tunnel would be essential to prove the feasibility of the whole scheme; this would cost £5,600,000 and would take five years to construct. The main tunnels, which would be twin tunnels, as proposed by William Low, would involve the expenditure of £25,300,000 and would take another three years to construct and equip for an electric railway. After weighing all the evidence, which covered every aspect of the scheme the Committee came to the decision that although some interests would be adversely affected, the Channel Tunnel, would be of economic advantage to the country.

So the matter rests today, but at present we must obviously regard with the greatest suspicion, in view of recent bitter happenings, any project which tends to make us more vulnerable than we already are to unscrupulous gangsters who pretend to represent their countries. Let us hope that in the not too distant future it may prove possible to reconsider the scheme, but this will have to be in an atmosphere purged of traitors, parachutists and similar pests.

One of the most important points which occurs to the author is that it will be useless to incur this vast expense if the works have to be flooded in wartime. Under such conditions the whole effort and expense would go for nothing.

Finally, the author is convinced that this great work could be carried out and that if political conditions could be stabilized on the Continent, then it would be of inestimable advantage to all. Let us hope that such conditions will speedily come to pass, but this may be delayed for a long time yet.

THE "HALIFAX" FOUR-ENGINED BOMBER

From *The Engineer* (London), September 19th, 1941

On Saturday, September 13th, details were released by the Air Ministry of the Handley-Page bomber, which, together with the "Stirling" and other types, forms the spearhead of the Royal Air Force offensive on Germany. The "Halifax" is an all-metal midwing monoplane, having a wing span of 99 ft. and a length of 70 ft., with a height of 22 ft. It is powered with four Rolls-Royce "Merlin" twelve-cylinder liquid-cooled engines, and has three-bladed airscrews. The fuselage is rectangular in shape and the position for the bomb aimer is arranged under the forward turret. It carries heavy defensive armament and is furnished with slotted flaps for the purpose of giving improved take-off. De-icing equipment is fitted, not only, as usual, to the wings but to the tail unit and to the airscrews. It is mentioned that points in the construction which may assist identification include square wing tips, and a rectangular tailplane with the twin fin and rudder units at its extremity. During last week Lord and Lady Halifax visited a Southern aircraft factory, and Lady Halifax, who a few weeks ago launched the thousandth bomber from a certain American aircraft works on its way to England, performed the naming ceremony for a new Halifax bomber. In a speech made by Lord Halifax reference was made to the part that that type of machine had recently played in heavy bombing attacks on Berlin and Turin.

ELECTRICITY SUPPLY IN THE BRITISH EMPIRE

From *Engineering* (London), September 26th, 1941

In his address to the London Students' Section of the Institution of Electrical Engineers, on August 27, Mr. J. R. Beard, the President of the Institution, gave an interesting account of the various ways in which the organization of public electricity supply has been carried out in the different countries of the Empire. He began by pointing out that the ultimate possibilities of electrical development in the vast areas concerned was almost impossible to visualize. Many of the countries were but sparsely populated and it was to this country, as the chief manufacturing centre of the Empire, that they would look for electrical equipment for many years to come. It was probable that the majority of his hearers would ultimately be concerned with Empire electrical development, either by taking some part in manufacture at home, or proceeding to some Dominion or Colony for the erection or operation of plant. The close connection of the Institution with this great sphere of electrical enterprise was illustrated by the fact that already one-fifth of the total membership was made up of overseas members; these were mainly domiciled in the Dominions.

The fields of major importance were naturally furnished by Canada, Australia, New Zealand, South Africa, India and the Far East, but many of the smaller countries offered considerable scope for future development. As an example, there were enormous sources of potential water power in British Guiana, as well as in the West Indies, West and East Africa, and Palestine, the relatively small installations at present existing representing only the beginnings of power supply over large areas. The electrical manufacturing production of Great Britain for home use was valued at 109,000,000£ ,per annum; for export to the Empire 18,000,000£, and to foreign countries 7,000,000£. In 1938, Great Britain supplied 70 per cent of the electrical imports of Australia, 16 per cent. of those of Canada and 51 per cent. of those of India. The figures for Eire, New Zealand and South Africa were respectively, 66 per cent., 61 per cent., and 60 per cent. In Australia there was an electrical manufacturing industry which, in 1938, had an output valued at 5,200,000£, the corresponding output in Canada having a value of 20,000,000£.

Turning to the organization of electricity supply in the various countries, Mr. Beard first dealt with Canada. In that country, 93 per cent. of the total generating capacity was in the form of hydro-electric plant which produced 98 per cent. of the total annual output. One quarter of this was off-peak power utilized for industrial heating, in paper works, for aluminium production, and extensively for domestic water heating. The general standard of consumption was four times that of Great Britain, possibly due to the general availability, especially in rural areas. The United States standards of 110 volts to 115 volts and 60 cycles, dominated Canadian practice. Canada, like Australia, was a Federation of Provinces and the Federal Government took no part in electrical matters. In the organization of electricity supply, Ontario and Quebec were of chief interest as they accounted for more than 80 per cent. of the Canadian output.

Mr. Beard then dealt with the organization of the Hydro-Electric Power Commission of Ontario, which came into existence in 1907. It is not necessary to reproduce this part of his address as the matter was dealt with on page 232 of our issue of last week. Some additional figures he gave may, however, be quoted. The Commission now owned 45 power stations, of capacities ranging up to 400,000 kw. and had a total load of 1,500,000 kw. It acted as agent and trustee for a partnership of 850 municipalities. In Quebec, the Provincial Government had hitherto exercised little influence over the electric-supply industry, which was mainly in the hands of a number of large companies. A Provincial Electricity Board was, however, established in 1937, to act as a regulating and controlling authority. A National Electricity Syndicate was also set up to develop generating plants and distribution systems, particularly with a view to the supply of rural areas. These organizations were roughly counterparts of the Electricity Commissioners in this country and the Hydro-Electric Commission in Ontario. It seemed probable that a provincially-controlled system of generation and distribution would ultimately replace private enterprise. Other provinces, such as Nova Scotia, Manitoba and Saskatchewan had smaller organizations based on the model of Ontario, but in British Columbia supply had been left entirely to private companies and the municipalities.

In New Zealand, where the sole right to use waterpower was vested in the Crown, over 90 per cent. of the annual output was obtained from hydro-electric stations. The first undertakings were established by local authorities and companies to which the government granted rights to develop certain areas. The Government itself entered the industry in 1910 when it began work on the Lake Coleridge scheme. Since that time operating through the Public Works Department, it had built or purchased plant and transmission lines forming complete interconnected systems in each island. The installed capacity in the North Island was 194,000 kw. and a further 174,000 kw. was under construction. In the South Island there were 73,500 kw. installed and 77,000 kw. under construction. In 1939, Government stations generated 90 per cent. of the 1,400 million units produced. The standard distribution voltage was 400-230. Although the policy of the Government had been to generate bulk power, retail distribution had been left to local authorities or Electric Power Boards responsible for sparsely populated areas. There were 31 such boards. Conditions in New Zealand were unusual in that generating and bulk supply were in the hands of an ordinary Government department.

In Australasia, various arrangements were in operation. On the mainland of Australia, practically all development was confined to the neighbourhood of the large cities, Sydney, Melbourne, Adelaide, Brisbane and Perth. In Brisbane, the Government was encouraging the amalgamation of various small private concerns into a private monopoly, ultimately to be taken over by the Government. Sydney had several large stations for municipal and urban supply, the 75,000 kw. installation at Balmain being of considerable technical interest as it operated at 1,200 lb. per square inch and 900 deg. F. The New South Wales Railways supplied its 311 miles of electrified track from its own generating station in Sydney. Melbourne had 439 track miles of suburban electrified line. In Victoria, a State Electricity Commission had been formed to undertake generation and bulk and retail supply. It had 10,000 miles of high-tension line.

In India, as in Australia, while certain districts were extensively electrified, others, particularly rural areas, were practically undeveloped. About half the total power was generated in hydro-electric stations. These were mainly situated in the North West Frontier District, the Punjab, the Tata group near Bombay, Madras and Mysore. Steam generation predominated in the United Provinces, Calcutta and Hyderabad. There was a certain amount of railway electrification, but the average consumption of the country was very low, being only five units per head of population. In Ceylon, Burma, the Malay States, Hong Kong and Shanghai, steam power predominated. Electrification, in general, was confined to the large towns, although the supply to the tin-mining area served by the Perak River undertaking was an important exception. In South Africa, the main development had also been in the neighbourhood of the large towns, such as Johannesburg, Cape Town, and Durban. In Natal, however, the supply for the railway from Durban to the Transvaal had been tapped at intervals to supply outlying towns. Owing to the influence of continental practice due to the strong Dutch interest, the standard supply in South Africa was given at 380-220 volts.

ATMOSPHERIC POLLUTION

From *Engineering* (London), September 5th, 1941

The Department of Scientific and Industrial Research has announced that the various bodies co-operating in the study of atmospheric pollution have agreed to a proposal to suspend publication of the annual reports for the duration of the war. The suspension applies to the 26th annual report for the year ended March 31, 1940, but, for the information of the co-operating organizations, a summary of the work done during that year, has been prepared by the Superintendent of Observations. This shows that the numbers of instruments maintained were as follows: deposit gauges, 127; automatic filters, 11; volumetric sulphur apparatus, 12; lead-peroxide apparatus, 60. On the outbreak of war, observations with some instruments were discontinued; in most cases, however, only temporarily.

The results obtained with the deposit gauges as summarized, by the figures for the total solids deposited, were as follows, the results for the previous year being given in brackets in each case: Class A, 31 (26); Class B, 69 (72); Class C, 0 (1); Class D, 0 (0). This shows that, in the year under review, there was an increase in the number of stations where the deposit ranked as Class A; in other words, the deposit over the whole country, as measured by the gauges, had decreased. This result continues the improving trend indicated by the diagram, Fig. 1, on page 88 of the previous annual report. The highest total deposit measured during the year (395 tons per square mile) was recorded at Manchester, and the lowest (57 tons) at Loggerheads. Both of these figures were less than the corresponding recordings in the previous year.

There were only three complete sets of results with automatic filters, namely, those from Cardiff, Coventry, and Stoke-on-Trent, and these alone are insufficient to provide a basis for comparison with previous figures; but the average monthly suspended impurity does show interesting characteristics (notably maxima) in January, 1940, which was unusually cold. This increase in suspended impurity was due, undoubtedly, to increased domestic heating, despite local shortages of fuel. All three places show such an increase in October, followed by a minimum in November, although the average temperature for that month was lower than the average for some 50 years. It is conjectured that the extension of Summer Time until November 20, 1939, and the restrictions imposed by the fuel rationing scheme, were responsible to some extent for the minima recorded during that month. Complete results for the measurement of sulphur-dioxide concentration by the volumetric method were obtained from the stations at London (Beckton and Crossness), Salford and Sheffield. The averages were slightly lower than those for the previous year. The measurement of sulphur gases by the lead-peroxide method did not show any unusual features.

Measurements of suspended impurity made in Central Park, New York City, by means of the automatic filter, showed that the air was purest between 1 p.m. and 3 p.m., whereas the measurements for British cities have invariably shown that the early morning air was the cleanest. This difference is presumed to be due to the greater convectional turbulence of a continental climate in the day time, resulting in a distribution of the pollution through a greater depth of atmosphere, and a corresponding reduction in the concentration at ground level. Further measurements made in Dublin showed an interesting correspondence between the concentration of sulphur dioxide and the suspended impurity, the two curves of average monthly values showing noticeable parallelism. Results with the automatic filter at Leinster Lawn, Dublin indicated a ratio of domestic to industrial pollution of 3.3 to 1 in winter and 2.3 to 1 in summer.

SANITATION FOR AMERICAN ARMY CAMPS

From *Engineering* (London) August, 1941.

In connection with the establishment of a number of permanent camps for the United States Army, a firm of consulting engineers has drafted the basic requirements for sewage treatment plants. The systems of treatment vary widely, including sludge digestion, activated sludge, preliminary and secondary filtration, chlorination, and single-stage and double-stage bio-filters. The quantities assumed average 70 gallons per capita per day, with a maximum of 140 for several hours, and a peak of 210 gallons. Suspended solids will average 460 parts per million, or 0.27 lb. per capital per day. Grit chambers are not generally used, but if provided they should be cleaned by hand and the grit disposed of by burial. Bar screens of 1 in. to 1½ in. openings may be cleaned by hand or by mechanical devices, the screenings to be buried or burned in an incinerator. In primary sedimentation tanks the period is three hours for trickling filter plants, 1½ hours for activated sludge and 6 to 7½ hours for bio-filter plants. Trickling filters are designed for 5,000 population per acre-foot in mild climate, or 4,000 where severe winters prevail. Final sedimentation tanks, 10 ft. to 12 ft. deep, are to have a flow not exceeding 800 gallons per square foot per twenty-four hours, or 1,600 gallons in two-stage bio-filter plants. Heated sludge digestion tanks are to have 2 to 3 cubic feet per capita, or 50 per cent more capacity for unheated tanks or for activated sludge plants. For Imhoff tanks the capacity to be 2 to 2½ cubic feet per capita with plain sedimentation alone, or 3 to 3½ cubic feet with trickling filter. For sludge drying beds in warm climates, without underdrains or filtering material, the capacity may be 2 to 3 square feet per capita. For plants of the trickling filter type the figures may be ½ to 1 square foot, or 1 to 1½ square feet for plants of the activated sludge type. In any case, provision is made for chlorination of the effluent. The selection of system of treatment depends largely on size and area of the camp and the general character of its surroundings.

DNJEPROGES DAM

From *Civil Engineering and Public Works Review* (London), September, 1941

The reported destruction of the great Lenin-Dnjeproges Dam, at Zaporoje, on the Dnieper River, by the retreating Russian armies under Marshall Budenny, comes as a shock to civil engineers. This deliberate act in the pursuance of the "scorched earth" policy so faithfully followed by the Russian people, brings into clear relief the ugliness of war in all its grim reality. This great dam was the pride of all Russia and was always instanced as a example of the success of the new regime and its determination to make Russia independent of foreign manufactured goods.

The great dam, built of ferro-concrete, was finished in 1932 mainly by the use of American skill and knowledge. At the dam was situated what is generally considered to be the largest hydro-electric plant in the world and was planned to have an annual output of 3,000,000,000 kilowatt hours. The passage of ships along the river was arranged for by means of locks.

The great Ukraine industrial centres were in large measure dependent upon power from these works. The iron mines of Krivoi Rog were entirely dependent upon its power, so, too, were the manganese mines of Nikopol, over a hundred miles east at Stalin Makeyevka. Kharkoff, the great Ukrainian industrial centre, was largely dependent upon this hydro-electric plant for its power. The magnitude of the disaster is realized when it is considered that 30,000,000 people are dependent for their livelihood upon the power derived from this dam.

From Month to Month

News of the Institute and other Societies, Comments and Correspondence, Elections and Transfers

CO-OPERATION IN NEW BRUNSWICK

Negotiations which have been carried on for some time between the Council of the Association of Professional Engineers of New Brunswick, and the Institute's Committee on Professional Interests have resulted finally in a draft of a co-operative agreement which is to be submitted to the members of the Association and the members of the Institute within the province.

The text of the agreement appears in this number of the *Journal*. A ballot will be sent shortly to all Councillors of the Institute and to corporate members in the province, in accordance with the requirements of By-law No. 78.

This will be the fourth agreement to be negotiated with the professional associations, and it is hoped that it will receive the same enthusiastic support by ballot as was accorded those in Saskatchewan, Nova Scotia, and Alberta. The successful result of the other agreements is a convincing proof of the value of such understandings and arrangements between engineers.

ECHOES OF THE ANNUAL MEETING

Those who attended the annual meeting this year in Hamilton, will well remember the address delivered at the banquet by Dr. W. E. Wickenden, president of the Case School of Applied Science. His topic "The Second Mile" gave him an opportunity to emphasize the professional possibilities of the practice of engineering.

It was interesting to see the amount of attention that was given to this address both in Canada and the United States. It was referred to in many places. A recent number of the weekly bulletin of the Cleveland Engineering Society partially sums up the case, and again pays tribute to a masterful accomplishment. It reads in part as follows:

"There are certain inspired moments in our lives which enable us to put into words thoughts which seem to take wings and soar into the realm of immortal expressions. Such an occasion was the address delivered by Dr. William E. Wickenden, President of Case School of Applied Science, at the Annual Banquet of the Engineering Institute of Canada in Hamilton, Ont., this past February. Since that address was first given it has been reprinted in part, or commented on in countless Engineering Bulletins throughout our nation. 'The Baltimore Engineer' reprinted it in its entirety, the 'Rochester Engineer' devoted four columns to it. Mr. Everett S. Lee of the General Electric Company wrote: 'Would that every engineer would read and study the address on 'The Second Mile' delivered by Dr. Wickenden.' Mr. Stetson, editor of "Mechanical Engineering' in the April, 1941, issue wrote: 'We ought to pluck Dr. Wickenden out of his many duties and send him around the country to carry this message to all engineers.' Dr. Wickenden quoted a preacher who was reproached for straying too widely from his text and who replied: 'A text is like a gate, it has two uses; you can either swing on it, or you can open it and pass through.' "Let us pass through" was Dr. Wickenden's conclusion.

"To be useful, they, the engineers must be team workers; and they must be prepared to deal with 'men and their ways,' no less than 'things and their forces.' The engineering profession will exercise a far greater influence in civic and national affairs. It will probably never be able to define its boundaries precisely, nor become exclusively a legal caste, nor fix a uniform code, of educational qualifications. Its leaders will receive higher awards and wider acclaim, the rank and file will probably multiply more rapidly than the elite, and rise in the economic scale to only a moderate degree."

"It is unfortunate that our space will not permit a more detailed account of the many gems found in Dr. Wickenden's article, but let us in the writer's words "open the gate and pass through it to the Second Mile." We are proud that Dr. Wickenden is a member of our Cleveland Society."

WARTIME BUREAU OF TECHNICAL PERSONNEL

MONTHLY BULLETIN

Several interesting things have been disclosed by the examination of the twenty-five thousand questionnaires which have been returned to the Bureau, but perhaps the most interesting is that practically everyone who was not engaged on essential work answered question number seventeen in the affirmative. This question asks if the person is willing to transfer to war work under certain specified conditions, including no reduction in income.

The questionnaire also shows that the majority do not ask for more money in any new position to which they might be transferred. In fact, in many cases, the services have been offered for war work at a substantial reduction from present earnings.

It is strikingly apparent that the professional group has a high concept of its obligations and duties to the nation. The information gathered from the questionnaires is corroborated by interviews in the office and subsequent correspondence. The opinion is expressed generally that the individual is willing to be told where he should work, and desires some form of regulation that will make certain that he shares with others in the war effort.

Many persons have sent pleading letters, that their services might be used in the national emergency and have offered to go any place, for any occupation, at almost any wages. It is true that the war requirements at the moment do not seem to offer suitable work for all these people, but it is significant that they desire to get in and help without profit to themselves.

The demand for mechanically trained engineers continues to be great, and the supply of unemployed in this group is a thing of the past. The Bureau has found persons who are competent to fill important positions in war industry occupied at least partially in non-essential work. The negotiations to get these men released for more important work have been long and not always successful. If hundreds of men are to be secured this way to fill the hundreds of openings that have been reported to the Bureau, it is going to be a long drawn out and not very efficient procedure.

At present there is no machinery to adjudicate on the value of the work being done as compared to other work which is seeking the services of an engineer. If some authority were established to rule quickly in such cases, and to authorize the transfer when such action seems to be in the best interests, it would not only speed up the work of finding the necessary personnel, but would be welcomed by employer and employee as a solution of their common problem.

The questionnaires for the research science group are now being distributed, and the inquiries for persons of this type are increasing. Already placements have been made in important places, and it is expected this division of the Bureau's activity will shortly gain momentum and importance.

PROPOSED AGREEMENT BETWEEN THE ENGINEERING INSTITUTE OF CANADA AND THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF NEW BRUNSWICK

MEMORANDUM OF AGREEMENT made in duplicate at the City of Saint John, in the Province of New Brunswick, this............ day of.................., 194....

BY AND BETWEEN:

THE ENGINEERING INSTITUTE OF CANADA, a corporation duly incorporated under the laws of the Dominion of Canada, having its head office in the City of Montreal, in the Province of Quebec, herein acting by its President and General Secretary, duly authorized for the purposes hereof by a resolution of its Council passed at a meeting duly called and held on the............day of ...., 194.., hereinafter called the Institute,

Party of the First Part,

and

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF NEW BRUNSWICK, a corporation duly incorporated under the laws of the Province of New Brunswick, having its head office at the City of Saint John, in the Province of New Brunswick, herein acting by its President and Secretary duly authorized for the purposes hereof by a resolution of its Council passed at a meeting duly called and held on the............day of...................., 194.., hereinafter called the Association.

Party of the Second Part.

WHEREAS it is desirable in the interest of the engineering profession that there be close co-operation between the Institute and the Association and

WHEREAS such close co-operation will be promoted if, so far as is practicable, there is effected:

(a) A common membership in the Institute and in the Association in the Province of New Brunswick.

(b) A simplification of existing arrangements for the collection of fees.

(c) A common interest in the training of young engineers.

NOW THEREFORE, the parties hereto agree with each other as follows:

1. (a) Every person resident in the Province of New Brunswick who, on the date of this agreement, is registered as a professional engineer under the provisions of Chapter 55 of the Statutes of the Province of New Brunswick, 10 George V (1920), and amendments, and is not a corporate member of the Institute, shall have the right, under the provisions of this agreement, to become a corporate member of the Institute. Any such registered professional engineer shall notify the secretary of the Association in writing within the first year of the term of this agreement if he desires to become a corporate member of the Institute under the conditions of this agreement.

(b) Any person resident in the Province of New Brunswick registering as a professional engineer in the Association subsequent to the date of this agreement, who is not a corporate member of the Institute, shall upon such registration become a corporate member of the Institute unless he notifies the Secretary of the Association of his desire to the contrary.

(c) Every person resident in the Province of New Brunswick, who is enrolled as an Engineer-in-Training with the Association, may become a Junior of the Institute providing he becomes and remains a subscriber to *The Engineering Journal*. Every person resident in the Province of New Brunswick, who is enrolled as a Student with the Association, shall also be a Student of the Institute.

(d) Members, Engineers-in-Training or Students of the Association who become Members, Juniors or Students, respectively, of the Institute, under the provisions of this agreement, shall not be required to pay the entrance or transfer fees of the Institute.

2. (a) Any corporate member of the Institute who is, at the date of this agreement, or who, within twelve months of such date becomes, a resident of the Province of New Brunswick, shall have the right to become a member of the Association, such right to be exercised by written notice to the Secretary of the Association, and all entrance fees otherwise payable to the Association shall be remitted, provided that application for membership in the Association is made within the first twelve months of the term of this agreement.

(b) Any corporate member of the Institute who becomes a resident of the province subsequent to twelve months from the date of this agreement, may become a Member of the Association, if qualified for such membership, upon payment to the Association of the difference in the amount of the entrance fee already paid to the Institute and the current entrance fee of the Association, providing that application for membership is made within twelve months of the date of his becoming a resident of the Province of New Brunswick.

(c) Every Junior or Student of the Institute resident in the Province of New Brunswick shall be enrolled with the Association as an Engineer-in-Training or a Student, respectively.

(d) Juniors or Students of the Institute who become enrolled as Engineers-in-Training or Students, respectively, with the Association, under the provisions of this agreement, shall not be required to pay the entrance fees of the Association.

3. (a) The Association shall, on behalf of the Institute, collect from each Member of the Association, who is also a corporate member of the Institute, the sum of six dollars ($6.00) per annum, which fee shall be in lieu of the ordinary annual corporate membership fee of the Institute. This fee shall entitle the member of the Association to the Institute classification of Member (M.E.I.C.) and to those privileges of the Institute membership provided by its by-laws, and shall include the annual subscription to *The Engineering Journal*. The payment of the six dollars ($6.00) shall not apply in the case of an Honorary, Paid-up or a Life Member of the Institute.

(b) The Association shall, on behalf of the Institute, collect from each Engineer-in-Training of the Association, who is also a Junior of the Institute, a fee in lieu of the ordinary annual Junior membership fee of the Institute, which shall be mutually agreed between the Secretary of the Association and the General Secretary of the Institute but which shall not be less than one dollar ($1.00) per annum, and from each Student of the Association, who is also a Student of the Institute, a fee so agreed in lieu of the ordinary annual Student membership fee of the Institute, which shall not be less than fifty cents (50c.) per annum.

(c) Such fees shall be due to the Institute on the............day of..................of each year, in respect of the year commencing on such due date, and shall be paid by the Association to the Institute as collected by the Association. Such fees shall be billed together with any fees due to the Association as one total fee.

4. It is agreed that the branches of the Institute in New Brunswick shall continue actively to function as such during the term of this agreement, and that the Association shall contribute to their support. To enable such functioning there shall be set up and continued from year to year during the term of this agreement a committee of five members, all of whom shall be members of both the Association and the Institute to be known as the Joint Finance Committee; two of said members shall be appointed annually by the Council of the Institute; two members shall be appointed annually by the Council of the Association, and the fifth member shall be appointed annually by the four members aforesaid and shall be the chairman of the Committee. In case the four members aforesaid fail to appoint the fifth member within thirty days from the date of their appointment, the said fifth member shall be appointed by the president of the Institute within a further period of thirty days. The said committee shall recommend to the Council of the Association, annually, the sums of money to be paid to the branches of the Institute for their operation, and such sums to be paid by the said Association shall be such that the ordinary revenue of each branch shall be the same as if this agreement were not in effect.

5. Nothing in this agreement shall prevent either party hereto from exercising its rights and privileges with respect to the disciplining, the suspension, or the expelling of any of its members, in accordance with its charter and by-laws.

Before final action is taken by either party with respect to the disciplining, the suspension, or the expelling of one of its members affected by this agreement, it shall furnish the other party with sufficient information to enable it to determine whether the circumstances warrant action by the other party, but neither party shall be affected by the lack of action by the other party.

6. This agreement is intended to apply to the residents of the Province of New Brunswick only, and no person who is not a resident of the Province of New Brunswick may become or continue to be a member of the Institute in good standing under this agreement, but may continue to be a member in good standing, on the same conditions as if he had been admitted as a member of the Institute without reference to this agreement.

7. The terms and conditions of this agreement may be amended by mutual consent, in writing, between the Councils of the parties hereto duly authorized where necessary by their respective bodies and executed by their accredited officers.

8. The term of this agreement shall be the period commencing on the....................day of.................., 194.., and ending on the..................day of................, 194.., but unless either of the parties hereto has given notice to the other at least six months prior to the said..........day of.................., 194.., that this agreement shall terminate on the said..............day of................, 194.., it will continue in full force and effect after the said.......... day of.................., 194.., from year to year, subject to termination, at the end of any such subsequent year, by six months' prior notice of intention to terminate given by either of the parties hereto, to the other. Notice of termination of this agreement shall be given by the delivery by one party to the other party of a certified copy of a resolution of the Council of the one party to that effect.

9. This agreement shall not come into operation unless a percentage of the membership of the Association, acceptable to the Council of the Institute and to the Council of the Association, takes full advantage of its provisions.

In witness whereof these presents have been duly executed on behalf of the parties hereto on the date and at the place above written.

THE ENGINEERING INSTITUTE OF CANADA

IN THE PRESENCE OF

....

....
President.

....
General Secretary.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF NEW BRUNSWICK

....

....
President.

....
Secretary.

CORRESPONDENCE

The Editor, Ottawa, October 25, 1941.
The Engineering Journal,
Engineering Institute of Canada,
2050 Mansfield Street, Montreal, Que.

Dear Sir:

Would you be good enough to allow me space in your publication in which I may thank your readers who have co-operated with the Wartime Bureau of Technical Personnel by completing the recently circulated questionnaire. Many thousands of engineers, chemists, and architects have placed their records with the Bureau, and thus have aided materially in the Bureau's problem of finding technical personnel for the active service forces, departments of government, and war contractors.

Many questionnaires have been circulated recently by various organizations and frequently one hears adverse comments about such things. Doubtless there is some reason for this criticism, but on the other hand, I feel it should be recognized that under many circumstances this is not only the best but the only method of securing fundamental information.

I would like your readers to know that the Bureau is functioning with considerable success. I am gratified to find that so many men have been placed, and that actual costs have been kept at a low figure. As technical personnel, and tax payers, your readers will be interested in this information.

Some people have misunderstood the purpose of the questionnaire, and have felt that they should have received some communication or offer of work after they had registered. On the form it was explained that it was not an application or offer of work, but simply a record of the person's qualifications and availability. We have had letters at Ottawa which indicate that there has been some confusion on this point.

Many persons have written letters offering their services immediately, and in some instances have expressed the thought that they were especially equipped to do important work. Unfortunately, employers to whom we have submitted these records have not always agreed on this point, and consequently acceptances of the offers have not followed. It is easy to understand that some persons may become impatient when their services are not immediately snatched up, but I am certain that if they had a better understanding of the needs of industry, they would appreicate the difficulty of finding quickly an opening where they could be used to advantage.

It is not right to regard the Bureau as an employment agency in the ordinary sense. Under existing conditions, its real purpose is to find men who can fill openings which are recorded with the Bureau, rather than to find openings for men who happen to be out of work or who desire to take a greater part in the war effort. I have seen some letters where persons have expressed indignation at the failure of the Bureau to place them. Naturally, we regret such instances, but we can only place men when the prospective employer finds them to be suitable.

The leadership that the engineers, chemists, and architects have given in establishing and supporting the Bureau must bring a great deal of satisfaction to your readers, as well as to many others. It is my belief that the future operation of the Bureau will add materially to this satisfaction.

While the principal purpose of this letter is to thank your readers who have met our requests, I would like to speak also to those who have not returned the questionnaires. The work of the Bureau is of great importance to the individual, as well as to the nation's effort, and yet without a complete record of information, the work cannot be done satisfactorily. May we count on your support ? If by chance the original questionniare has been mislaid, a duplicate will be sent to you upon request. Thank you.

Yours truly,
(*Signed*) E. M. Little, *Director.*

To the Editor:

Sir:

On page 23 in the advertising section of *The Engineering Journal* for September, 1941, there appears, referring to the new power plant on the St. Maurice River at La Tuque, the statement, "Pozzolith Concrete used in bulkheads". To supplement this statement, may I remark that some sever per cent of the concrete placed in the east bulkhead contained Pozzolith. For the west bulkhead, the figure was under three per cent.

Very truly yours,
J. B. Macphail,
Montreal, 28th October, 1941. M.E.I.C.

COVER PICTURE

The picture on the cover of this issue is that of the new bridge over the Richelieu river between Beloeil and St. Hilaire, Que., on the Montreal-St. Hyacinthe highway.

This bridge consists of a 258-ft. central swing span flanked on each side by three continuous plate girder spans—two of 103 ft. 6 in. and one of 102 ft.—and by a 66-ft. reinforced concrete approach span forming a total length of 1,008 ft. The substructure units, of reinforced concrete, comprise nine piers and two abutments with a protection pier (defence) for the swing span. The flooring of the bridge is of reinforced concrete with the exception of that of the swing span which consists of a creosoted-wood floor covered with asphalt planks. The roadway is 33 ft. wide with a 5-ft. sidewalk on each side and the bridge is provided with a modern electric light system.

The clearance under the swing span at mean water level is 30 ft. and the horizontal clearance 100 ft. Each of the two 66-ft. approach spans forms a viaduct over the roads that pass on both sides of the river. Construction work was started in the latter part of June 1940 and the bridge was opened to traffic on September 22nd 1941. Communications with both shores were made possible in the past by means of a ferry-boat service and the bridge now forms an important link in the Montreal-St. Hyacinthe-Quebec highway.

This bridge was built under the direction of the Department of Public Works of the Province of Quebec at an approximate cost of $525,000.

MEETING OF COUNCIL

A meeting of the Council of the Institute was held at Headquarters on Saturday, October 18th, 1941, at ten-thirty a.m.

Vice-President K. M. Cameron was in the chair; Vice-President deGaspe Beaubien, Councillors J. G. Hall, H. Massue and G. M. Pitts; Secretary-Emeritus R. J. Durley, Mr. Trudel and the general secretary were present.

Secretary-Emeritus Durley presented a revised report on prizes and awards. Each item was dealt with separately, and a very full discussion developed. Several minor changes were proposed, and Mr. Durley was asked to incorporate these in the recommendations.

The general secretary was instructed to supply each councillor with a copy of the revised report so that everyone might have an opportunity to study the proposals in detail. It will be considered again at a later meeting of Council and perhaps submitted at the annual business meeting next February.

The secretary reported that following discussions with Mr. C. C. Kirby, who had come to Montreal for the purpose, a revised draft of the proposed agreement between the Institute and the Association of Professional Engineers of New Brunswick had been prepared. It was expected that at an early date this proposed agreement would be submitted to the members of both bodies for approval.

The president had undertaken to discuss with the committee in Alberta the results of the agreement in that province. His report had not yet been received, but a letter from the registrar of the Association indicated that they were well satisfied with the percentage of members of both organizations who had taken advantage of joint membership.

The general secretary reported that he had met with the executive of the Winnipeg Branch at the time of the President's visit to that city, and had discussed the affairs of the branch and in particular the programme for the coming season.

The secretary reported that copies of the communications received from the National Construction Council and the Canadian Association of Social Workers regarding plans for post-war conditions had been sent to all councillors, but that no comments had been received. It was decided to hold this question for discussion at a later meeting of Council.

The financial statement up to the end of September had been examined by the Finance Committee and found to be satisfactory. Income was substantially ahead of the same time last year, and expenditures were approximately the same.

In view of the increased responsibilities of Mr. Trudel, due to Mr. Wright's frequent absence in Ottawa on work of the Wartime Bureau of Technical Personnel, the recommendation of the Finance Committee that Mr. Trudel be given the title of Assistant General Secretary, rather than Assistant to the General Secretary, was unanimously approved.

The general secretary reported that the Department of Labour had requested the Wartime Bureau of Technical Personnel to expand its organization so that it could take care of developments which would follow certain proposed changes in the present procedures. New regulations were being drawn up by the Department which would place a much greater responsibility on the Bureau. Among other things, this responsibility would require that offices be opened in several parts of Canada. At the moment it was considered that suitable places for such offices would be Vancouver, Winnipeg, Toronto, Montreal and Halifax.

The general secretary reported receipt of a letter from an engineer in one of the refugee camps, requesting permission to write the Institute examinations with a view to receiving some kind of a qualifying certificate to be used as a future reference. These men are classed by the government as friendly aliens, but, being of enemy nationality, could not join the Institute at the present time, even if released from the refugee camps. It was the feeling of members present that favourable consideration might be given to such a request, but it was decided to defer action until a report had been received from the Wartime Bureau of Technical Personnel which is investigating the status of these refugees and the possibility of them being released from camps, providing satisfactory work can be obtained for them.

The general secretary reported that H. J. Vennes, councillor for the Montreal Branch, had written to inform Council that he had moved to the United States, and therefore submitted his resignation. This news came as a distinct surprise and disappointment to Council. The secretary was instructed to write Mr. Vennes and inform him that under the circumstances there was no alternative but to accept the resignation and at the same time explain Council's sincere regret that such a valuable member of Council and of the Institute should be lost, at least temporarily, from the Montreal Branch activities.

The secretary reported that letters had been received from several of the branches expressing willingness to co-operate with Council in extending the facilities of the Institute to professional engineers from other countries now working in Canada. A similar letter had been received from one branch, pointing out that as many of these engineers were getting well established in Canada they should join the Institute in the usual way. It was decided to bring this matter up for further discussion at the next meeting of Council which will be held in Quebec City.

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

ADMISSIONS	
Members	2
Juniors	3
Affiliates	2
TRANSFERS	
Junior to Member	1
Student to Member	3
Student to Junior	3

The general secretary reported that following correspondence with the Quebec Branch, it had been decided that the November meeting of Council would be held in that city on Saturday, the fifteenth. Present arrangements included a branch luncheon at one o'clock with a branch meeting at two-thirty, at which the president would speak. The Council meeting would be held later in the afternoon. This arrangement would give out of town councillors an opportunity to reach Quebec during the morning, and, if necessary, return to their homes that evening. It was suggested that motor transportation from Montreal to Quebec might be arranged, details of which will be available at a later date.

The Council rose at one o'clock p.m.

ELECTIONS AND TRANSFERS

At the meeting of Council held on October 18th, 1941, the following elections and transfers were effected:

Members

deBondy, Joseph Agapit, metallurgist, Manitoba Steel Foundries Ltd., Selkirk, Man.

Neave, Roger, B.Sc. (Elec.), (Univ. of Man.), designing engr., gen. engrg. dept., Imperial Oil Limited, Sarnia, Ont.

Juniors

Gravel, Maurice, B.A.Sc., C.E., (Ecole Polytech.), Prov. Road Dept., Beauport, Que.

Kline, Joseph Douglas, B.Eng. (Civil), (N.S. Tech. Coll.), Defence Industries Ltd., Oshawa, Ont.

Mable, Wilfred H., B.Sc. (Elec.), (Queen's Univ.), elec. design engr., H. G. Acres & Co. Ltd., Niagara Falls, Ont.

Affiliates

Hebert, Adjutor J. G., designing engr., Plessisville Foundry, Plessisville, Que.

Malkin, Alfred, elec. engr., Canadian Car Munitions, Ltd., Montreal, Que

Transferred from the class of Junior to that of Member

Ramsay, William Wallace, B.Sc. (Civil), (Univ. of Man.), asst. engr. (P.F.R.A.), Dept. of Agriculture, Winnipeg, Man.

Transferred from the class of Student to that of Member

Cooper, William Everett, B.Eng. (Elec.), (McGill Univ.), i/c of engrg., Saguenay Power Co. Ltd., Isle Maligne, Que.

Strong, Robert L., B.A.Sc. (Univ. of Toronto), S.B. (Mass. Inst. Tech.), inspection work, Associated Factory Mutual Fire Insurance Companies, Boston, Mass.

Young, William Richard, B.Sc. (Civil), (Univ. of Man.), engr., E. G. M. Cape & Co. Ltd., St. Johns, Nfld.

Transferred from the class of Student to that of Junior

Buchanan, Arnold Amherst, B.Eng. (Mech.), (McGill Univ.), Engineer Officer (F/O), R.C.A.F., Camp Borden, Ont.

Giles, John Oscar, B.Sc. (Mech.), (Queen's Univ.), engrg. dftsman., Imperial Oil Limited, Sarnia, Ont.

Mackay, William Brydon Fraser, B.Sc. (Elec.), (Univ. of Man.), B.Met.E. (Univ. of Minn.), Fl.-Lieut., R.C.A.F., No. 1 Air Navigation School, Rivers, Man.

Students Admitted

Baxter, John Frederick (McGill Univ.), Belgrave Ave., East Saint John, N.B.

Baylis, Walter John, B.Sc. (Elec.), (Univ. of Alta.), 76 East Ave. No.; Hamilton, Ont.

Davis, Bruce Lumbers, B.A.Sc. (Univ. of Toronto), Saguenay Inn, Arvida, Que.

Dunbar, George G., (McGill Univ.), P.O. Box 588, Stellarton, N.S.

Extence, Alan Barr, (Univ. of Toronto), 103 Westmount Ave., Toronto, Ont.

Eyre, Alan M., (Univ. of B.C.), 4606 West 9th Ave., Vancouver, B.C.

Farago, William James, B.Sc. (Mech.) (Univ. of Sask.), 83 George St., St. Catharines, Ont.

Hogarth, James Earle, Instr'man., Dept. Works & Bldgs., R.C.A.F., St. Johns, Que.

Kraft, Robert William, M.Sc. (Queen's Univ.), Saguenay Inn, Arvida, Que.

Loane, George Herbert, (Univ. of N.B.), Campbellton, N.B.

Love, John Gordon, (Univ. of Toronto), 321 Bloor St. W., Toronto, Ont.

Mundec, Lawrence Sterling, (Univ. of N.B.), 352 Duke St., West Saint John, N.B.

Wells, James Edwin, (McGill Univ.), 4412 Draper Ave., Montreal, Que.

Personals

News of the Personal Activities of members of the Institute, and visitors to Headquarters

C. D. Howe, Hon.M.E.I.C., Minister of Munitions and Supply, has recently been awarded an Honorary Membership in the American Society of Mechanical Engineers, which will be presented to him at the annual meeting of the Society in New York in December.

C. R. Young, M.E.I.C., Dean of Engineering at the University of Toronto, was guest speaker at the Cleveland Engineering Society on the occasion of the general meeting of the fall season in Cleveland, Ohio, on October 14th. He spoke on "Transition from Peace to War" with particular reference to the engineers' share in it.

At noon the same day, a group of Toronto graduates entertained him at luncheon. There were nineteen "Schoolmen" present, including one from the class of '95, and one from '38. Dean Young also visited the Case School of Applied Science.

Dr. A. Surveyer, M.E.I.C., was appointed a director of the Shawinigan Water & Power Company, Montreal, at a meeting of the board held last month. Dr. Surveyer, a past president of the Institute, is a well-known consulting engineer.

Brig. Gen. J. P. Mackenzie, D.S.O., M.E.I.C., has recently been promoted to this rank and appointed to command infantry brigades with the Canadian army overseas. Before the war he was general manager of the Western Bridge Company, Limited, at Vancouver, B.C.

T. M. Moran, M.E.I.C., vice-president of Stevenson & Kellogg, Ltd., management engineers, is now permanently located in Toronto. He was previously connected with the Montreal office of the company.

E. G. Patterson, M.E.I.C., has recently been appointed general manager of Ottawa Car and Aircraft Limited. He became associated with the company in 1940 as assistant to the general manager and spent several months in Great Britain at the works of Handley-Page Limited with a view to preparing the manufacture of Hampden bombers in Canada. Previously he was associated with the St. Lawrence Paper Mills Ltd., the Canadian International Paper Co. Ltd., and the Northern Electric Company.

H. J. Vennes, M.E.I.C., special products engineer, Northern Electric Company Limited, Montreal, has been transferred to the specialty products division of the Western Electric Company, Kearney, N.J., and has taken up residence at Westfield, N.J. He had been connected with the Northern Electric Company since 1921 when he came from New York, where he had previously spent five years with the engineering department of the Western Electric Company to which he is now returning. During his stay in Canada, he has been connected with the designing and installation of the many carrier current telephone and telegram systems, radio broadcasting stations, sound pictures and public address systems in this country. He was responsible for several new developments along those lines.

Mr. Vennes will be greatly missed by the several friends that he had made in Canada and particularly in the Institute where he has been very active. He was chairman of the Montreal Branch in 1940 and at the time of his return to the States, he was a Councillor of the Institute. On several occasions he has delivered papers on various subjects some of which have been published in the *Journal.*

L. P. Cousineau, M.E.I.C., has recently joined the staff of Dufresne Engineering Company Limited of Montreal. He was previously connected with the Quebec Streams Commission and has been stationed for the last two years on the Ottawa River, where he acted as assistant resident engineer on the construction of the power development just completed at Rapid No. 7 near Cadillac, Que.

Mr. Cousineau was graduated in civil engineering from the Ecole Polytechnique in 1936 and he did post graduate work in Paris at the Ecole Supérieure de Soudure Autogène, from which he was graduated as a welding engineer in 1937. Upon his return to Canada, he had been with Marine Industries Limited, at Sorel, Que., for two years, where he was connected with the construction department, later becoming welding superintendent.

Major C. N. Mitchell, V.C., M.C., M.E.I.C., has been appointed to command a field company, Corps Troops, R.C.E. with the Canadian Army overseas.

John H. Legg, M.E.I.C., has recently been appointed superintendent of the Wakefield, Que., plant of the Aluminum Company of Canada Limited.

Col. D. A. White, M.E.I.C., has been appointed commandant, Canadian Army Trades School at Hamilton, Ont. He is president of D. A. White & Company Ltd., Montreal.

Malcolm D. Stewart, M.E.I.C., has obtained a commission as second lieutenant with the Royal Canadian Engineers and is at the present time attending the officers' training centre at Brockville. He was previously with Hugh C. MacLean Publications, Toronto.

J. Leslie Smith, M.E.I.C., has been loaned by the Department of Transport of Canada to the Federal Aircraft Limited, Montreal, as aeronautical engineer. He has been connected with the aeronautical engineering division of the Federal government at Ottawa since he came from England in 1930.

J. G. Welsh, M.E.I.C., has been appointed design engineer for the Bouchard Works of Defence Industries Limited, Ste. Therese, Que. He joined the engineering department of Defence Industries Limited in May, 1940, and was transferred to the Bouchard Works in June of this year acting as assistant to the resident engineer, in which capacity he took charge of the mechanical equipment section during construction.

R. W. Dunlop, M.E.I.C., has been transferred from Sarnia to Regina, Sask., with the Imperial Oil Limited.

A. J. Mickelson, M.E.I.C., is now employed as assistant engineer with The Great Lakes Paper Company, Limited, Fort William, Ont. He was previously on the engineering staff of C. D. Howe Company, Limited, at Port Arthur.

Roland Lemieux, M.E.I.C., has recently accepted the position of city engineer and secretary-treasurer of the municipality of Sillery, just outside of Quebec city. He was previously employed as assistant to the district engineer, District No. 1, with the Department of Roads for the Province of Quebec. Mr. Lemieux was graduated from the Ecole Polytechnique in 1937.

R. McD. Richardson, M.E.I.C., has joined the staff of the New Brunswick Telephone Co. Ltd., at the head office in Saint John, N.B. Since his graduation in 1924 he had been with the Bell Telephone Company of Canada Ltd.

M. W. Huggins, M.E.I.C., has joined the staff of the department of civil engineering at the University of Toronto. He was formerly lecturer in civil engineering at Queen's University, Kingston, Ont.

Lieut. Philip Hughes, R.C.N.V.R., M.E.I.C., is at present serving as engineer officer on H.M.S. Ramillies.

Flying Officer W. E. Seely, M.E.I.C., who joined the Royal Canadian Air Force a few months ago, has been posted as engineer with the works and buildings department, No. 8 Service Flying Training School at Moncton, N.B.

E. R. Brannen, Jr.E.I.C., has joined the staff of Spruce Falls Power & Paper Company at Kapuskasing, Ont. He was previously connected with the Canadian Johns-Manville Company, Limited, at Asbestos, Que.

E. A. Russell, Jr.E.I.C., has received an academic fellowship in sanitary engineering at the University of Toronto. He was previously on the maintenance and construction staff of Canadian Industries Limited at Beloeil, Que.

J. W. Brooks, Jr.E.I.C., is at present employed with the H. G. Acres Company at Niagara Falls, Ont. He was previously a lecturer in civil engineering at Queen's University.

Roger K. Cheng, S.E.I.C., has recently been commissioned a second lieutenant in the Canadian Army and is attending a signals course at Brockville. He was graduated in electrical engineering from McGill University in 1937. Lieutenant Cheng is said to be the first Chinese to receive a commission in the Canadian Army.

C. E. Green, S.E.I.C., is at present employed with the engineering department of Defence Industries Limited at Ste. Therese, Que.

Jean Lacombe, S.E.I.C., was erroneously reported, in the last issue of the *Journal*, as having joined the staff of Dominion Bridge Company, Limited, Montreal. Mr. Lacombe is still employed with the Quebec North Shore Paper Company at Baie Comeau, Que., on the engineering staff.

B. D. McDermott, S.E.I.C., is employed with Fraser Brace Engineering Co. Limited at Shawinigan Falls, Que. He had previously been located at Nobel.

A. J. Ring, S.E.I.C., has recently been transferred from the Montreal to the Toronto office of Defence Industries Limited.

J. L. Vaillancourt, S.E.I.C., has recently been commissioned as a pilot officer in the Royal Canadian Air Force and will report this month at No. 1 Air Navigation School at Rivers, Man. In the last few months he had been with the city of Outremont, Que. He was graduated from the Ecole Polytechnique in 1940.

Harold T. Kummen, S.E.I.C., is employed on the staff of the Aluminum Company of Canada, Limited, at Arvida, Que. He was graduated in electrical engineering from the University of Manitoba last spring.

Edward I. Wigdor, S.E.I.C., is employed as a technical officer with the British Air Commission at the Vultee Aircraft Limited, Los Angeles, Cal.

J. M. Courtright, S.E.I.C., is employed with the Shell Oil Company of Canada, Limited, in their refinery at Montreal. He was graduated in civil engineering from Queen's University last spring.

E. W. McKernan, S.E.I.C., has joined the staff of Canadian General Electric Company Limited and is at present taking the test course at Peterborough, Ont.

William Tkacz, S.E.I.C., is employed as process engineer with the Ottawa Car and Aircraft Limited at Ottawa. He was graduated in mechanical engineering from Queen's University last spring.

J. F. Ross, S.E.I.C., is employed with the Aeronautical Inspection Directorate, Royal Canadian Air Force, and is stationed at Winnipeg, Man.

VISITORS TO HEADQUARTERS

C. C. Kirby, M.E.I.C., secretary, Association of Professional Engineers of New Brunswick, Saint John, N.B., on September 29th.

P. E. Cadrin, Jr.E.I.C., Sorel Industries Limited, Sorel, Que., on September 29th.

John E. Cade, M.E.I.C., assistant chief engineer, Fraser Companies Limited, Edmundston, N.B., on October 2nd.

P. Turner Bone, M.E.I.C., Calgary, Alta., on October 2nd.

J. M. Courtright, S.E.I.C., Ottawa, Ont., on October 2nd.

Flt. Lieut. J. M. Pope, Jr.E.I.C., Royal Canadian Air Force Headquarters, Ottawa, Ont., on October 4th.

Ernest Davis, M.E.I.C., comptroller of Water Rights and member of Water Board, Province of British Columbia, Victoria, B.C., on October 9th.

T. A. Lindsay, M.E.I.C., sales engineer, Canadian Telephones and Supplies Limited, Winnipeg, Man., on October 9th.

H. Lloyd Johnston, Jr., M.E.I.C., Canadian Industries Limited, Windsor, Ont., on October 9th.

K. A. Brebner, M.E.I.C., plant engineer, Price Bros. & Co. Limited, Riverbend, Que., on October 14th.

Robert W. Tassie, M.E.I.C., vice-president, Emprezas Electricas Brasileiras, Rio de Janeiro, S.A., on October 15th.

Jacques P. Leroux, Jr.E.I.C., resident engineer, Mont-Joli Airport, Mont Joli, Que., on October 16th.

Sidney Hogg, M.E.I.C., Saint John Drydock and Shipbuilding Co. Limited, Saint John, N.B., on October 16th.

Brig. G. R. Turner, M.E.I.C., Headquarters Canadian Corps., England, on October 17th.

L. E. Westman, editor, *Canadian Chemistry & Process Industries*, Toronto, Ont., on October 22nd.

T. S. Mathieson, M.E.I.C., designing mechanical engineer, Falconbridge Nickel Mines, Falconbridge, Ont., on October 27th.

Obituaries

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

William Israel Bishop, M.E.I.C., of Montreal died suddenly at Joliette, Que., on September 29th, 1941. He was born at Montreal on July 7, 1875, and received his education in the local schools. He served his apprenticeship as a land surveyor with Joseph Rielle, Montreal, and J. N. Patton, and later with G. H. Massey, civil engineer. He held the position of assistant engineer with the City of Westmount from June, 1895, to March, 1896, at which time he joined the staff of T. Pringle & Son, Montreal, as chief engineer.

William I. Bishop, M.E.I.C.

In 1902 he went with the Pittsburgh Reduction Company at Pittsburgh, Pa. From 1905 to 1906 he was superintendent and engineer for the T. A. Gillespie Company, contractors, of New York and Pittsburgh. In 1906 he went into business as an engineer and contractor and carried out a large contract for the construction of a power house and factory buildings for the Northern Aluminum Company at Shawinigan Falls, Que. Later he was engaged on important engineering projects with James Stewart & Company, Toronto, Foundation Company of Canada in Victoria, B.C., and in New York and also with the Raymond Concrete Pile Company in Montreal.

During the Great War he was manager of a group of five shipyards, building wooden and steel vessels for the Allies. In 1920 he established his own company, William I. Bishop Limited, in Montreal, and at the time of his death was still president. During his career he was engaged on some of the most important construction projects in Canada and the United States, among these being development work in Shawinigan Falls and the St. Maurice river area and with the Southern Canada Power Company. He designed the Gouin storage reservoir at the head of the St. Maurice river, one of the largest in the world. He was a member of the Montreal Tramways Commission having been appointed in 1934.

Mr. Bishop joined the Institute as an Associate Member in 1889 and was transferred to Member in 1907.

James Munro Bloomfield, M.E.I.C., died at Kamsack, Sask., on September 20th, 1941, after a few weeks illness. He was born at Thurmah Factory, Behar State, India, on December 22nd, 1888, and received his education at Heriot Watt College, Edinburgh, Scotland. He served his apprenticeship with British Thomson Houston Company Ltd., Rugby, England, and with the Lancashire Dynamo & Motor Company Ltd., of Manchester.

He came to Canada in 1913 and was employed with the Cunningham Electric Company at Calgary. A year later he went with Bowness Improvement Company Limited at Calgary. He served overseas in the Great War with the Canadian engineers from 1915 to 1918. Upon his return to Canada he joined the firm of General Engineers Limited, Calgary, as a junior partner and was engaged in the repair and maintenance of electrical apparatus and layout of distribution systems. In 1923 he was appointed superintendent of utilities with the Town of Kamsack, Sask., a position which he occupied until his death. Under his supervision the electric power plant of Kamsack was greatly improved and the service was extended to Pelly and Verigin.

Mr. Bloomfield joined the Institute as an Associate Member in 1929.

George Henry Davis, K.C, died in the Winnipeg General Hospital on May 27th, 1941, after a short illness. Born in London, England, on May 14, 1872, he came to Canada as a boy of 14 and worked on a farm near Brandon. Coming to Winnipeg in 1894, he entered Manitoba College and after graduation was a lecturer in French at the college for two years. He articled as a law student with the firm of Munson and Allan in 1900, and became a member of the firm when he was admitted to the bar in 1903. He was created a King's Counsel in 1925 and was associated with the law firm of Allan, Laird & Davis until the time of his death.

Mr. Davis' interests were wide and varied: he was a former president of the Canadian Club, a member of the International Institute of Foreign Affairs, the St. Charles Country Club, the Manitoba Club, and the Motor Country Club.

Although engaged in the profession of law, Mr. Davis was intensely interested in all engineering projects. For a number of years he made a study of large bridges, and had one of the most up-to-date libraries and files on the world's famous bridges, most of which he had visited at some time, either during their construction or after their completion.

Mr. Davis had been associated with the Institute as a Branch Affiliate for several years and had always taken a keen interest in the affairs of the Winnipeg Branch.

Joseph A. Vermette, M.E.I.C., died in the hospital at Ottawa on October 10th, 1941. He was born at Hull, Que., on November 16, 1879, and was educated at Ottawa College. After spending some years in the service of the Quebec Government as a civil engineer, he went to the Dominion Department of Public Works at Ottawa in that capacity and won promotions rapidly reaching the position of senior assistant engineer, which he held at the time of his death.

Mr. Vermette joined the Institute as an Associate Member in 1914.

News of the Branches

Activities of the Twenty-five Branches of the Institute and abstracts of papers presented

HAMILTON BRANCH

A. R. Hannaford, m.e.i.c. - *Secretary-Treasurer*
W. E. Brown, Jr.e.i.c. - - *Branch News Editor*

On the evening of Thursday, October 2nd, a joint meeting of the branch was held with the Hamilton Group of the Toronto Section of the American Institute of Electrical Engineers, in the Westinghouse Auditorium. The Speaker was Mr. A. H. Frampton, assistant engineer, Hydro-Electric Power Commission of Ontario, and his subject was **The 220 kv. System of the Hydro Electric Power Commission.** The speaker stated that the new 220 kv. system was commenced in 1927, following a contract between the Commission and the Gatineau Power Company, under which 260,000 hp. was to be supplied from the Paugan development on the Gatineau River, some 250 miles east of Toronto. The first 220 kv. receiving station was located at Toronto as the load there was sufficiently large to absorb all of the original contract, with a large margin to spare for future needs. Since the expansion of the 220 kv. system, constant study has been made to determine the amount of power that may safely be transmitted under the changing conditions. One of the most important phases has been that of a system of stability, in which a development of the Westinghouse Company has been one of the most valuable tools, namely, the A.C. network analyzer. Transmission lines, being built in the open, are subject to all the hazards resulting from the forces of nature, such as wind, sleet and lightning. Every reasonable precaution has been used in the construction of these new transmission lines so that they will not collapse under normal anticipated stresses. They are designed to withstand 60 miles-an-hour gales while covered with a half inch of ice and will undoubtedly withstand a higher wind velocity. Lightning flashovers and the accidental contact of conductors while they are moving under what is known as "galloping" conditions, and excessive wind storms are the things that engineers are striving to eliminate so that industry may work along without delays. The new station at Burlington, Ont., was described together with the whole system reaching from Montreal.

The lecture was followed by three motion pictures which showed the building of the giant towers which hold the voltage wires and the construction of the lines into the north over miles and miles of barren land to supply the distant industries that are helping with the war effort of Canada. Many of these lines were built in sub-zero weather and the workmen worked with tremendous speed to complete these lines whose towers are made of the lumber cut and formed at the site of the lines. The address was most instructive to all engineers.

James T. Thwaite, chairman of the Hamilton Group, A.I.E.E., introduced the speaker and after the lecture a vote of thanks was made by Mr. Porter. W. A. T. Gilmour, chairman of the Hamilton Branch, E.I.C., opened the meeting, as chairman of the evening, and the usual custom of this joint meeting was followed in that the chairman of the Electrical Engineers occupied the chair during the lecture which was enjoyed by 154 engineers and visitors.

LAKEHEAD BRANCH

W. C. Byers, Jr.e.i.c. - *Secretary-Treasurer*

A special meeting was called on August 16th at 4.00 p.m. to take advantage of the opportunity to make an inspection tour of Temporary Grain Storage Buildings and conveyor galleries being constructed for the bulk storage of grain. The storage buildings inspected were those being constructed for the United Grain Growers Limited at Port Arthur.

There are two storage buildings of wood construction with a combined capacity of 4,000,000 bushels. The first building is 144 ft. x 600 ft. and the second one is 144 ft. x 572 ft. and the side walls are 21 ft. 6 in. high with the roof sloping up at about 5 in 12. A cupola is constructed along the top of each building to house a conveyor belt, walkways on each side of the conveyor belt, and a moveable plow which removes the grain at any desired point along the building. The roof of each building is supported by braced towers 9 ft. 6 in. x 9 ft. 6 in. spaced at 28 ft. 6 in. centre to centre longitudinally and transversely. The walls are constructed of 2 in. x 6 in. cribbing and 12 in. x 14 in. posts with 2 in. diameter tie rods to resist the grain pressure. A concrete slab was used as a floor and footing for the interior towers and crib walls. A concrete tunnel runs along the centre of each building to house a conveyor belt which will be used to remove the grain from the Temporary Storages through spout openings in the tunnel walls.

At the luncheon of the executive of the Lakehead Branch—from left to right: G. H. Burbridge, W. H. Bird, W. L. Bird, W. H. Small, President C. J. Mackenzie, G. R. Duncan, P. E. Doncaster, B. A. Culpeper, S. E. Flook, W. C. Byers, J. I. Carmichael, J. M. Fleming, R. B. Chandler, Miss E. M. G. MacGill, H. G. O'Leary and Vice-President K. M. Cameron.

A system of galleries and one timber tunnel run from the Terminal Elevator to the Temporary buildings a distance of 1,260 ft. The gallery towers and trusses are constructed of British Columbia fir and ring connectors are used throughout. The gallery trusses vary from 64 ft. to 97 ft. span.

J. Antonisen thanks the speakers. From left to right: Secretary-Treasurer W. C. Byers, J. Antonisen, H. G. O'Leary, Vice-President K. M. Cameron, R. B. Chandler, President C. J. Mackenzie, Chairman B. A. Culpeper.

Power is supplied from the existing terminal substation and is distributed by an open feeder run along the top of the galleries and storages. The first storage requires 190 hp. to fill and 280 hp. to empty, while the second requires 230 hp. to fill and 320 hp. to empty.

Protective floodlighting is provided around the storages and galleries to facilitate inspection by the night-watchmen.

Mr. Wilson of the British Air Commission, W. H. Small, Vice-President K. M. Cameron, and R. B. Chandler.

The tour of inspection was conducted by the engineering staff of C. D. Howe Company, and forty members and guests were present. After the tour of inspection refreshments were served in one of the storage buildings.

The President, Dr. C. J. Mackenzie visited the Lakehead Branch on Monday, September 22nd. He was accompanied on his visit by Vice-President, K. M. Cameron and the General Secretary, L. Austin Wright.

The president, vice-president and general secretary were taken on a tour of inspection of the Port Arthur Shipyards during the morning and at 12.45 p.m. were guests at an executive luncheon. A tour of inspection of the Canadian Car & Foundry was made during the afternoon.

A dinner meeting was held in the Royal Edward Hotel, Fort William, commencing at 6.45 and thirty members and guests were present.

The Chairman, B. A. Culpeper, presided at the meeting and welcomed the president, vice-president and general secretary to the Lakehead. P. E. Doncaster introduced Dr. Mackenzie and mentioned a few highlights of his distinguished career.

Dr. Mackenzie expressed his appreciation of the welcome shown by the members of the Lakehead Branch and then spoke on the **National Research Council in Relationship to the War.** He dwelt on the importance of scientific

In the foreground: Miss E. M. MacGill chatting with Chairman Culpeper. In the background: Councillor J. M. Fleming, G. R. Duncan and H. G. O'Leary.

research and how it had made the British supreme in the air. He mentioned the radio locator which had done away with continuous patrolling of the air and made it possible to assign planes to a definite location.

He stated that the war had developed into an engineers' war and that the engineers had risen to the occasion and were pooling their resources and were working together as a team.

He mentioned how the National Research Council had increased in importance since the war began and this evidence is shown by the large donations made by industrialists and individuals, whereas, before the war small amounts of money were difficult to obtain.

Scientific research to-day meant the full co-operation of all the individuals from the Ph.D's to the mechanic at the bench and the importance of one individual over another was not considered.

When preparing for an industrial war it was not possible to spring to arms overnight except emotionally. There are four steps in an industrial combat. First there was research and development; second, engineering design; third, industrial production; and fourthly, the operations by and equipment of the men.

When war broke out the research council had a staff of 267 with a budget of $800,000.00. Next year it is planned to employ a staff of 900 and spend from five to six millions of dollars.

The council operates under four divisions, mechanical engineering, physics and electrical engineering, chemistry and biology. The council had 150 projects under consideration with 56 in the aeronautical field. The Council is investigating stability of various aircraft, bomb sights, instruments fuel and de-icing.

Councillor J. M. Fleming introduced vice-president K. M. Cameron. Mr. Cameron expressed his appreciation of being able to be present at the meeting and referred to the development of the Lakehead Community and mentioned the harbour improvements that had been made and the large sums of money spent by the public works on the breakwater.

R. B. Chandler introduced L. Austin Wright who spoke on the work of the **Wartime Bureau of Technical Personnel** and also described the work done on the repairs to the Headquarters building.

J. Antonisen gave a vote of thanks to the visiting speakers for their addresses.

LONDON BRANCH

H. A. Stead, Jr.E.I.C. - - *Secretary-Treasurer*
A. L. Furanna, S.E.I.C. - *Branch News Editor*

The opening fall meeting of the Branch was held on Wednesday, October 1st, 1941 in the Officers' Mess of the Talbot St. Armouries. Mr. J. A. M. Galilee, assistant advertising manager of the Canadian Westinghouse Company was the speaker.

Speaking on the **Recent Research and Development Work in Electric Equipment,** Mr. Galilee stressed the value of research in the war effort. He said that scientists were fighting many difficult battles behind the locked doors of the laboratories and that although science has given Hitler many of his tools of war, science would also finally spell his doom.

Unbelievable possibilities, he said, rested in the uranium atom U235. When all the potential energy of this element is realized, houses may be heated for an entire winter with a piece of uranium the size of a headache capsule. A piece the size of a walnut would release energy equivalent to that of 1,250 tons of coal.

Experiments were performed to illustrate many other new principals. In the field of metallurgy, Mr. Galilee demonstrated the bi-metal strips, the addition of tungsten powder to steel in order to eliminate bounce, some small but very powerful permanent magnets and a new transformer steel with reluctance so low that it became magnetic when placed in the direction of the earth's field.

Some of the many uses of ultra violet light were also shown. One of the most interesting applications was in the modern fluorescent lighting. Ultra violet light may also be used as a germicide and to produce colour effects. Another lighting marvel on display was polarized light. This is now being used in the strength analysis of structural shapes. Polarized light also holds the answer to the automobile headlight problem. Unfortunately, this cannot be applied until after the war because the system would have to be used exclusively in order to be effective.

Among the electrical experiments an electric eye was used in the transition of sound waves into light waves and light back to sound.

Mr. Galilee was introduced by the branch chairman, Mr. R. W. Garrett, and Mr. V. A. McKillop proposed the vote of thanks.

PETERBOROUGH BRANCH

D. J. Emery, m.e.i.c. - *Secretary-Treasurer*
E. Whiteley, s.e.i.c. - *Branch News Editor*

At their opening meeting for the 1941-42 season, on September 27th, Peterborough Branch were joined by Toronto Branch of the American Institute of Electrical Engineers. At 2 p.m. members of both groups gathered at Kawartha Golf and Country Club where golf was arranged for those who wished it, and trips through the Peterborough Works of the Canadian General Electric Company Limited were organized for the others.

All were back at the club by 7.30 p.m. in time for an excellent dinner. Mr. J. Cameron, chairman of the Peterborough Branch, served as toast master. Mr. R. Robbin distributed prizes (donated by the Western Clock Company Limited) to several lucky members.

After a pause and some re-arrangement of chairs the meeting came to order again for a technical discussion of **Electromagnetic and Heating Effects of Fault Currents.** Mr. O. Titus, chairman of the Toronto Branch, A.I.E.E., took the chair.

After several short prepared papers by Mr. Langley, Dr. F. G. A. Tarr, Mr. D. V. Canning, of the Canadian General Electric Company, Mr. J. T. Thwaites, Canadian Westinghouse Company, and Dr. J. H. Thompson, Ferranti Electric, others gave their comments until a surprising amount of information had come out. The effects of heavy fault currents on bus structures, cables, switchgear, relays, transformers, motors, were all mentioned.

The meeting was well up to the standard set by a similar event last season, and encourages those who hope it will be an annual affair. 108 members and guests were present.

SAGUENAY BRANCH

D. S. Estabrooks, m.e.i.c. - *Secretary-Treasurer*
J. P. Estabrook, Jr.e.i.c. - *Branch News Editor*

The Saguenay Branch met at Arvida, Que., on the evening of October 14th with chairman N. F. McCaghey presiding over the meeting.

The speaker on this occasion was Mr. V. G. Younghusband, vice-president of the Foundation Company of Canada, presenting as his subject **Construction Problem.**

Mr. Younghusband described several of the interesting projects he had been associated with in his wide experience in construction engineering, dealing first with a construction railroad used in connection with excavation work for the Granby Mining and Smelting Company. He then reviewed the construction of the University of Saskatchewan and the reconstruction of the central block of the Parliament Buildings at Ottawa.

On the Comeau Bay construction job, transportation was the chief difficulty to be faced, stone being the only local material used in building the mill and townsite. The construction of a pipe line over 17 ft. in diameter and 5,900 ft. long was of particular interest. Various materials were considered for the construction of the pipe but wood stave was given preference over steel and pre-stressed concrete.

In concluding Mr. Younghusband stressed the labour problems to be faced by industry after the war and expressed a hope that any slowdown at that time would be of short duration. He pictured Canada as coming into her own with her industrial capacity and population doubling in size as a result of decentralization of industry in Great Britain and expansion to Canada. In connection with this, he called for closer co-operation between construction men and engineers. This was his expressed hope for the advance of each group in the future.

SAINT JOHN BRANCH

V. S. Chesnut, m.e.i.c. - *Secretary-Treasurer*

At a meeting of the Demolition Committee of Air Raid Protection held on August 19th it was decided to adopt the English system, as laid down in publication of the British Home Office, for organization of Rescue Parties and Clearing of Debris.

It was arranged that following an air raid the Municipal Demolition Officer would be on duty at A.R.P. Headquarters with liaison officers under him. A Demolition Officer will be assigned to each City Ward to work in co-operation with the A.R.P. Captain of Wardens for that Ward.

In recognition of the fact that buildings may become wrecked without fire occuring in them and that the Fire Department and Police services will be fully occupied with other duties, a system of Rescue Parties will be organized for each Ward. These Rescue Parties will be of two kinds, Light and Heavy and will be led by experienced construction foremen. They will comprise a nucleus of skilled men and be equipped with tools and appliances. A proportion of the men in each Light party will be given a first aid course in order to succour persons who may be trapped, until other first aid parties can arrive.

A Light Party will be first despatched to the scene of a casualty, to be followed up by a Heavy Party with more extensive equipment should the need for further assistance be evident.

The primary task of Light Parties will be to rescue living persons who are trapped in the wreckage and remove the bodies of persons killed in the collapse of a building, where this can be done without further risk of life at the moment.

The services of Construction companies will be organized for heavier types of demolition work and clearance of debris and for assistance to civic forces in clearing and repairing streets and restoring services.

The Light and Heavy rescue parties will be under the orders of the Ward Demolition Officer and will assemble at designated points upon the sounding of an alarm.

Volunteers for the personnel of these rescue parties will be called for in the near future. A considerable number of carpenters, masons, plumbers and other skilled construction personnel will be needed.

SAULT STE. MARIE BRANCH

O. A. Evans, Jr.e.i.c. - *Secretary-Treasurer*
N. C. Cowie, Jr.e.i.c. - *Branch News Editor*

The fifth general meeting for the year 1941 was held in the Grill Room of the Windsor Hotel on Friday, September 26th, 1941, when 17 members and guests sat down to dinner at 6.45 p.m. The business portion of the meeting began at 8.00 p.m. with L. R. Brown, vice-chairman, presiding in the absence of E. M. MacQuarrie. N. C. Cowie replaced the secretary who was also away.

At the conclusion of the business portion of the meeting Mr. T. F. Rahilly addressed the club on **The Blast Furnace Plant of the Algoma Steel Corporation.**

After the discussion A. M. Wilson moved the adjournment.

TORONTO BRANCH

J. J. Spence, m.e.i.c. - *Secretary-Treasurer*
D. Forgan, m.e.i.c. - *Branch News Editor*

The first meeting of the Toronto Branch of the Institute was held in Hart House, University of Toronto, on October 16th. An excellent attendance attested to the apparent interest in the subject for the evening's discussion, and, it is hoped, to interest in the activities of the branch in general. A satisfactory feature was the large number of younger engineers who turned out. It is hoped that this interest will continue to be shown to at least as great an extent for the rest of the season. The programme which has been adopted for the ensuing meetings is one which should hold the interest of both experience and younger engineers alike.

A cosmopolitan atmosphere was given to the gathering by the presence of a group of 12 Polish engineers now located in the Toronto area. It was the desire of the branch to show its appreciation of the spirit of these people who are now our Allies in the War, and who after great hardships are endeavouring to establish themselves in this country.

In the course of his opening remarks, Mr. H. E. Brandon, the branch chairman, formally tendered in a most happy vein the branch's congratulations to Professor C. R. Young of the University of Toronto on his recent appointment as Dean of the Faculty of Applied Science. The enthusiasm with which the meeting received Mr. Brandon's address indicated the universal and sincere pleasure which Dean Young's appointment has given to all those who have been fortunate enough to come in contact with him and his work.

During his response Dean Young commented on his association with the Polish forces in the last Great War, and then introduced to the meeting each of the Polish engineers present. Of interest were the brief biographical notes he gave on each individual and the route by which each at last reached this country. He then introduced the speaker of the evening, Mr. W. J. Jakimiuk, an eminent aeronautical engineer who now holds the position of chief designer of the de Havilland Aircraft Company of Canada.

Mr. Jakimiuk was formerly chief engineer of the National Aircraft Corporation of Poland. His subject was **Plastic Laminated Wood in Aircraft Construction.** It is expected the paper will be published in full in the *Journal* at an early date. In his address Mr. Jakimiuk showed that wood was extensively used in aircraft construction in earlier periods of aviation until 1925-1930. At that time, wood was pushed out by steel and light alloys, especially with the advent of stressed skin construction.

Wood is a good structural material with high strength to weight ratio, but possesses many defects which have slowed the development of wooden aircraft construction.

About 1935, synthetic resins were introduced in wooden construction and most of the defects were eliminated when laminated plastic wood was developed. Laminated panels made of wooden veneers of proper thickness and properly assembled with synthetic adhesives are fairly uniform in strength and volume. Thermosetting synthetic adhesives such as phenol formaldehyde and urea formaldehyde give very good and reliable joints.

Experimental work on plastic moulded wood development is carried out in Canada at the National Research Council, Ottawa, the Massey-Harris Company, and de Havilland Aircraft of Canada.

The pressure tank moulding method is fairly well developed. Other methods, such as curing of resins by high frequency electro-static fields, are experimental. De Havilland is making a wooden wing for one of the metal aeroplanes produced in Canada. The paper was most interesting well presented and well received.

Mr. O. Holden, chief hydraulic engineer of the Hydro-Electric Power Commission of Ontario, presented the second portion of the programme. This consisted of a coloured motion picture and coloured stills, showing various features in the construction of the Commission's Barrett Chute development on the Madawaska River. Work on this development, designed and constructed by the Commission's staff, was put in hand September, 1940, and is scheduled for completion in the early summer of 1942. It will have an installed capacity of two 57,000 hp. units. The pictures were excellent examples of the beauty and clarity of good colour photography. Considerable added interest was given to them by Mr. Holden's brief description of the salient features of the development and his descriptive comments on each operation and feature shown on the screen.

The new seating arrangements in the Debates Room at Hart House added considerably to the comfort of the audience, most of which joined in the light refreshments which were provided after the meeting and which afforded an opportunity for further discussion and meeting with old friends.

WINNIPEG BRANCH

C. P. Haltalin, m.e.i.c. - *Secretary-Treasurer*
T. A. Lindsay, m.e.i.c. - *Branch News Editor*

The Winnipeg Branch was highly honoured in September by the visit of President C. J. Mackenzie, who was accompanied by Vice-President K. M. Cameron and General Secretary L. Austin Wright.

Mr. Cameron and Mr. Wright were present at a luncheon meeting of the executive held at the Engineer's Club on September 23rd, at which meeting various Institute matters were discussed by Mr. Cameron and Mr. Wright. Several problems of special interest to the Branch were brought up and valuable advice and opinions were advanced by the members from Headquarters.

President Mackenzie held an informal reception at the Fort Garry Hotel on the evening of the 23rd, in order to make the acquaintance of the executive and various members of the Branch, and to renew old acquaintances.

A general luncheon meeting in honour of the visiting party from Headquarters was held in the Georgian Dining Room of the Hudson's Bay Company on Wednesday, September 24th, at which 65 members were present.

Winnipeg Branch Executive with visitors from Headquarters. Front row, from left to right: Councillor J. W. Sanger, President C. J. Mackenzie, Vice-Chairman D. M. Stephens, Vice-President K. M. Cameron, Dean E. P. Fetherstonhaugh. Back row: Secretary-Treasurer C. P. Haltalin, H. L. Briggs, T. E. Storey, E. S. Braddell, S. G. Harknett, C. V. Antenbring, J. T. Dyment, H. B. Brehaut, H. W. McLeod.

The head table at the general luncheon meeting. From left to right: Dean E. P. Fetherstonhaugh, Vice-President K. M. Cameron, President C. J. Mackenzie, Vice-Chairman D. M. Stephens, Councillor J. W. Sanger, Secretary-Treasurer C. P. Haltalin, left foreground, J. T. Dyment.

Mr. D. M. Stephens, vice-chairman of the branch, presided in the absence of the chairman, Mr. V. Michie. Mr. Stephens welcomed the Headquarters party and expressed the pleasure of the branch at having them present.

President Mackenzie, the main speaker of the occasion, was introduced by Councillor J. W. Sanger. Dean Mackenzie emphasized the value of the Institute to all engineers, and gave a personal example of how committee work in the Institute had benefited him after the last war.

He outlined the part that engineers were playing in the present war not only with reference to military service, but also to industry and research work.

As acting president of the National Research Council he was able to give the audience a particularly stirring account of the work of the Council. Although he pointed out that with the short time at his disposal he could only touch on the highlights, he gave very interesting outlines of the jobs being done by the various divisions of Aviation Medicine, Physics, Radio, Optics and Chemistry.

Prior to Dean Mackenzie's address, Vice-President K. M. Cameron was introduced by Mr. Stephens, and he conveyed the greetings of the Ottawa Branch to the Winnipeg Branch. He also outlined the relationship of a vice-president to Institute affairs, and touched on some of the problems of Council.

Mr. Wright reported on results of the Headquarters Building Fund, and pointed out that while the results to date were gratifying, the objective of $10,000.00 had not yet been reached.

A general view looking towards the head table.

As assistant director of the Wartime Bureau of Technical Personnel, Mr. Wright explained the purpose and use of the questionnaires that had been sent out. He also elaborated on the work and aims of the Bureau, and urged his listeners not to be too impatient for results, pointing out that the wholehearted co-operation and support of all engineers was necessary for the success of the Bureau.

Dean E. P. Fetherstonhaugh expressed the thanks of the meeting to President Mackenzie and his party from Headquarters, which was thoroughly concurred in by members present, through hearty applause.

The Winnipeg Branch, at the invitation of the local branch of the C.I.M.M. attended a luncheon meeting on September 27th to welcome the president of the C.I.M.M., Mr. W. G. McBride, who was accompanied by Secretary Carlyle and Mr. E. M. Little, Director of the Wartime Bureau of Technical Personnel.

From left to right: J. J. White, Registrar of the Association of Professional Engineers of Saskatchewan, A. W. Davison, G. M. Pearston and George Clark.

Mr. Little, who was the main speaker at the meeting, gave a talk on **Industries' Help in the War Effort.** Mr. Little divided his subject into two parts, the first being an outline of the work of the Bureau, and the latter part being devoted to the relationship between engineers and industry in the war effort.

Left-hand row, facing the camera: Major N. M. Hall, W. M. Scott, S. J. Hadden, J. E. Granich, V. C. Jones, A. Blackie, R. A. Sara, E. V. Caton.

EDMONTON BRANCH

F. R. Burfield, M.E.I.C. - *Secretary-Treasurer*
L. A. Thorssen, Jr.E.I.C. - *Branch News Editor*

On his visit to the western branches, President Mackenzie stopped at Edmonton, on October 1st. In the evening, he met with the executive of the Branch, together with Mr. P. M. Sauder, Dean Wilson and Professor Boomer, representing the University. The meeting took place in the Jasper Room at the Macdonald Hotel, where Dean Mackenzie gave an interesting and confidential talk on his work with the National Research Council.

On Thursday evening, October 2nd, several members of the branch attended the banquet of the western convention of the Canadian Institute of Mining and Metallurgy, at which Dean Mackenzie spoke.

Professor W. G. McBride, M.E.I.C., president of the Mining Institute, presided at the head table.

Dean Mackenzie spoke on the achievements of the National Research Council. "There is no doubt," said the President, "that the scientific integrity of the British is easily on a par with that of the Germans. We are doing a great deal of work with the three services, navy, army and air force, and Canada may well be proud of the accomplishments of her scientific men. They are making a great contribution to the war effort."

Day and night research is being made, Dr. Mackenzie said. "We are working on plastic airplanes and just as vigorously on de-icing instruments for planes." Aviation medicine is being studied hard for the welfare of the pilot at high altitudes and during steep dives and other situations."

Dr. Mackenzie revealed research had been made so the British were "well prepared" for chemical warfare.

"I do think if we were not so well prepared in chemical warfare the Germans would have started on this type of war before this," Dr. Mackenzie declared.

Dr. Mackenzie said he believed scientific research was responsible "for saving England last July and August." He said the integrity and bravery of British pilots played an important and essential part, but he believed it was the scientific research that made the British planes superior to those of the Germans and resulted in the Nazis not invading England at that time.

This was the opinion of many British military authorities, including such men as Lt. Gen. A. G. L. McNaughton, commander of the Canadian Corps.

Finances of the council are being well spent, Dr. Mackenzie said. "There is no doubt whatever the research council has become a very important part of the war effort."

Library Notes

Book notes, Additions to the Library of the Engineering Institute, Reviews of New Books and Publications

ADDITIONS TO THE LIBRARY

TECHNICAL BOOKS

Canada Year Book, 1941:
Dominion Bureau of Statistics, Ottawa, 1941. 9 x 6¼ in., $1.50.

Electrical Engineering Fundamentals:
By George F. Corcoran and Edwin B. Kurtz. New York, John Wiley & Sons, Inc., 1941. 9¼ x 6 in., $4.00.

Elements of Electrical Engineering:
By Arthur L. Cook. New York, John Wiley & Sons, Inc., 1941. 9¼ x 6 in., $4.00.

Fatigue of Metals:
By D. Landau. New York, The Nitralloy Corporation, 1941. 45 pp., pamphlet.

Photoelasticity:
By Max Mark Frocht. Vol. 1. New York, John Wiley & Sons, Inc., 1941. 9¼ x 6 in., $6.00.

Practical Solution of Torsional Vibration Problems:
By W. Ker Wilson. Vol. 2, 2nd edition. New York, John Wiley & Sons, Inc., 1941. 5¾ x 8¾ in., $8.50.

Traffic Accidents and Congestion:
By Maxwell Halsey. New York, John Wiley & Sons, Inc., 1941. 6¾ x 10 ⅛in., $4.00.

REPORTS

Canadian Broadcasting Corporation:
Annual report for the fiscal year ended March 31, 1941. Ottawa, 1941.

Canadian Chamber of Commerce:
14th Annual report, September 17-18, 1941.

Canada Department of Mines and Resources—Bureau of Mines:
Physical and chemical survey of coals from Pictou County Coalfield. Memorandum series, No. 79, 1941.

Canada Department of Mines and Resources—Mines and Geology Branch—Geological Survey Memoir:
Mineral industry of the Northwest Territories, No. 230.

Canada Department of Mines and Resources—Mines and Geology Branch—Geological Survey Papers:
Preliminary map Redcliff, Alberta; preliminary map Bighorn River, Alberta. Papers 41-11 and 41-9.

Canadian Engineering Standards Association—Specifications:
Canadian Electrical Code, part 2, Construction and test of isolating switches, No. 58. Standard specification for cast iron soil pipe and fittings, B70-1941.

Canadian Government Purchasing Standards Committee — Specifications:
Rubber hot water bottles, for general use; rubber coated cotton sheeting, for hospital use.

Bell Telephone System—Technical Publications:
Notes on the time relation between solar emission and terrestrial disturbances; Vario-losser circuits; Crystalline behavior of linear polyamides; Heat of absorption of water by papers: Design and operation of new copper wire drawing plant—parts 1 and 11; Single sampling and double sampling inspection tables; Insulation of telephone wire with paper pulp; Television transmission over wire lines; Abrasion resistance of anodically oxidized coatings on aluminum; Electrical breakdown for checking thickness of anodized finishes; Surge characteristics of a buried bare wire; Development of the civil aeronautics authority instrument landing system; Debt of modern physics to recent instruments; Measurements of orchestral pitch; An interferometric dilatometer with photographic recording; Ultrasonic absorption and velocity measurements in numerous liquids; effect of the earth's curvature on ground-wave propagation; After-acceleration and deflection; engineering requirements for programme transmission circuits; Kiln drying longleaf southern pine poles; An electrical test for moisture content in southern pine timbers; A new mirror light-modulator; Time division multiplex systems; Steady state delay as related to aperiodic signals; Steady state solutions of transmission line equations; Engineering problems in dimensions and tolerances; Room noise spectra at subscribers' telephone locations; reduction of magnesium oxide by tungsten in vacuum.

Electrochemical Society—Preprints:
Alloy plating; Studies on the electrolytic deposition of copper; Porous carbon electrodes; Treatment by electrolysis of weak ammonia liquors produced in by-product coke plants; Platinized porous graphite as a hydrogen electrode; Nickel plating; Chromium plating; Alkaline tin plating; Electrolytic reduction of benzophenone in acidic and in alkaline media; Cadmium plating; Acid copper electroplating and electroforming; Electrolytic reduction of sorbic acid; Electrolytic reduction of acetone; electrodeposition of tin from acid solutions; Cobalt plating; General principles and methods of electroplating; Copper-lead alloys from ethylene diamine solution; Silver plating; Cyanide zinc plating baths; Brass plating. Nos. 18 to 37.

National Research Council of Canada:
Twenty-fourth annual report, 1940-41. Ottawa, 1941.

U.S. Department of Commerce—Building Materials and Structures:
Survey of roofing materials in the North Central States, BMS75.

U.S. Department of the Interior—Geological Survey Bulletin:
Geology of area between Green and Colorado rivers Grand and San Juan Counties Utah; Fineness of gold from Alaska Placers; Ore deposits in the vicinity of the London fault of Colorado. Bulletins 908, 910-C, 911.

U.S. Department of the Interior—Geological Survey Water-Supply Paper:
Surface water supply of Hawaii, July 1, 1938, to June 30, 1939; Flood of August, 1935, in the Muskingum river basin, Ohio; Ground water in Keith County, Nebraska. Paper 885, 869, 848.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet the books are not in the Institute Library, but inquiries will be welcomed at headquarters, or may be sent direct to the publishers.

AEROSPHERE, 1941, including Modern Aircraft, Modern Aircraft Engines, Aircraft Statistics, Buyers' Guide,
Edited by G. D. Angle. Aircraft Publications, New York, 1941. 948 pp., illus., diagrs., tables, 12 x 8½ in., cloth, $10.00.

In this second edition the historical section describing the world's aircraft engines of all time has been omitted and will henceforth be available in a separate volume. The construction, performance and characteristics of all current types of aircraft and aircraft engines are given in the first two sections. Statistics, records and other useful data are included in the third section. A buyer's guide, containing first an alphabetical list of firms for each country, and second a product directory by countries, completes the volume. Hundreds of photographs and cross-sections accompany the descriptions.

AIRCRAFT ENGINES, Vol. 2
By A. W. Judge. D. Van Nostrand Co., New York, 1941. 446 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, $9.00.

The theoretical and experimental aspects of aircraft engines having been covered in Volume I, the present volume is devoted principally to detailed descriptions of a large number of representative engines from various countries. Certain design and theoretical considerations concerning lubrication, ignition and exhaust systems, torque and balance, and other topics not previously dealt with are also included.

AIRCRAFT MECHANIC'S POCKET MANUAL
By J. A. Ashkouti. Pitman Publishing Corp., New York and Chicago, 1941. Diagrs., tables, 7½ x 5 in., cloth, $1.50.

Prepared for the man in the shop, this manual contains basic data on aircraft production. Pattern layout, materials, finishes, tools, tolerances, and standard parts approved by the Army and Navy are covered in separate sections. Aircraft identification standards and a large glossary of aeronautical terms are also included.

AIRCRAFT TEMPLATE DEVELOPMENT
Compiled and edited by Aero Publishers, Inc. Aero Publishers, Glendale, Calif., 1941. 312 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $4.00.

Fundamental principles involved in the developing and making of aircraft templates are presented in this comprehensive, practical textbook for students, apprentices and trainees. There is a large section of sample problems, including blueprints and suggested procedures. A brief glossary is appended.

ARCHITECTURAL GRAPHIC STANDARDS for Architects, Engineers, Decorators, Builders and Draftsmen
By C. G. Ramsey and H. R. Sleeper. 3 ed. John Wiley & Sons, New York: Chapman & Hall, London, 1941. 344 pp., diagrs., charts, tables, 12 x 9½ in., cloth, $6.00.

Standards and recommended practices in building, with many other data constantly used by architects and designers, are presented here in an unusually convenient form for quick reference. The book consists entirely of plates with a very full index. It covers a broad field, including not only building construction but also landscaping and site development, the planning of sports fields, furniture and miscellaneous equipment for various types of buildings.

DAVISON'S TEXTILE BLUE BOOK, United States, Canada and Mexico

76th Year, July, 1941, Handy edition, Davison Publishing Co., Ridgewood, New Jersey, 1,200 pp., maps, 8 x 5 in., fabrikoid, $5.00.

This annual publication lists geographically manufacturers of cotton, woolen and worsted, silk and rayon, and knit goods; dyers and finishers; commission merchants, dealers and importers; domestic and foreign raw cotton firms; and other groups useful to the trade. There are two special lists of pertinent associations and railroads serving the various mills, and an alphabetical index to mills and dyers is included.

DEEP WATER

Published by New York Marine News Co., New York, N.Y.; printed by Recorder Press, Plainfield, New Jersey, 1941. 77 pp., illus., maps, tables, 11½ x 9 in., fabrikoid, apply (not for sale).

A series of descriptive articles on the major inland waterways of the United States is presented in this volume, in an endeavour to point out the benefits to the public from the development and use of these facilities. Statistical and technical information is included, and there are numerous illustrations.

DESIGN HANDBOOK FOR PRACTICAL ENGINEERS

By A. Cibulka. Apply to author, Dr. Alois Cibulka, Baytown, Texas, 1941. Diagrs., charts, tables, 12 x 9 in., paper, $10; reduced price in lots of three or more.

The five parts of this compilation of design data and formulae cover respectively: strength of materials, steel and concrete structures; pressure and vacuum vessels, piping and metals; hydraulics and heat transfer; mathematical tables and general engineering formulas. Most of the material is in the form of tables and charts, with such explanation as is considered necessary.

(The) DRILLING EQUIPMENT DIRECTORY 1941-42

Published every two years by Petroleum Directory Publishing Co., affiliated with the Oil and Gas Journal.
Petroleum Directory Publishing Co., Tulsa, Okla., 1941. Paged in sections, illus., diagrs., charts, tables, 11 x 8½ in., fabrikoid, $10.00

The special feature of this biennial directory is the several hundred pages of classified practical engineering, A.P.I. and reference data, with each section of which is included the advertisements of related manufacturers. A complete classified buyers' guide lists all companies offering equipment or services required in the drilling of oil and gas wells.

ECONOMICS OF OIL INVESTMENTS IN COLUMBIA

By E. Ospina-Racines. 1941, paged in sections, diagrs., charts, maps, tables, 13 x 8½ in., cloth, apply to author, E. Ospina-Racines, Apartado Nacional 27-23, Bogota, Colombia.

As an aid in promoting a better understanding of oil exploitation in South America the author presents a discussion of the nature of the principal economic problems connected with that industry. Although the situation in Colombia is taken as an example, the broad treatment of the various aspects allows the conclusions to be applied as well to other South American oil countries. Much of the factual material appears in tabular or graphic form.

ELECTRICAL ENGINEERING FUNDAMENTALS

By G. F. Corcoran and E. B. Kurtz. John Wiley & Sons, New York, 1941. 450 pp., diagrs., charts, tables, 9 x 6 in., cloth, $4.00.

The subject matter presented in this textbook is intended as first course material and is designed to prepare electrical engineering students for specialized courses. Special emphasis has been given to the arrangement and explanation of basic principles and concepts, although certain chapters deal with more advanced topics, such as the electrical structure of matter, electrochemistry and field mapping.

ELEMENTS OF ELECTRICAL ENGINEERING

By A. L. Cook. 4 ed. rev. John Wiley & Sons, New York, 1941. 622 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $4.00.

The fundamentals of electrical engineering and their application in practice are dealt with in this textbook, which is intended for both electrical engineering students and students specializing in other branches of engineering. All the material has been revised in the light of recent developments, and some chapters have been completely rewritten. An entirely new set of problems has been included.

ELEMENTS OF ENGINEERING THERMODYNAMICS

By J. A. Moyer, J. P. Calderwood, A. A. Potter. 6 ed. rewritten. John Wiley & Sons, New York; Chapman & Hall, London, 1941. 217 pp., diagrs., charts, tables, 9½ x 6 in., cloth, $2.50.

In the present edition, as in the previous ones, this book is designed to stress the fundamental principles of engineering thermodynamics as a foundation for the more advanced and practical applications of the theory. It is intended particularly for use in technical colleges having special courses in advanced thermodynamics, steam turbines, internal combustion engines, heating, refrigeration and other applications of thermodynamics.

ENGINEERING DESCRIPTIVE GEOMETRY AND DRAWING

By F. W. Bartlett and T. W. Johnson. John Wiley & Sons, New York; Chapman & Hall, Ltd., London, 1941. 572 pp., illus., diagrs., charts, tables, cloth, $4.50.

This comprehensive textbook, developed for use at the U.S. Naval Academy, consists of three parts: I, Line drawing, which is chiefly concerned with the manner of handling the instruments; II, Engineering descriptive geometry, which deals with the rules of orthographic projection applied to simple geometrical shapes; and III, Engineering drawing, which describes the application of the general principles of drawing to engineering purposes with emphasis on detail drawing.

ENGINEERING ENCYCLOPEDIA, 2 Vols.

Edited by F. D. Jones. Industrial Press, New York, 1941. 1,431 pp., diagrs., charts, tables, 9½ x 6 in., fabrikoid, $8.00.

This two-volume reference work supplies such practical and useful information as the various important mechanical laws, rules and principles; physical properties and compositions of a large variety of materials used in engineering practice; the characteristic features and functions of different types of machine tools and other equipment, etc. The 4,500 topics included are alphabetically arranged and cross-indexed for convenient reference, and have been selected for their usefulness in the mechanical industries.

(The) ENGINEERING PROFESSION

By T. J. Hoover and J. C. L. Fish. Stanford University Press, Stanford, Calif.; Humphrey Milford and Oxford University Press, London, 1941. 441 pp., diagrs., charts, maps, tables, 9½ x 6 in., cloth, $5.00.

This book describes the qualifications and duties of the professional engineer and his habit of mind, and indicates the rewards that an engineering career has to offer to qualified men. It presents an extended analysis of the sphere and status of the profession and points out its capacities for future development. The study will be especially valuable to young men contemplating a career in engineering and to instructors, because of the light it throws on the engineering method and its relation to school work, but should also prove of interest to the practical engineer.

GENERAL CHEMISTRY

By H. N. Holmes. 4 ed. Macmillan Co., New York, 1941. 720 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $3.75.

This excellent textbook meets the needs of those who are studying chemistry for cultural purposes and is also suitable as an introduction to advanced study of the subject. In addition to the extensive revision necessary to keep up with recent advances in chemical theory and industrial practice, a short timely chapter on strategic raw materials has been added in the present edition.

Great Britain, Dept. of Scientific and Industrial Research, Building Research Wartime Building Bulletin No. 15. STANDARD DESIGNS FOR SINGLE STOREY FACTORIES FOR WAR INDUSTRIES, WITH NOTES ON SITING AND LAYOUT

His Majesty's Stationery Office, London, 1941. 36 pp., diagrs., tables, 11 x 8½ in., paper, (obtainable from British Library of Information, 620 Fifth Ave., New York, 30c.).

In this bulletin designs previously issued have been revised in the light of experience of air attack, and further types have been added to the series. Notes are also given upon the choosing of sites and the layout of factories for war industries.

Great Britain, Ministry of Transport EXPERIMENTAL WORK ON ROADS

Report for 1938-39 of the Experimental Work on Highways (Technical) Committee. His Majesty's Stationery Office, London, 1939. 179 pp., tables, 9½ x 6 in., paper, (obtainable from British Library of Information, 620 Fifth Ave., New York, 75c.).

Beginning about the year 1929, the Ministry of Transport has built a number of experimental roads in Great Britain, in order to study the behaviour of various types of construction. The present report covers the condition of these roads after an added year of use, and gives interim conclusions as to their suitability. Roads of concrete and cement-bound macadam, roads with bituminous surfacings and with thin surfacing coats are described. Surface dressings, rural footpaths and bicycle tracks are also considered.

HANDBOOK OF CHEMISTRY

Compiled and edited by N. A. Lange and others. Handbook Publishers, Sandusky, Ohio. 4 ed. rev. and enl., 1941. 1,603 pp.; Appendix, Mathematical Tables and Formulas, 271 pp.; Index, 35 pp., diagrs., charts, tables, 8 x 5 in., fabrikoid, $6.00.

This extensive collection of chemical and physical data for chemists, engineers and physicists has again been revised to conform with recent developments. New tables have been added, and previously included ones have been extended, in addition to changes in the standing matter throughout the work. All the information is presented in convenient form for ready reference.

HEAT ENGINES, Steam, Gas, Steam Turbines and Their Auxiliaries

By J. R. Allan and J. A. Bursley. 5 ed. McGraw-Hill Book Co., New York, 1941. 576 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $4.00.

The essential principles of steam engines, boiler plants, internal-combustion engines, steam turbines and their auxiliaries are presented in this introductory textbook. In the present revision particular attention has been given to boiler auxiliaries, steam turbines and the internal-combustion engine, and there is a new chapter on air compressors and refrigerating machinery.

HOTEL ENGINEERING, Vol. 2. Electric Current Consumption, Costs and Savings

By G. C. St. Laurent. American Hotel Association of the United States and Canada, 221 West 57th St., New York, 1941. 43 pp., tables, 11 x 8½ in., paper, $1.50.

This booklet is the second in a series of four covering important subjects of hotel engineering, of which the first, published in 1940, dealt with water consumption, cost and savings. The present issue covers hotel electric problems and trends, and discusses ways of saving electric current. Considerable statistical data are included in tabular form.

HOW TO DESIGN AND INSTALL PLUMBING, Materials and Methods of Standard Practice

By A. J. Matthias. American Technical Society, Chicago, 1941. 442 pp., illus., diagrs., tables, 8½ x 5½ in., cloth, $3.00.

This textbook for home study and for use in vocational schools provides a practical course in the selection and installation of modern plumbing equipment in residences, hospitals and other buildings. A new chapter containing an illustrative example in plumbing estimating, including blueprints drawn to scale, has been added in this edition.

IMPACT RESISTANCE AND TENSILE PROPERTIES OF METALS AT SUB-ATMOSPHERIC TEMPERATURES

Prepared by H. W. Gillett, Project No. 13 of the Joint A.S.M.E.-A.S.T.M. Research Committee on Effect of Temperature on the Properties of Metals, August, 1941; authorized reprint from Proceedings of American Society for Testing Materials, Phila., Pa. 112 pp., diagrs., charts, tables, 9 x 6 in., board, $2.50.

This report contains information and data collected from laboratories interested in low-temperature work. Much of the material is in tabular form for convenience. There is a full discussion of impact resistance, followed by impact data for both ferrous and nonferrous materials, and some fifteen pages relate to low-temperature tensile properties. There is a bibliography.

INDEX TO THE LITERATURE ON SPECTROCHEMICAL ANALYSIS, 1920-1939. 2 ed.

By W. F. Meggers and B. F. Scribner; publication sponsored by Committee E-2 on Spectrographic Analysis of the American Society for Testing Materials, Phila., Pa., 1941. 94 pp., 9 x 6 in., paper, $1.00.

Nearly 1,500 references are contained in this second edition of an index which appeared originally in 1937, constituting a fifty per cent increase. The literature from 1920 to 1939 is covered chronologically, with the authors alphabetically arranged within each calendar year. There is a detailed subject index.

MACHINE SHOP TRAINING COURSE, 2 Vols.

By F. D. Jones. 2 ed. Industrial Press, New York, 1941. Vol. 1, 538 pp.; Vol. 2, 552 pp., illus., diagrs., charts, tables, 9½ x 6 in., fabrikoid, Vols. I and II, $6.00; either Vol. separately, $4.00.

Especially designed for shop courses, vocational schools and self instruction, this treatise covers fundamental principles, methods of adjusting and using different types of machine tools, measuring instruments and gages, screw-thread cutting, thread grinding, gear cutting and precision toolmaking methods. The chapter subheadings are in the form of questions which are answered in a practical manner, with typical examples. There is a large glossary with full definitions, and the new edition contains a chapter on blueprint reading.

MACHINE TOOLS IN AIRCRAFT PRODUCTION

By R. R. Nolan. Pitman Publishing Corp., New York and Chicago, 1941. 158 pp., illus., diagrs., tables, 8½ x 5 in., cloth, $1.50.

It is the purpose of this book to acquaint the vocational student, the beginner or the young mechanic with the fundamentals of aircraft machine tools and the underlying theory of their application. The more important machine tools and their operations are discussed, and there is a general guide for the selection of machines for various types of aircraft parts.

MATHEMATICS (The Pennsylvania State College Industrial Series)

By J. W. Breneman. 210 pp., $1.75.

MECHANICS (The Pennsylvania State College Industrial Series)

By J. W. Breneman. 141 pp., $1.50.

STRENGTH OF MATERIALS (The Pennsylvania State College Industrial Series)

By J. W. Breneman. 145 pp., $1.50.

BLUE PRINT READING AND SKETCHING (The Pennsylvania State College Industrial Series)

By H. R. Thayer. 141 pp., $2.00.
McGraw-Hill Book Co., New York, 1941. illus., diagrs., charts, tables, 9½ x 6 in., cloth,

The texts included in this new series are designed to give simplified presentations of the fundamentals of their respective subjects. Intended for the student or apprentice with limited mathematical background, the theoretical treatment is held to a minimum. Stress is laid on the application of principles of these subjects to important practical problems that are common in industry. Further volumes on engineering drawing, machine design, electricity, etc., are to be included in the series.

(The) TECHNOLOGY OF MAGNESIUM AND ITS ALLOYS, a translation from the German by the technical staffs of F. A. Hughes & Co. Limited and Magnesium Elektron Limited, of "Magnesium und seine Legierungen"

Compiled by A. Beck. F. A. Hughes & Co., London, 1940. 512 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, 30 s.

This important treatise is a translation of a German work written by a number of specialists, and is the only comprehensive work on the subject available in English. The magnesium ores and the methods of producing the metal are described. The metallography of the metal and its alloys and their physical and mechanical properties are set forth extensively. Chemical behaviour, corrosion and surface treatment are discussed. Methods of casting, forging, rolling and machining are thoroughly treated. A chapter is devoted to magnesium in pyrotechnics and thermochemistry, and a list of patents is provided. The translators have corrected errors and made some additions.

MECHANICAL ENGINEERING PRACTICE, a Laboratory Reference Text

By C. F. Shoop and G. L. Tuve. 3 ed. McGraw-Hill Book Co., New York and London, 1941. 506 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $4.00.

Originally intended as a manual of laboratory practice, this book also provides a comprehensive reference text on experimental mechanical engineering. Major topics covered are: methods and instruments for mechanical measurements, friction and lubrication, heat transfer, properties of gases and vapors, fluid flow, pumps and compressors, steam power generating units, refrigeration and internal combustion engines. The revision includes many laboratory experiments in such newer fields as fluid mechanics and air conditioning.

MECHANICAL ENGINEERS' HANDBOOK

Edited by L. S. Marks, 4th ed. McGraw-Hill Book Co., New York and London, 1941. 2,274 pp., diagrs., charts, tables, 7½ x 5 in., lea., $7.00.

Most of the sections in this well-known reference work have been completely rewritten as a result of the great advances which have occurred since the appearance of the last edition in practice, in theory, and in the systematization of existing knowledge in the field of the mechanical engineer. Among the new subjects are the theory of models, plastic behaviour of materials, stress concentration, creep, packings, wind pressure on structures, sound and noise, automatic process control, and power metallurgy. The present edition of this authoritative handbook is the result of the co-operation of more than ninety specialists.

MINERALS YEARBOOK, Review of 1940. U.S. Bureau of Mines

Published by Government Printing Office, Washington, D.C., 1941. 1,459 pp., charts, tables, 9 x 6 in., cloth, $2.00.

The new edition of this valuable annual contains seventy-two chapters prepared by specialists in the field of mineral economics and technology. A general summary of the principal developments during the year precedes the chapters on specific metals and non-metals, in which production statistics and market conditions are given. "Strategic" minerals receive special consideration in the present volume. There is a short section on mine safety conditions.

MODERN GLASS PRACTICE

By S. R. Scholes. Industrial Publications, Chicago, 1941. 289 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $6.00.

A comprehensive account of modern glass-making, this book covers materials, processes, properties, coloring methods and special uses. It is intended primarily for students of glass technology, but will also be of use to glass makers and others who wish a general account of current practice.

PHOTOELASTICITY, Vol. 1

By M. M. Frocht. John Wiley & Sons, New York; Chapman & Hall, London, 1941. 411 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $6.00.

The two-volume work, of which this text is Vol. I, contains the essential material for a thorough understanding of the theoretical principles and experimental procedures for the exploration of all two-dimentional stress systems by the method of photoelasticity. This first volume is confined to the strictly photoelastic methods for plane stress analysis, which are based entirely on the stress pattern and the isoclinics.

PRACTICAL SOLUTION OF TORSIONAL VIBRATION PROBLEMS, Vol. 2

By W. K. Wilson, 2 ed. John Wiley & Sons, New York, 1941. 694 pp., illus., diagrs., charts, tables, 9 x 5½ in., cloth, $8.50.

Owing to the extensive revision and enlargement of the new edition of this work, it was divided into two volumes. The second volume deals with the determination and measurement of stresses owing to torsional vibration, the analysis of torsiograph records, damping devices and rotating-pendulum vibration absorbers, and the dynamic characteristics of electrical-mechanical direct-coupled systems. Many practical examples are worked out, and an appendix contains a discussion of harmonic analysis, a bibliography and a selected list of British patents.

PRINCIPLES AND PRACTICE OF HEAT TREATMENT

By J. Winning. Emmott & Co., Manchester and London, 1941. 99 pp., illus., diagrs., charts, tables, 7½ x 5 in., paper, 2s.

This concise, rational account of modern heat treatment methods and the principles on which they are based is intended for the engineer whose work is affected by heat-treatment problems. The alloys considered have been selected as representative of their particular class as well as being industrially important.

PYROMETRY

By W. P. Wood and J. M. Cork. 2 ed. McGraw-Hill Book Co., New York and London, 1941. 263 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $3.00.

This text is designed for a college course in the subject. Introductory material on temperature scales and fluid thermometers precedes the chapters devoted to the description and use of thermoelectric, optical and total radiation pyrometers and resistance thermometers. Temperature recorders and controlling devices are considered, and there is a brief discussion of transition points. Problems and outlines for laboratory experiments are included.

(The) Second Yearbook of RESEARCH and STATISTICAL METHODOLOGY BOOKS AND REVIEWS

Edited by O. K. Buros. Gryphon Press, Highland Park, New Jersey, 1941. 344 pp., 11 x 7½ in., cloth, $5.00.

This book consists of carefully selected critical reviews of books dealing with statistical methods and techniques in a variety of fields. Three hundred and fifty-nine books published since 1932 are included. The work thus provides a list of the latest publications on the subject and also the means for evaluating them. There are indexes of titles, subjects and reviewers.

SHIPFITTER'S MANUAL

By A. F. Crivelli. Pitman Publishing Corp., New York and Chicago, 1941. 145 pp., diagrs., charts, tables, 8½ x 5½ in., cloth, $1.50.

The purpose of this manual is to provide the groundwork upon which the student shipfitter may build a thorough knowledge by practical application of its contents. The first chapter contains an illustrated glossary of shipbuilding terms. The succeeding chapters cover materials, equipment, the various phases of shipfitting in ship construction, plan reading and electric welding practice.

SPECIFICATION DOCUMENTS FOR BUILDING MATERIALS AND CONSTRUCTION, 1941 ed.

Pacific Coast Building Officials Conference, 124 West Fourth St., Los Angeles, Calif. 400 pp., illus., diagrs., charts, tables, 8 x 5 in., cloth, $5.00.

Sixty-two standard and tentative specifications and test programmes, to which reference is made in the Uniform Building Code of the Pacific Coast Building Officials Conference, are combined in this volume. The material is classified and arranged for ready reference. Like the previous editions, this comprehensive collection of structural standards should prove a great convenience to structural engineers, architects and specification writers.

(The) SPOTTER'S HANDBOOK

By F. Chichester. George Allen & Unwin, London, 1941. 149 pp., diagrs., tables, 7½ x 5 in., cloth, 2s 6d.

The spotter's job of watching for and warning of the approach of enemy aircraft is particularly important for the efficient operation of industrial plants. The author describes the proper organization of this duty including requirements. He explains which indications are most important and why, and gives definite rules for the recognition of all types of airplanes. The behavior of bombs is discussed.

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS

Edited by A. E. Knowlton and R. M. Shoop. 7 ed. McGraw-Hill Book Co., New York and London, 1941. 2,303 pp., diagrs., charts, tables, 9½ x 6 in., lea., $8.00.

The plan and general character of earlier issues of this well-known handbook have been retained in the present edition. There has been, however, considerable change in the text and grouping of subject matter, owing to recent developments, the many new contributors and the intention to provide primarily an encyclopedia of directly applicable information. Condensation of the material on abstract principles allows the practical aspect to be stressed. The enlarged format is designed to facilitate the use of the book as a reference tool.

STEEL SQUARE POCKET BOOK

By D. L. Stoddard. 6 ed. rev. and enl. Scientific Book Corporation, New York, 1941. 183 pp., diagrs., charts, 6 x 4 in., cloth, $1.00.

The practical application of the steel square to many of the problems which must be handled by carpenters and mechanics is clearly described in this small book. Roofs, stairs and various types of framing are among the topics covered. The use of exact engravings of the square laid on the work simplifies or eliminates otherwise long descriptions.

STRENGTH OF MATERIALS, Pt. 2. Advanced Theory and Problems

By S. Timoshenko. 2 ed. D. Van Nostrand Co., New York, 1941. 510 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $4.50.

This standard textbook for advanced students, research engineers and designers has been revised after a period of eleven years. The material, both theoretical and experimental, which has been added, represents recent developments in the fields of stress analysis and experimental investigation of mechanical properties of structural materials. For the most part these additions are applicable to current problems such as airplane construction.

STUDIES IN THE HISTORY OF SCIENCE (University of Pennsylvania Bicentennial Conference)

By E. A. Speiser and others. University of Pennsylvania Press, Phila., 1941. 123 pp., diagrs., charts, tables, 9 x 6 in., cloth, $1.50.

Four of the eight lectures contained in this small volume cover certain periods of development of various phases of medicine and surgery. The remaining four lectures deal respectively with ancient Mesopotamian science, early astronomical concepts, philosophy and mathematical thought.

SYMPOSIUM ON COLOR—Its Specification and Use in Evaluating the Appearance of Materials; jointly sponsored by the American Society for Testing Materials and the Inter-Society Color Council.

Washington Spring Meeting, American Society for Testing Materials, Phila., Pa., 1941. 79 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $1.25, paper, $1.00.

Six extensive technical papers, affording a broad view of the various aspects of color research, are contained in this symposium. The following list of titles indicates the scope: introduction to color; color specifications of transparent materials; hiding power and opacity; color standards for opaque materials; spectrophotometry and color evaluation; photoelectric tristimulus colorimetry.

TABLE OF NATURAL LOGARITHMS, Vol. 1. Logarithms of the Integers from 1 to 50,000

Prepared by the Federal Works Agency, Work Projects Administration for the City of New York; conducted under the sponsorship of and for sale by the National Bureau of Standards, Washington, D.C., 1941. 501 pp., tables, 11 x 8 in., cloth, $2.00, payment in advance.

Continuing the series of mathematical tables being compiled by the Work Projects Administration, this book constitutes Vol. 1 of a projected four-volume table of natural logarithms. The natural logarithms are given here to sixteen decimal places for the integers from 1 to 50,000. Succeeding volumes will carry to 100,000 and cover the range from 0 to 10 at intervals of 0.0001.

TABLES OF PROBABILITY FUNCTIONS, Vol. 1

Prepared by the Federal Works Agency, Work Projects Administration for the City of New York; conducted under the sponsorship of and for sale by the National Bureau of Standards, Washington, D.C., 1941. 302 pp., tables, 11 x 8 in., cloth, $2.00, payment in advance.

The present volume of this series of mathematical tables extends the range of previous tables of the error function and provides a smaller tabular interval. As in all the volumes of this series, provision has been made to facilitate both direct and inverse interpolation. Entries are given to fifteen decimal places.

THERMOCHEMICAL CALCULATIONS

By R. R. Wenner. McGraw-Hill Book Co., New York and London, 1941. 384 pp., diagrs., charts, tables, 9 x 6 in., cloth, $4.00.

A comprehensive introduction is provided to the principles, methods and data available for the solution of a wide variety of practical laboratory and technological problems. Features of the book are presentations of (1) the fundamental principles of thermodynamics of primary interest to the chemist and chemical engineer, (2) the practical contributions of the theoretical physicist to the field of thermodynamics, and (3) various semiempirical methods for the estimation of thermodynamic functions of value in solving technical problems.

TRANE AIR CONDITIONING MANUAL

Published by The Trane Company, La Crosse, Wisconsin, 1941. revised ed. 376 pp., illus., diagrs., charts, maps, tables, 11½ x 8½ in., cloth, $5.00.

Primarily concerned with the application of the fundamental facts of engineering to the design of air conditioning systems, this publication touches on all phases of the field. Heat and its transmission, physical comfort, air properties and supply, psychrometry, refrigeration and ventilation processes, the functions of water in air conditioning and a chapter on ducts and fans, new in this edition, are all covered in this comprehensive treatment of the subject. Diagrams, tables, problems and numerical examples add to its practical value.

UNITED STATES TENNESSEE VALLEY AUTHORITY

The Pickwick Landing Project, Technical Report No. 3, 1941. 431 pp., Government Printing Office, Washington, D.C., illus., diagrs., charts, maps, tables, 9½ x 6 in., cloth, $1.00.

The Guntersville Project, Technical Report No. 4, 1941. 423 pp., Tennessee Valley Authority, Treasurer's Office, Knoxville, Tenn., illus., diagrs., charts, maps, tables, 9½ x 6 in., cloth, $1.00.

Facts about the planning, design and construction of the Pickwick Landing and Guntersville projects on the Tennessee River are presented in these two technical reports. The general programme of the Tennessee River system is considered in each case, and the descriptions of the particular projects cover all phases from the preliminary investigations to complete statistical summaries of equipment and costs. Bibliographies are included.

PRELIMINARY NOTICE

of Applications for Admission and for Transfer

October 25th, 1941.

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 at the December meeting.

L. Austin Wright, General Secretary.

*The professional requirements are as follows:—

A 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 or 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 attainment 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

BREKKE—HANS KRISHAN ANDREAS, of Winnipeg, Man. Born at Skjerstad, Norway, Oct. 13th, 1890; R.P.E. of Man., 1931; Educ.: Civil Engr., German University, Prague, 1925; 1912-13, railroad constrn., instr'man.; 1913-14, Bodo city engrg., constrn. foreman; 1917-20, designer, power developments, Groendahl & Kjorhott; 1927-28, dftsman., Dominion Bridge Company; 1928-31, hydraulic designer, and 1931 to date, hydraulic engr., City of Winnipeg Hydro Electric System, Winnipeg, Man.

References: J. W. Sanger, H. L. Briggs, T. E. Storey, E. V. Caton, A. Campbell, G. H. Herriot, W. S. Lea.

CAMM—HARRY JOSEPH, of Montreal, Que. Born at Montreal, June 18th, 1913; Educ.: 1931-35, completed mech. engrg. course, American Locomotive Company; with Montreal Locomotive Works Ltd. as follows: 1929-35, served ap'ticeship and engrg. course, later on detail design and layout. 1935-37, leading dftsman., designing mech. and structural steel work; 1937-40, engr. respons. for design, calculations and finished drawings on locomotive work; 1940 (Feb.-Sept.), senior dftsman., R.C.A.F., i/c design of shop equipment for air stations; 1940-41, mech. engr., Canada Wire & Cable Co.; at present designing dftsman., Canadian Industries Ltd., Montreal.

References: E. T. Sanne, H. Johnsen.

DAVIS—FREDERICK ALLAN, of 532 Ville Marie St., Montreal, Que. Born at Montreal, Sept. 4th, 1916; Educ.: B.Sc. (Chem.), Queen's Univ., 1940; 1935-36, Ont. Dept. of Highways, prelim. surveys and estimates, etc.; also summer 1937, rodman, chainman, instr'man.; 1938 (May-Sept.), engr., Caswell Constrn. Ltd., Kirkland Lake, Ont.; 1939 (May-Sept.), asst. engr., Corpn. of Twp. of Teck, Kirkland Lake; 1940, in training, Defence Industries Ltd., Brownsburg; Nov., 1940, to date, asst. refinery engr., British American Oil Company, Montreal East, Que.

References: D. S. Ellis, A. Jackson, D. Hillman, A. O. Wolff, M. D. Stewart.

DUNKER—CARL EDWARD, of 1009 Maitland St. London, Ont. Born at Kitchener, Ont., Dec. 9th, 1908; Educ.: Senior Matriculation. Two years Technical School; 1920-26, after school and during vacations, on minor jobs with the Dunker Construction Company, Kitchener, Ont. 1927 to Jan., 1941, Member and Director of above company, on gen. constrn. work, incl. concrete, masonry, carpentry, elec. plumbing and heating; Jan., 1941, to date, Lieut., Works Officer, R.C.E. (A.F.), Mil. Dist. No. 1, London, Ont.

References: W. M. Veitch, R. W. Garrett, S. Shupe, W. H. Riehl, M. Pequegnat.

GREY—NOEL WILLIAM, of Lobitos, Peru. Born at Maidstone, Kent, England, Dec. 20th, 1906; Educ.: 1921-27, Regent Street Polytechnic, London, England; Assoc. Member, Institution of Chem. Engrs.; Fellow, Institute of Petroleum; Member, Technological Inst. of Great Britain; 1921-24, pupil to Gibbons Bros. Ltd., London, England. Constrn. of steel bldgs., concrete work and heavy machinery; 1924-25, Medway Oil and Storage Co., Kent, England, in labs. and later i/c of gas distribution; 1925-26, with Humphries & Glasgow, London, on erection of three million per diem water gas plant; 1926-27, pupil to C. V. Bennett, engr. and gen. mgr., Rochester, Gillingham and Chatham Gas Co.; Oct., 1927, to date, with the Lobitos Oilfields Ltd., Lobitos, Peru, as follows: 1927-28, shift engr., 1928-29, charge shift engr.; 1929-30, mtce. engr., gasoline dept., 1933-37, supt., gasoline dept., 1937 to date, gen. supt., gasoline dept., and chemical engr. to company.

References: G. E. Kent, B. P. Rapley.

HANSON—RALPH HAROLD, of North Devon, N.B. Born at Fredericton, N.B., Oct. 7th, 1907; Educ.: 1928-31, Univ. of N.B.; 1928-31, instr'man. on highway work in N.B.; 1931-34, land surveyor, private and crown land, Prov. of N.B.; 1934-35, res. engr., Oromocto highway; 1934-35, asst. chief engr., on Renous-Plaster Rock highway location; 1936, asst. to bridge engr., on various small bridges in N.B. for Bridge Dept.; 1939-40, res. engr., military and internment camps, Dept. of National Defence, 1941, office and field engr. on Shipshaw power development for Foundation Company of Canada; at present, office engr., on defence programme in Nfld., for E. G. M. Cape & Co. Ltd.

References: C. L. Stevenson, R. Strickland, E. O. Turner, J. Stephens, W. E. Seeley.

HARE—WILFRED ALMON, of 833 Kildare Road, Windsor, Ont. Born at Halifax, N.S., May 4th, 1875; Educ.: B.A.Sc., Univ. of Toronto, 1899: 1900-02, dftsman.; 1902-03, engr. on new plant for Rhodes, Curry & Co., Amherst, N.S.; 1903-04, engr. for changes in steam plant, Illinois Steel Co., Joliet, Ill.; 1904-07, asst. engr. and later chief engr., Underfeed Stoker Co., Toronto; 1907-16, Hare Engineering Co. Ltd., Toronto, mfg. mech. stokers for power plants, also designed and built heavy shell turning lathe for shell plants; 1916-17, chief engr., stoker divn., James A. Brady Foundry Co., Chicago, Ill.; 1917-18, James E. Morrison Co., Consltg. Engrs., Detroit, Mich., as advisory engr. on steel heating equipment and forge plant design; 1919-26, vice-president and chief engr., The Houstoker Corpn., Detroit, Mich.; 1926-29, partner, engr. and mgr., Hare-Luers Stoker Company; 1929-32, mgr. and engr., Stoker Divn., Whitehead & Kales Co., River Rouge, Mich.; 1932-35, on death of Mr. Whitehead assets of above company purchased by Hare Stoker Corpn., Detroit, Mich. President and gen. mgr. until 1935, when interest in company sold to others; 1935-38, consltg. mech. engr., Detroit; 1938 to date, partner and mgr., Sawyer-Hare Furnace Company, Detroit, Mich.

References: J. C. Keith, J. J. Newman, H. S. Clark.

HOWSE—GEORGE WESLEY, of Port Nelson, Ont. Born at Beamsville, Ont. June 29th, 1884; Educ.: I.C.S. Corres. Course, Electrical; 1906-07, power house operator, Almonte Power Co.; 1907-08, asst. supt. on power, for W. E. Edwards, Ottawa; 1908-10, constrn. engr., Can. Gen. Elec. Co.; with the H.E.P.C. of Ontario, as follows: 1910-11, constrn. engr., 1911-14, chief operator, St. Thomas, 1914-20, elec. inspr., St. Thomas, and 1920 to date, district electrical inspector, Hamilton, Ont. Consltg. on large power installns., checking plans, and specifications and approving same.

References: T. H. Hogg, W. P. Dobson, H. A. Cooch, C. H. Hutton, W. L. McFaul, A. R. Hannaford, G. Moes, J. R. Dunbar.

KENNEDY—SAMUEL McNEE, of 148 Cote St. Antoine Road, Westmount, Que. Born at Cannington, Ont., Jan. 28th, 1913; Educ.: B.A.Sc. (Civil), Univ. of Toronto, 1936; 1933-34 (summers), road bldg., A. E. Jupp Constrn. Co.; 1936-37, Toronto Iron Works, on design and detail of tanks and pressure vessels, also fabrication of same in shops; 1937-41, Dominion Bridge Co. Ltd., 6 mos. in detail office, 7 mos. on loan to Aluminum Co. of Canada, and 2 years engr. in boiler design dept.; at present, on steam plant design, engrg. dept., Defence Industries Ltd., Montreal, Que.

References: H. C. Karn, C. R. Young, R. S. Eadie, C. D. Bailey, P. Millar, R. H. Self.

McKERLIE—JARDINE, of 54 Rowanwood Ave., Toronto, Ont. Born at Glasgow, Scotland, July 23rd, 1896; Educ.: 1911-14, Royal Technical College, Glasgow, concurrently with apprenticeship as shipwright, Barclay, Curle & Company, Whiteinch, Glasgow; interrupted by military service, 1914-16. 1916-17, completed apprenticeship by transferring to elec. engrg. with W. C. Martin & Co., Glasgow; after war, home study and corres. courses with McKinley-Roosevelt Univ. of Chicago, receiving B.Sc. in Engrg. (Elec. and Mech.), 1938, and Ph.D. in Education, 1941; 1917-19, supt. of elec. contracts on naval ships being fitted by W. C. Martin & Co.; 1919-21, elec. contractor on own account; 1921-23, mgr., Milligan's Wireless Station, Glasgow; 1923-25, chief engr., Webb's Bakery, Toronto, Ont.; 1926, sales engr. and transportation analyst, Ward Motor Vehicle Co., Mount Vernon, N.Y.; 1926-34, various positions in Toronto and Montreal as agent and partially on own account, and in partnerships concerned in elec. refrigeration and air conditioning sales and engrg.; 1934-38, editor, "Refrigeration and Air Conditioning"; Concur-

(Continued on page 565)

Employment Service Bureau

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party. Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted upon request after a lapse of one month. All correspondence should be addressed to THE EMPLOYMENT SERVICE BUREAU, THE ENGINEERING INSTITUTE OF CANADA, 2050 Mansfield Street, Montreal.

SITUATIONS VACANT

EXPERIENCED MECHANICAL DESIGNING DRAUGHTSMAN for general mechanical work and industrial piping. Apply Box No. 2375-V.

CONCRETE DRAUGHTSMEN for industrial plant design. Apply Box No. 2401-V.

MECHANICAL GRADUATE ENGINEER, with machine shop experience, required for work in South America on important war contract. Apply Box No. 2441-V.

SALES ENGINEER with excellent technical or industrial qualifications, for work largely in the electrical industry. This is a splendid opportunity for a good man. Employment will be permanent. State training, experience and other qualifications. Apply Box No. 2451-V.

ENGINEERING DRAUGHTSMAN with experience in machine and structural design, proficient in steel design calculation, and having ability for estimating. We require a man with at least five years' industrial experience, preferably in the paper mill field. Position is permanent· State experience and give physical description. Include small photograph and a sample of draughtsmanship. Apply to Box No. 2458-V.

MECHANICAL DRAUGHTSMAN, experienced in making layouts for various installations, piping, etc., around a paper mill. Applicant must be a college graduate. State previous experience, wages expected, etc. Apply to Box No. 2461-V.

ALLOY METALLURGISTS for research laboratory of large industrial firm. Men should be between 20 and 30 years of age preferably post-graduate students. They should have had educational training in physical chemistry or elementary metallography. Apply to Box No. 2464-V.

ASSISTANT ENGINEER wanted immediately for newsprint mill near Quebec City. General engineering including equipment layouts and raw material surveys. Salary depends on ability. Applications will not be considered from persons in the employment of any firm, corporation or other employer engaged in the production of munitions, war equipment or supplies for the armed forces, unless such employee is not actually employed in his usual trade or occupation. Apply to Box No. 2471-V.

SITUATIONS WANTED

ELECTRICAL ENGINEER, B.Sc. in electrical engineering, age 43, married, available on two weeks notice. Fifteen years experience in electrical work. Including electrical installations of all kinds in hydro-electric plants and sub-stations. Maintenance and operation of hydro-electric plants. Electrical maintenance and installations in pulp and paper mill. Considerable experience on relays and meters. At present employed, but desires change. Apply Box No. 636-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., age 29, married. Two years city engineer, five years experience in highway work, including surveying, location, construction, estimating and inspection. Apply Box No. 2409-W.

ELECTRICAL ENGINEER, B.E., in electrical engineering, McGill University, Age 24, married, available on two weeks notice. Undergraduate experience, cable testing and cathode ray oscillography. Since graduation, five months on construction of large and small electrical equipment in plant and sub-station. One year operating electrical engineer in medium size central steam station paralleled with large Hydro system. At present employed, but is interested in research or teaching. Associate member of the American Institute of Electrical Engineers. Apply to Box No. 2419-W.

PRELIMINARY NOTICE (*Continued from page 564*)

rently, acted as constrn. engr. for the erection of air conditioned paper warehouse accommodation and building for Garden City Press, Gardenvale, Que.; 1938-39, director of training, Industrial Training Systems Limited, Toronto, subsidiary of Industrial Training Corpn., Chicago; Sept., 1939, appointed Inspr. of Guns and Carriages, M.G.O. Branch, Dept. of National Defence; Feb., 1940, transferred to office of Chief Ordnance Mech. Engr.; June, 1940, appointed Asst. Chief Ordnance Mech. Engr.; Dec., 1940. transferred to General Staff, Canadian Army, and appointed Director of Technical Instruction, Canadian Army Trade School; May, 1941, transferred to position of Division Manager, Ontario-Great Lakes Division, Wartime Merchant Shipping Ltd., a branch of the Dept. of Munitions and Supply.

References: P. L. Pratley, N. C. Sherman, F. S. B. Heward, H. A. Cooch, R. E. Heartz.

STARK—JOHN EDWARD, of 65 Wendover Road, Toronto, Ont. Born at Plumstead, Kent, England, May 15th, 1892; Educ.: 1906-07, British Govt. Scholarship, Royal Arsenal & Woolwich Polytechnic. Mech. drawing and design, machine and tool shop training; R.P.E. of Ont.; 1907, machine shop, Toronto Bedding Co.; 1907-10, press set up work with Warwick Bros. & Rutter, Nilne Bingham Co., and Brown Searle Co.; 1910-15, with Warden King Ltd., heating equipment design and layouts. Also private contract work on bldgs. in Toronto and Detroit. Also some specialized work with Minneapolis Honeywell, etc.; 1915-19, with C.E.F. Dec., 1916, commissioned with appointment as officer i/c Technical Equipment, 2nd C.R.T., and continued in this capacity until end of war. Mostly rly. and bridge work —some survey work; 1919, with D.S.C.R., i/c Vocational Board; 1919 to date, with H.E.P.C. of Ontario, constrn. dept., first on elec. installn. and costing; later i/c of office; 1924-28, head office superintendence of bldg. structure (stations) constrn. throughout Ontario; 1928-31, field supt. of constrn., Leaside Transmission Station; 1932 to date, head office supt., station constrn.

References: J. M. Gibson, H. E. Brandon, G. Mitchell, D. Forgan, J. W. Falkner.

TESKEY—ARTHUR G., of Winnipeg, Man. Born at Winnipeg, Nov. 15th, 1915; Educ.: B.Sc. (Elec.), Univ. of Man., 1937; 1937-39, ap'ticeship, and 1939 to date, sales engineer, Canadian Westinghouse Co. Ltd., at present at Winnipeg office.

References: E. P. Fetherstonhaugh, A. E. Macdonald, C. P. Haltalin, L. M. Hovey, E. V. Caton, J. R. Dunbar, D. W. Callander.

WESTMAN—LeROY EGERTON, of 295 Riverside Drive, Toronto, Ont. Born at Granton, Ont., June 28th, 1890; Educ.: B.A., M.A., Univ. of Toronto, 1914; R.P.E. of Ontario; 1914 (5 mos.), Dominion Coal Co. Glace Bay; 1914-15, public analyst, Dom. Govt. Chemist in charge of Inspection Laboratory, New York; 1915-18, employed by Dom. Govt. or on loan to other organizations. Analytical and chemical control work and inspection; 1919 to date, editor of Canadian Chemical Journal, now Canadian Chemistry and Process Industries; 1928, organized Cheney Chemicals Ltd., and established the manufacture of nitrous oxide in Canada. In charge of design and constrn. of plant in Toronto; 1934, associated with the constrn. of wood flour plant, grinding wood flour suitable for use as filler in synthetic resins; 1921-36, Secretary, Canadian Institute of Chemistry; at present, President, Westman Publications Ltd., Toronto, Ont.

References: H. W. Lea, C. K. McLeod, W. P. Dobson, L. A. Wright, J. R. Donald.

WINGFIELD—HAROLD ERNEST, of Stratford, Ont. Born at Loughton, Essex, England, March 8th, 1901; Educ.: B.A.Sc., Univ. of Toronto, 1923; 1918-19, asst. to supt., Canadian Engineers Ltd., Dunnville; 1923-25, engr., research and and production work, 1926-30 branch mgr., western office, Winnipeg, and 1930-33, sales mgr., Turnbull Elevator Company, Toronto, Ont.; 1933-36, industrial engr., Toronto Industrial Commission; at present, director of sales, advertising and purchasing, Imperial Rattan Co. Ltd., Stratford, Ont. Vice-President, V. H. McIntyre Ltd., Toronto, Ont.

References: C. R. Young, A. R. Robertson, L. A. Wright, T. H. Hogg, O. Holden, W. P. Dobson, W. S. Wilson, J. B. Challies, W. D. Black.

WOLSTENHOLME—PHILIP GEORGE, of Valleyfield, Que. Born at Rochdale, Lancs., England, August 3rd, 1910; Educ.: 1932-34, College of Technology, Manchester; 1934-35, Technical College, Bradford, Yorks.; extended course in electric traction. Special course in hydraulics; 1926-33, elec. and mech. engrg. ap'ticeship, incl. shop work and installns., Fryer & Hartley Ltd., Rochdale, England; 1933-35, with Balfour & Beatty Ltd., constrn. and elec. engrs., Edinburgh; 1935, testing asst. on switchgear and rectifying equipment, English Electric Co. Ltd., Stafford, England; 1935-37, erection and testing engr., Phoenix works of same company at Bradford; 1937-38, New Zealand Steamship Co., engr. on Diesel marine engines and refrigeration plant, R.M.S. "Rangitiki"; 1938-39, erection engr., and 1939-40, testing engr., New Zealand Govt. Rlys.; 1940, English Electric Co. of Canada, St. Catharines, Ont.; 1940 (Oct.-Dec.), asst. to elec. supt., Defence Industries Ltd., Nobel, Ont.; at present, elec. supt., Defence Industries Ltd., Nitro, Que. i/c of elec. transformation, distribution and mtce. of elec. plant. Also respons. for new elec. constrn., etc.

References: J. R. Auld, H. C. Karn, D. Andersen, T. L. Crossley, R. C. Wiren, G. Kearney, C. L. Blackmore.

FOR TRANSFER FROM JUNIOR

POPE—JOSEPH MORLEY, of 197 Fifth Ave., Ottawa, Ont. Born at Montreal, Nov. 5th, 1906; Educ.: B.Sc., McGill Univ., 1929; 1925-27 (summers), Electrical Commission, City of Montreal; 1928-30, engrg. dept., Northern Electric Co. Ltd.; 1931-33, engrg. dept., Canadian Marconi Co.; 1934-35, test. dept., R.C.A. Victor Co.; 1936-40, with the Consolidated Paper Corpn. Ltd., 1937-38, asst. to the elec. supt., Belgo Divn., and 1938-40, same position, Wayagamack Divn.; 1940 to date, Flight-Lieut., Aeronautical Engrg. Divn., R.C.A.F., Ottawa, Ont. (St. 1927, Jr. 1937).

References: H. O. Keay, E. W. Stedman, A. Ferrier, W. A. E. McLeish, E. B. Wardle, S. P. MacNab.

TUCK—JOSEPH HOWARD, of Port Colborne, Ont. Born at Port Colborne, July 23rd, 1909; Educ.: B.Sc. (Mech.), Queen's Univ., 1932; 1932-36, i/c time study and plant scheduling; 1936-37, machinist, and 1937 to date, supt. of monel dept., i/c design and fabrication of unfired pressure vessels and special monel containers, International Nickel Co., Port Colborne, Ont. (St. 1928, Jr. 1938).

References: C. H. McL. Burns, G. E. Griffiths, A. L. McPhail, C. N. Geale, P. E. Buss.

FOR TRANSFER FROM STUDENT

BAGGS—WILLIAM CLYDE, of Bathurst, N.B. Born at Curling, Nfld., April 12th, 1914; Educ.: B.Eng., McGill Univ., 1936; 1930-36 (summers), surveyor and dftsman., 1936 (June-Nov.), asst. supt., reconstrn. hydro electric development, and 1936-37, engr., International Power & Paper Co. of Nfld. Ltd.; with Bathurst Power & Paper Co. Ltd. as follows: 1939-40, project engr. i/c design and constrn. new recovery plant; 1940 (June-Sept.), foreman, kraft mill; Oct. 1940 to date, asst. to the manager. (St. 1935.)

References: K. O. Elderkin, R. L. Weldon, C. M. McKergow, H. W. McKiel, G. E. Booker, A. H. Chisholm, F. L. West.

MURRAY—ROBERT LESLIE, of Vernon, P.E.I. Born at Vernon, Nov. 11th, 1912; Educ.: Engrg. Cert., Mt. Allison Univ., 1933. 1934-35, postgraduate studies in mech. engrg., N.S. Tech. College; 1937-40, with the Dept. of Highways, Charlottetown, land surveying, instr'man., highway constrn., gen. field and office work, etc.; 1937-41 (part time), land surveying in Charlottetown, and in various parts of the province; 1940-41, airport constrn., R.C.A.F., Dept. of National Defence (a) asst. engr. i/c design, layout and installn. of water, sewage and surface drainage systems, etc., (b) acting res. engr., i/c of constrn., and at present, asst. engr. i/c of constrn. (St. 1931.)

References: F. H. Sexton, S. Ball, S. J. Montgomery, H. W. McKiel, F. L. West, V. C. Blackett, H. E. Miller, E. L. Miles.

THOMSON—ARTHUR McCALL, of Winnipeg, Man. Born at Medicine Hat, Alta., May 5th, 1913; Educ.: B.Sc. (Elec.), Univ. of Alta., 1937; 1937-38, test course, 1938-39, departmental plan, and 1939 to date, apparatus sales engr., Can. Gen. Elec. Co. Ltd., Winnipeg, Man., (St. 1937).

References: E. S. Braddell, L. M. Hovey, S. G. Harknett, W. E. Cornish, R. S. L. Wilson.

Industrial News

Industrial development — new products — changes in personnel — special events — trade literature

LIFT TRUCKS

A folder containing 22 loose leaf pages and entitled "Facts about Towmotor," has been issued by Towmotor Co., Cleveland, Ohio. This folder is essentially a file of operating data and specifications, accompanied by short descriptions and illustrations of this company's various models of lift trucks.

SAFETY POSTER SERVICE

The Consolidated Optical Co. Ltd., Toronto, Ont., has announced that it will be glad to place any industrial firm's name on its mailing list for a free safety poster service which was inaugurated several years ago. At certain intervals during the year, dramatic, colourful safety posters, driving home to workers the value of safety precautions, are made up and mailed to concerns desiring the service.

INSULATION TESTING SET

A 2-page folder issued by Milton-Thompson Electric, of Toronto, Ont., features the "Megometer," an instrument for testing the insulation of electrical installations, domestic appliances and small motors, etc., which operate on voltages up to 250 v. It may be used also as a voltmeter. The instrument is made in England.

EXPANDED METAL MESH

The Pedlar People Limited, Oshawa, Ont., is distributing a 6-page booklet which features a few of the many applications of "Pedlar's 'Steelcrete' Expanded Metal Products" and includes numerous progress photographs showing the use of various types of mesh in industrial plants, for floors and tunnels, bank vaults, skywalks, storage bins, partitions, safety guards, etc.

TRADE MARK ADOPTED

The B. F. Goodrich Rubber Company of Canada, Limited, announces the adoption of this new trade mark in line with the parent company in the United States, and it is already becoming a familiar sight on B. F. Goodrich advertising, dealer signs, and station identification. It will be noted that the new design features the famous initials "BFG" and the date "1870," the large "G" being partially enclosed in a laurel wreath.

SYNCHRONOUS MOTOR CONTROLLERS

English Electric Co. of Canada, Ltd., St. Catharines, Ont., feature its Type "FX" Synchronous Motor Controllers, in a new 8-page bulletin, No. 1354B, which provides details of construction and operation with a diagrammatic illustration of the sequence of operation. Other data given include adjustments and maintenance.

ELECTRODES

"Stelco Electrod" is the title of a 24-page booklet issued by The Steel Co. of Canada, Ltd., of Montreal and Hamilton, which features the various types of "Stelco" coated electrodes. Numerous photographs show the application of the products to actual jobs, while each type is described under the headings, application, properties, procedure, recommended currents and qualifications.

BIOFILTRATION SYSTEM

With photographs and descriptive matter, a 20-page bulletin, No. 7311, issued by The Dorr Co. Inc., Toronto, Ont., tells what the "Biofiltration System" is, what it does and how it does it. It also contains flowsheets, plant layouts, operating data, cost analyses, general dimensioned drawings of the major equipment units and data upon which design can be based.

ELECTRICAL CONNECTORS

In a 2-page folder, Canadian Line Materials, Ltd., Toronto, Ont., describes various types of "Burndy Electrical Connectors" which provide "permanently tight connections with the turn of a wrench." Several types are illustrated which take care of most ordinary connection jobs. Many other types are shown in the company's catalogue No. 41.

EAR PROTECTORS

A 4-page bulletin No. HA-1, issued by Mine Safety Appliances Co. of Canada Ltd., Montreal, Que., contains a description of this company's recently announced "Ear Defenders," which are designed to greatly modify loud noises common to industrial plants. These small devices fit snugly into each ear, reducing the volume of loud sounds but permitting the wearer to hear warning signals and ordinary conversation.

PORTABLE PLATFORM SCALES

A folder of The Canadian Fairbanks-Morse Co. Ltd., Montreal, Que., describes the Fairbanks all-metal scale with steel clad platform; contains illustrations, specifications and a general description setting forth the special features of the scale.

BUILDING INSULATION

Fiberglas Canada Limited, Oshawa, Ont., are distributing a 6-page booklet entitled "Fiberglas Insulating Blankets and Junior Bats" which describes the use of these products for the insulation of buildings and gives an illustrated outline of how to apply "Roll Blankets," "Bat Blankets" and "Junior Bats."

POTENTIAL TRANSFORMERS

The new 24-page bulletin, No. 404, published by Ferranti Electric Ltd., Mount Dennis, Toronto 9, Ont., replaces former bulletin No. 404 and features several major and a number of minor changes. The compound-filled Type PW-4 outdoor unit for 4000-v. service has been replaced by the oil-filled Type PWA-4. Also, the PW-110 outdoor potential transformer for 115,000-v. service is included in the standard line. Additional data on standards and a description of how to determine the ratio and phase-angle errors at any burden from the standard curves, are incorporated.

PACKINGS AND GASKETS

Canadian Johns-Manville Co. Limited, Toronto, Ont., has announced the publication of a 44-page catalogue, designated as "Form PK-12A, which contains detailed information on J-M packing and gasket styles and includes tables as guides to proper packing selection for various types of equipment under such service conditions as steam, brine, ammonia, acids, caustics and oils. An analysis of factors determining packing performance and a section on "How to get the best results from packings" are also included.

BROWN BOVERI CELEBRATES 50th ANNIVERSARY

On October 2, Brown Boveri & Company, Limited, celebrated its fiftieth anniversary at the head office and factory in Baden, Switzerland.

From a modest beginning in 1891, when it was founded by Messrs. C. E. L. Brown and Walter Boveri, it has grown into one of the great engineering firms of the world. In 1891 the firm had seventy employees. To-day, in Switzerland and around the world in overseas branches and affiliated firms, the total number of persons employed by the company is forty thousand.

When the firm was established for the purpose of manufacturing all types of electrical machinery which had hitherto been produced in small workshops, Mr. Brown was already renowned as an engineer. He had previously designed the 40-pole, 3-phase alternator with claw type pole-wheel and concentric coil fields for the Lauffen Power Station. Stepped up to 25,000 volts by 3-phase transformers—which, the company states, was the first oil-cooled transformer ever built—the current from this machine was transmitted over a line 175 km. long to Frankfort-on-the-Main. This transmission of power demonstrated the practicability of transmitting large power over long distances by means of high voltage, single-phase, or three-phase current. The generators, motors, transformers, etc., manufactured by the company found the largest part of their market in Switzerland, where, about the middle of the 1890's, the beginning of the development of Swiss water power opened up an intensive field of operations.

The Company points out that in 1900 Brown Boveri became the first concern on the continent of Europe to build steam turbines, and parallel with this development, the construction of generators for direct coupling to steam turbines was taken up. While the largest machines built during the first year of development were only for a few hundred kva, two-pole machines (3,000 and 3,600 r.p.m. at 50 and 60 cycles, respectively) are now being built for outputs up to 45,000 kva. and 4 pole machines (1,500 and 1,800 r.p.m. at 50 and 60 cycles, respectively) for outputs up to 100,000 kva. without reaching limiting sizes. This development was only rendered possible by constructing the rotors as cylindrical drums and milling out the slots for the field windings—one of the most ingenious inventions of C. E. L. Brown—as this is the only design in which the centrifugal forces produced at the high speed of rotation can be withstood.

Located, as it is, in one of the last strongholds of democracy on the European continent, the Brown Boveri Company, in looking back over the past 50 years, faces the future with quiet confidence. The firm is represented in Canada by its subsidiary, Swiss Electric Company of Canada Limited, Montreal.

THE ENGINEERING JOURNAL

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★ ★ ★

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RATIONAL COLUMN ANALYSIS

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Paper to be presented before the General Professional Meeting of The Engineering Institute of Canada, at Montreal, Que., on February 6th, 1942

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INTRODUCTION

In mathematical analyses we need as many equations as there are unknowns. If we can guess the value of one of the unknowns intelligently, we can dispense with one of the otherwise necessary equations and thus materially simplify our analysis. In column analysis we may simplify our efforts by following this procedure. In "Euler's Column Formulae"[1] (see Figs. 8a, 9a and 11a) the type of elastic curve which the column would assume was determined by guess with complete accuracy, and what are recognized as "exact" strength formulae were obtained. In "Columns Subject to Transverse Loading"[2] the type of elastic curve was guessed with a quite high degree of accuracy and the resulting formulae proved accurate to within a fraction of one per cent. In this and the following analyses we propose to follow the same procedure and obtain formulae which are either technically "exact" or approximate, depending on whether or not we are able to determine in advance the true type of elastic curve.

In the appendix the results of some column tests are presented. *The significant feature of these tests is that, first, the eccentricity (or lack of eccentricity) is quite definitely controlled up to the point of failure; second, the load-axial deformation relationship is recorded far beyond the critical load.*

THE SECANT FORMULA

In the analysis of eccentrically loaded prismatic columns we are able to determine exactly what is the type of elastic curve which the columns will assume, and thus we obtain what is recognized as the "exact" formula.

Figure 1c[3] shows an eccentrically loaded column. When the eccentricity e approaches zero as a limit the elastic curve approaches a sine curve. When e approaches infinity the elastic curve approaches an arc of a circle as a limiting curve. The true curve, then, will fall between a sine curve and an arc of a circle.

The free-body sketch for the portion BD of Fig. 1a as well as for the portion BD of Fig. 1c is, in either case, given by Fig. 1b. Therefore, BD of Fig. 1c and BD of Fig. 1a are identical. The curve ABCDE of Fig. 1a is a sine curve, and if we adopt mathematical usage we may say it is a full arch of a sine curve. The portion BD of this curve is then an arc of a full arch of a sine curve. By virtue of the identity which we have just established the portion BD of Fig. 1c also is an arc of an arch of a sine curve. Once we are agreed on this fact the mathematical development is direct and relatively brief.

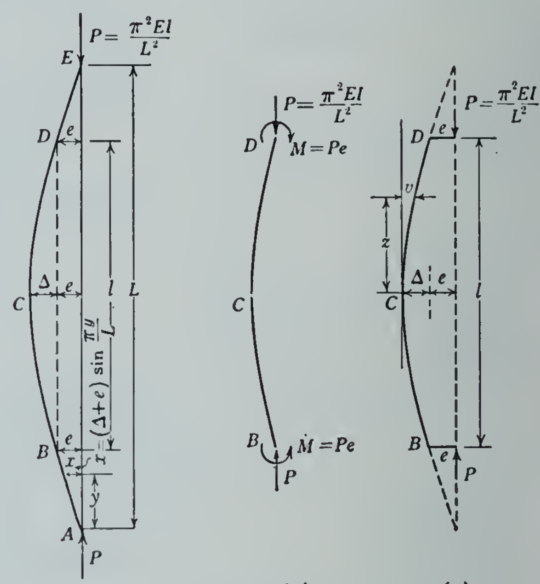

Fig. 1

The equation for the curve ABCDE in Fig. 1a, or for the curve BCD in Fig. 1c, is:

$$x=(\Delta+e)\sin\frac{\pi y}{L}$$

$$e=(\Delta+e)\sin\frac{\pi(L-l)}{2L}=(\Delta+e)\cos\frac{\pi}{2}\frac{l}{L} \qquad \text{(a)}$$

$$\frac{dx}{dy}=(\Delta+e)\frac{\pi}{L}\cos\frac{\pi y}{L}$$

$$\frac{d^2x}{dy^2}=-(\Delta+e)\frac{\pi^2}{L^2}\sin\frac{\pi y}{L}$$

The curvature, or $\frac{1}{R}=\dfrac{\frac{d^2x}{dy^2}}{\left(1+(\frac{dx}{dy})^2\right)^{3/2}}$

This expression is a maximum for the value $y=\frac{L}{2}$

Thus $\quad (\frac{1}{R})_{max}=-\frac{d^2x}{dy^2}=(\Delta+e)\frac{\pi^2}{L^2}=\frac{s}{Ec}$

in which s is stress due to curvature in the extreme fibre of the column at point C.

$$s=\frac{\pi^2Ec}{L^2}(\Delta+e)$$

This stress s, due to curvature, is augmented by a stress P/A, due to the direct load. Thus the equation

$$s = \frac{\pi^2 Ec\,(\triangle + e)}{L^2} + \frac{P}{A}$$

gives a general load-stress relationship for the midpoint of the column on the inside of the elastic curve. But since this relationship is not linear it throws no light on the strength of the column. An estimate of the column strength can be made only when we assign a definite maximum value for s, say the elastic limit stress s_1, and simultaneously define the corresponding load P as being equivalent to the limit load, critical load or maximum load, which the column can carry. With s_1 and P so defined we may write.

$$s_1 = \frac{\pi^2 Ec\,(\triangle + e)}{L^2} + \frac{P}{A}, \text{ or}$$

$$(\triangle + e) = \frac{L^2}{\pi^2 Ec}\left(s_1 - \frac{P}{A}\right) \qquad \text{(b)}$$

Eliminating $(\triangle + e)$ between equations (a) and (b), we obtain

$$e = \frac{L^2\left(s_1 - \frac{P}{A}\right)}{\pi^2 Ec} \cos\frac{\pi l}{2L}$$

From Fig. 1a we have $L^2 = \frac{\pi^2 EI}{P}$ and $\frac{l}{L} = \frac{l}{\pi}\sqrt{\frac{P}{EI}}$. Substituting these values in the foregoing equation we obtain

$$e = \left(s_1 - \frac{P}{A}\right)\frac{I}{Pc}\cos\frac{l}{2}\sqrt{\frac{P}{EI}}$$

$$s_1 - \frac{P}{A} = \frac{ecP}{I\cos\frac{l}{2}\sqrt{\frac{EI}{P}}}$$

$$s_1 = \frac{P}{A}\left(1 + \frac{ec}{i^2}\sec\frac{l}{2}\sqrt{\frac{EI}{P}}\right) \qquad \text{Formula 1}$$

Approximate Eccentric Loading Formula

Formula 1 is quite exact, but to say the least it is awkward because we can effect a solution only by cut and try procedure. This awkwardness can effectively be avoided by the simple procedure of assuming a compromise curve in place of an arc of a full arch of a sine curve. An analysis based on the assumption that the shape of the elastic curve in Fig. 1c is a second degree parabola gives very satisfactory results. The mathematical development will appear in Elastic Energy Theory[4]. The resulting formula is:

$$\frac{P}{A} = \frac{1}{2}\left[s_1 + \frac{9.6\,E}{\left(\frac{l}{i}\right)^2}\left(1 + \frac{ec}{i^2}\right) - \sqrt{\left\{s_1 + \frac{9.6\,E}{\left(\frac{l}{i}\right)^2}\left(1 + \frac{ec}{i^2}\right)\right\}^2 - \frac{38.4\,s_1 E}{\left(\frac{l}{i}\right)^2}}\right]$$

Formula 2

A graphical comparison between Formula 2 and the secant formula was published in the closing discussion of the author's paper on "Columns Subject to Uniformly Distributed Transverse Loads"[2] in the *Engineering Journal* of September, 1941.

Initial Crookedness or Wow

Assume a column to be initially curved in the shape of a complete arch of a sine curve with an initial offset and radius of curvature at the midpoint equal to e' and R respectively (Fig. 2). As the column is loaded with a load P the deflection will increase an amount $\triangle$. The bending moment area is one half of the area bounded by the line of action of the load and the elastic curve. The maximum ordinate of this bending moment area is at the midpoint and equals $P\,(e' + \triangle)$. The deflection $\triangle = \frac{Area\ \bar{y}}{EI}$. The Area in question, shown cross hatched in Fig. 2, is $2/\pi \times$ the circumscribed rectangle. Thus $Area = \frac{2}{\pi}P(e' + \triangle)\frac{l}{2}$. The $\bar{y}$ of an area under a sine curve, shown in Fig. 2, is $\frac{l}{\pi}$.

Therefore $$\triangle = \frac{Area\ \bar{y}}{EI} = \frac{Pl^2}{\pi^2}(e' + \triangle) = \frac{Pl^2\triangle}{\pi^2 EI} + \frac{Pl^2 e'}{\pi^2 EI}$$

or $$\left(EI - \frac{Pl^2}{\pi^2}\right)\triangle = \frac{Pl^2 e'}{\pi^2} \qquad \text{(c)}$$

From the theory of strength we have:

$$\frac{1}{r} - \frac{1}{R} = \frac{M}{EI} = \frac{s}{cE}$$

$$\frac{d^2x}{dy^2} = \frac{1}{r} = \frac{\pi^2(\triangle + e')}{l^2}$$

$$\frac{d^2x}{dy^2} = \frac{1}{R} = \frac{\pi^2 e'}{l^2}$$

$$\frac{1}{r} - \frac{1}{R} = \frac{\pi^2\triangle}{l^2} = \frac{s}{cE}$$

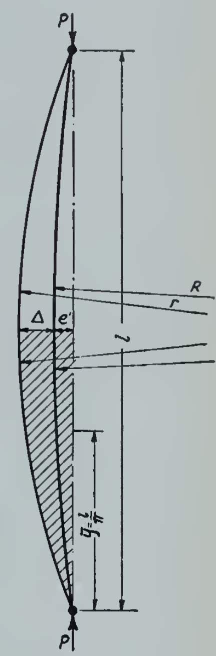

Fig. 2

The stress due to the increase in curvature therefore is:

$$s = \frac{\pi^2\triangle cE}{l^2}$$

This stress is augmented by the stress P/A due to the direct load.

Thus the resulting extreme fibre stress on the inside of the curve at the midsection of the column is:

$$s = \frac{\pi^2\triangle cE}{l^2} + \frac{P}{A}, \text{ or}$$

$$\triangle = \left(s - \frac{P}{A}\right)\frac{l^2}{\pi^2 cE} \qquad \text{(d)}$$

Eliminating $\triangle$ between equations (c) and (d) we obtain

$$\left(EI - \frac{Pl^2}{\pi^2}\right)\left(s - \frac{P}{A}\right) = Pe'cE, \text{ or}$$

$$P^2 - \left(\frac{\pi^2 EI}{l^2} + sA + \frac{\pi^2 Ee'cAi^2}{l^2 i^2}\right)P + \frac{\pi^2 EIsA}{l^2} = 0$$

If we let $\frac{\pi^2 EI}{l^2} = P_{cr}$, then the solution of this equation gives

$$P = \frac{1}{2}\left[\left\{sA + P_{cr}\left(1 + \frac{e'c}{i^2}\right)\right\} - \sqrt{\left\{sA + P_{cr}\left(1 + \frac{e'c}{i^2}\right)\right\}^2 - 4\,P_{cr}\,sA}\right]$$

or

$$\frac{P}{A} = \frac{1}{2}\left[\left\{s + \frac{\pi^2 E}{\left(\frac{l}{i}\right)^2}\left(1 + \frac{e'c}{i^2}\right)\right\} - \sqrt{\left\{s + \frac{\pi^2 E}{\left(\frac{l}{i}\right)^2}\left(1 + \frac{e'c}{i^2}\right)\right\}^2 - 4\frac{\pi^2 E}{\left(\frac{l}{i}\right)^2}s}\right]$$

The last two expressions give a relationship between the load P and the maximum stress in the column. This relationship is purely academic and of no interest to the designer. If we define s as being equal to the elastic limit stress s_1, P immediately assumes special significance because it then becomes the symbol for the limit or maximum load which the column can carry. The resulting formula for the limit load P then is:

$$\frac{P}{A} = \frac{1}{2}\left[\left\{s_1 + \frac{\pi^2 E}{\left(\frac{l}{i}\right)^2}\left(1+\frac{e'c}{i^2}\right)\right\} - \sqrt{\left\{s_1 + \frac{\pi^2 E}{\left(\frac{l}{i}\right)^2}\left(1+\frac{e'c}{i^2}\right)\right\}^2 - 4\,\frac{\pi^2 E}{\left(\frac{l}{i}\right)^2}s_1}\;\right]$$

Formula 3

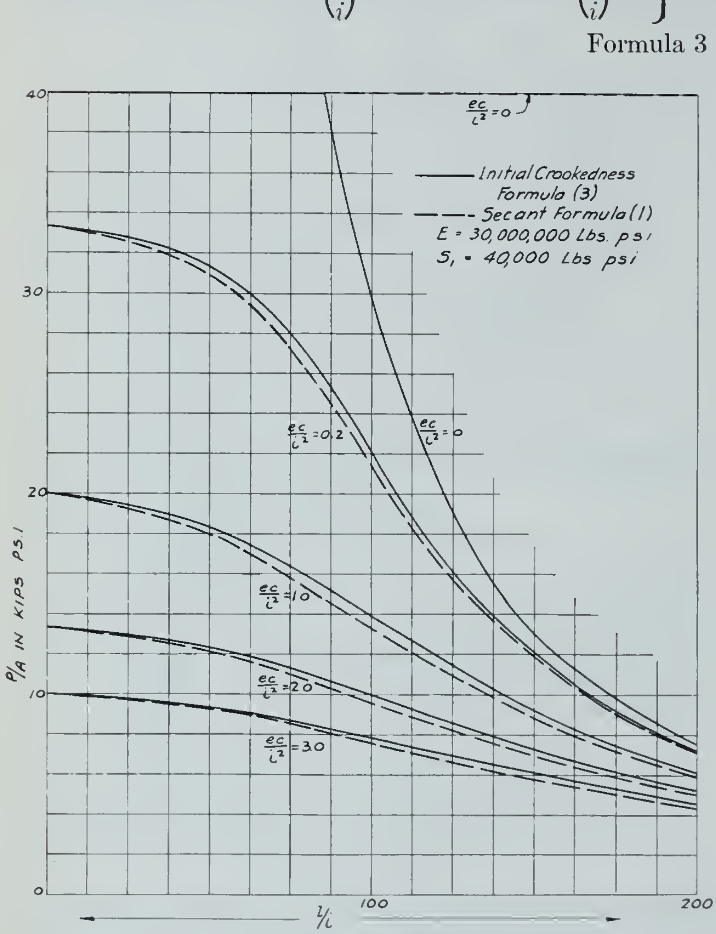

Fig. 3—Comparison between wow formula and secant formula.

Figure 3 shows graphically a comparison of values obtained by Formula 1 (the secant formula) with those obtained by Formula 3 (the wow formula). It shows that for all values (even for values of e' which are much greater than any that can reasonably be expected) the two formulae give results which are nearly the same. More important than Fig. 3 is Fig. 4 which shows how the limit strength of columns is affected by a wow expressed as a function of the length of the column for the following values of e', namely:

$$e' = \frac{l}{600};\ e' = \frac{l}{1000};\ e' = \frac{l}{2000};\ e' = \frac{l}{5000}\ \text{and}\ e' = \frac{l}{\infty} = 0.$$

It appears that for slender columns the weakening effect of initial crookedness is insignificant.

Objectives and Sense of Value

Much confusion and misunderstanding concerning the column phenomena appears to result from an incomplete agreement among engineers as to proper objectives. This disagreement seems to stem from a failure to distinguish clearly between factors of primary and those of secondary importance. To avoid, if possible, such uncertainties and to eliminate this possible cause for misunderstanding in this paper, the author will set forth in some detail his sense of value in regard to the column problem.

No one, including the scientist, is immune to psychological pitfalls. It seems to the author that, in the science of strength, we have fallen into a rut in over-emphasizing the concept "stress" to such a degree that it obscures the problem of "strength." The author regards as basically unsound the practice of dividing an ultimate stress, or an elastic limit stress, by a factor of safety to arrive at a working stress. This tradition was harmless enough in the era which lies behind us—the era of statically determinate construction. It is harmless so long as a linear relationship exists between stress and load. In the present era of redundant construction, a type of construction in which the linear relationship between stress and load is not maintained until the limit load is reached, and in stability problems in which the relationship between stress and load is never linear, the author regards the emphasis on working stress as archaic, generally confusing, and often misleading.

In our formulae we introduce the term P/A. We do so in order to present these formulae in their most general form, which is the form that best lends itself to effective graphical representation. We do so with one misgiving. The first strength formula the engineer learns is P/A = stress. This is no reason for invariably interpreting P/A as stress. The author objects to mathematical terms in engineering science to which he is unable to give a physical interpretation. The term P/A in our formulae is such a term. A is explicitly defined as the cross-sectional area, and P with equal explicitness defines the capacity or maximum load, the load which will induce the elastic limit stress in the column. The term P/A then has no physical significance. It assumes such significance only after it is multiplied by A. Then it yields the load P, the maximum load the column can carry. Once the designing engineer knows the maximum load which would cause his column to fail, he certainly will know how to apply a factor of safety with which to avoid this failure load by a safe margin.

Eccentricity, End Moments or Partial Restraint, and the Ratio of Effective Length over Geometric Length ($n = L/l$) are Identities

Consider Fig. 5 which schematically represents a column with built-in ends under varying loads. Perfect straightness and zero eccentricity are both abstractions and both are

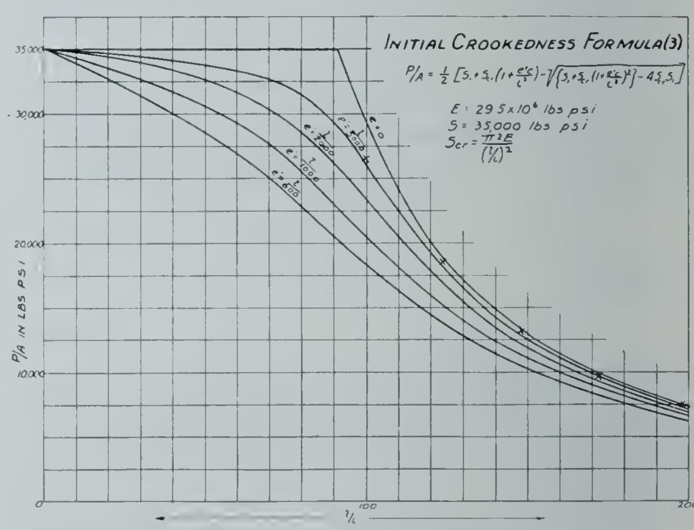

Fig. 4—Strength of columns as affected by wow expressed as a function of the length.

unobtainable. As the column is loaded, either a slight initial crookedness or a slight eccentricity to one side or the other of the centre line determines the direction in which the column deflects. Of the two, initial eccentricity is more likely to be the determining factor. Figure 5 represents the column as a free body. The force and moment or partial restraint shown acting at point A are opposite in sign but otherwise the equivalent of the single force acting with an eccentricity e at point C. As the column deflects the initial eccentricity, or for that matter any intermediate eccentricity, does not concern us in the least. If our aim is to determine the strength of the column then the only eccentricity which would concern us, if we were able to determine it, is that which prevails at the instant the elastic limit stress s_1 is reached on the inside of the curve at point B. The fact is we may determine this eccentricity for any particular column, but we can determine it only as the climax of a complete solution of the column problem. It is never ascertainable as initial data upon which the column analysis may be predicated, except possibly for short struts. Note that in Fig. 5, while the eccentricity is variable, the point of inflection always coincides with the quarterpoint. Thus, while the eccentricity e changes, the ratio $n = L/l$ is a constant up to and including the load condition at which the elastic limit stress in the column is first induced. In this connection we stress the following points.

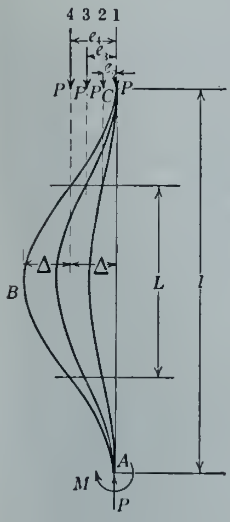

Fig. 5—Fixed-end column in various stages of loading

1. The logic upon which we base the contention—that eccentricity, partial restraint or end moments, and the L/l ratio, are identities—is a logic involving only the theory of equilibrium (statics). It thus supersedes any argument given in terms of elasticity. The theory of equilibrium is the most basic, the most fundamental, theory we have. Our conclusions as to the identity of L/l ratio, eccentricity and partial restraint thus seem irrefutable.

2. The word identical is a strong word. It means "the same in every conceivable respect." This being the case we should be privileged to confine our attention solely to one of the three concepts without in any way doing violence to sound logic.

General Column Formula

The characteristic feature of the pin-ended column, the Euler column, is that when it deflects it assumes the shape of a sine curve. Our development of the secant formula makes it clear that the eccentrically loaded column is but a special case of the concentrically loaded (Euler) column. The analysis of the initially crooked column was also predicated on the assumption that the elastic curve of the column was a sine curve before loading, and remained a sine curve after loading. In the author's paper, in the *Engineering Journal*, on "Columns Subject to Uniformly Distributed Loads"② it was shown that very satisfactory results are obtained if the analysis is based on the assumption that the column subject to uniformly distributed transverse loads assumes the shape of a sine curve. If we keep in mind that eccentricity may effectively, very advantageously in fact, be replaced by the coefficient $n = L/l$, then we may proceed with the derivation of a general formula for a prismatic column of elastic material subject to eccentricity (end moment or end restraint) to wow and to uniformly distributed transverse loads. If the elastic curve assumes the shape of a sine curve under any one of these loadings individually, it will do so under the action of any combination of these loadings collectively.

In Fig. 6b the dashed line represents the shape of the initially-crooked column. The solid line represents the shape of this same column under the combined action of the axial load P and the uniformly distributed load kuA (u is weight per unit volume, A is the cross-section area of the column, $uA = w$ or weight per unit of length, $uAl = W$ or weight of entire column, k is a constant. Thus, for example, if an aeroplane manoeuvres with an acceleration of kg, any strut in this plane placed parallel to the axis of the wings would be loaded with a uniformly distributed inertia loading of $w = kuA$ lb. per inch. In a top chord of a bridge the constant k expresses the maximum inertia effect caused by the vibration of the bridge)③. From the fundamental elastic energy equation,④

$$F\,\triangle = \int \frac{mMdx}{EI},$$

we obtain:

$$\triangle = \frac{Area\ x}{EI},$$

where area represents the bending moment area for one half of the column. This bending moment area consists of two parts, the bending moment area due to the load P which is the area bounded by the elastic curve and the line of action of the load, and the bending moment area for a simple beam subject to a uniformly distributed transverse load. Thus the deflection

$$\triangle = \frac{P\,(\triangle + e')l^2}{\pi^2 EI} + \frac{5kuAl^4}{384EI} \qquad \text{(e)}$$

The identity $F\,\triangle = \int \frac{mMdx}{EI}$ is independent of the principle of superposition. It forms the basic philosophy of all the author's earlier publications on columns ①, ③, ④. Its applicability is contingent on the two assumptions, that the material is elastic, and that m, the moment caused by the auxiliary load F, remains constant.

Rearranging equation (e), we obtain:

$$(EI - \frac{Pl^2}{\pi^2})\,\triangle = \frac{5}{384}\,kuAl^4 + \frac{e'l^2P}{\pi^2}$$

$$s = \frac{Ec\pi^2\triangle}{l^2} + \frac{P}{A}$$

$$\triangle = (s - \frac{P}{A})\,\frac{l^2}{\pi^2 Ec} \qquad \text{(f)}$$

Eliminating $\triangle$ between equations (e) and (f) we obtain:

$$(EI - \frac{Pl^2}{\pi^2})\,(s - \frac{P}{A}) = \frac{5\pi^2 kuAcEl^2}{384} + Ece'P$$

or

$$P^2 - (P_{cr} + sA + P_{cr}\frac{e'c}{i^2})\,P - \frac{5}{384}\,\pi^4 kuA^2cE + P_{cr}\,sA = 0$$

Solving this quadratic equation we obtain:

$$P = \frac{1}{2}\left[\left\{sA + P_{cr}\,(1 + \frac{e'c}{i^2})\right\} - \sqrt{\left\{sA + P_{cr}\,(1 + \frac{e'c}{i^2})\right\}^2 + 5.07\,kuA^2cE - 4P_{cr}\,sA}\right]$$

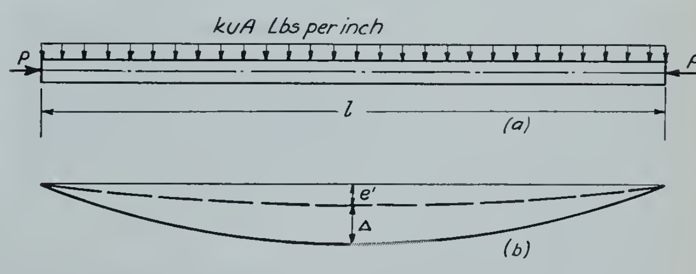

Fig. 6—Column subject to wow and to uniformly distributed loads.

We have already discussed why a non-linear load-stress relationship throws no light on the strength of a column when the controlling stress is not properly specified. We thus define s_1, the elastic limit stress at the midpoint and on the inside of the elastic curve of the column, as this controlling stress, and simultaneously define the corresponding load P as the load which induces this elastic limit stress or as the capacity load which the column can carry. We have also discussed in detail why eccentricity, end moments, and partial restraints, are identities. This effect on a column may therefore be fully expressed by a constant

n by which the length l is multiplied. To express the column formula in its most general terms we divide through by A. After we apply all these three steps to the above equation we obtain:

$$\frac{P}{A} = \frac{1}{2}\left[\left\{s_1 + \frac{\pi^2 E}{\left(\frac{nl}{i}\right)^2}\left(1+\frac{e'c}{i^2}\right)\right\} - \sqrt{\left\{s_1 + \frac{\pi^2 E}{\left(\frac{nl}{i}\right)^2}\left(1+\frac{e'c}{i^2}\right)\right\}^2 + 5.07kucE - \frac{4\pi^2 E s_1}{\left(\frac{nl}{i}\right)^2}}\right]$$

Formula 4

When $n = 1$ and $k = 0$ Formula 4 reduces to Formula 3, the initial crookedness formula. When $n = 1$ and $e' = 0$ Formula 4 reduces to the formula which was first presented in the author's paper on "Column Subject to Uniformly Distributed Transverse Loading"[2]. When $n = 1$ and both k and e' are zero then Formula 4 reduces to:

$$\frac{P}{A} = \frac{1}{2}\left[s_1 + \frac{\pi^2 E}{\left(\frac{l}{i}\right)^2} - \sqrt{\left\{s_1 - \frac{\pi^2 E}{\left(\frac{l}{i}\right)^2}\right\}^2}\right] \quad \text{Formula 5}$$

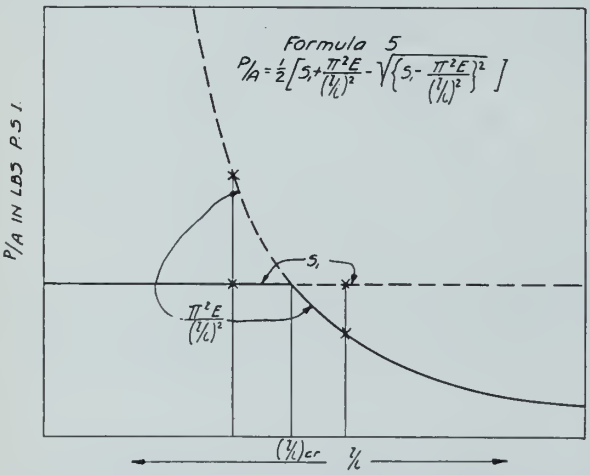

Fig. 7—Graphical representation of Formula 5. For all values of l/i, except $(l/i)_{cr}$, two roots are obtained, marked by crosses. The smaller of the two roots, represented by the solid line, is always the controlling one.

At first glance Formula 5 appears identical with Euler's formula, $\frac{P}{A} = \frac{\pi^2 E}{\left(\frac{l}{i}\right)^2}$, yet it has one attribute which the latter formula lacks. When l/i approaches zero, then P/A in Euler's formula approaches infinity. It is the custom (more or less arbitrary) to cut the graph for Euler's formula short and bring the curve in along a horizontal line for all values which the formula would give as $P/A < s_1$. If we plot Formula 5 we find that the curve automatically turns a sharp corner as a result of the manner in which it is expressed, and presents a horizontal line for all values $0 < l/i < (l/i)_{cr}$. (See Figs. 3 and 4).

NOTE—*Euler's curve appears as a limiting graph of Formula 5 (Figs. 3, 4, and 7).* The solution of a quadratic equation provides two roots. We might have written Formulae 3, 4 and 5 with a $\pm$ sign in front of the radical, and stipulated that the smallest of the two roots be always selected. Thus, in Formula 5 we would obtain two results, either $P/A = s_1$, or $P/A = \frac{\pi^2 E}{\left(\frac{l}{i}\right)^2}$. If we plot graphs for these two expressions (Fig. 7) and select the lower ordinate of the two graphs, we obtain the limiting curve for Euler's formula as we have described it. However, we do not require any stipulation as to selecting the lowest value root, and we obtain identical results by using only the minus sign before the radical in Formulae 3, 4 and 5, if we proceed as follows. In case $\frac{\pi^2 E}{\left(\frac{l}{i}\right)^2} > s_1$, the quantity in the brackets is negative. When we square this quantity it becomes positive. After extracting the square root we select the positive root. The sign before the radical changes this to a negative value and $P/A = s_1$ results for all value of $\frac{l}{i} < \left(\frac{l}{i}\right)_{cr}$. Note also that in Fig. 3 and Fig. 4 the Euler curve, with the horizontal line and the sharp corner, appears clearly as the limiting curve for the case when $e' = 0$. It similarly appears as a limiting curve in the formula for "Columns Subject to Uniformly Distributed Transverse Loads[2]" when $k = 0$, that is, when the transverse loading is zero.

Theory, Tests and Practice

The author regards as a contradiction the statement that theory and practice may conflict. Any real conflict between theory and practice is *prima facie* evidence of a deficiency in the theory if not of its utter worthlessness. The merit of an engineering theory lies in the effectiveness with which it correlates and interprets engineering phenomena, and not in the medium in which it is expressed. The best theory in this paper is the proof of the identity of eccentricity and the L/l ratio. This theory involved no mathematics whatsoever in its expression. The theory of columns is nearly two hundred years old and the amount of literature on the subject is overwhelming (see "Columns," by E. H. Salmon[5]). Some of this theory is philosophically perfect, and yet as an aid to engineering design completely worthless. *The secant formula* (Formula 1) is a case in point. The theory involved in the development of the secant formula is perfect, it is beautiful, yet the formula is futile. The author has never heard of anyone suggesting how the eccentricity e, which prevails at the instant the column collapses, may be determined in advance of a solution of a slender column design problem. (For very short columns, in which the value of e is determinable with reasonable accuracy, the formula $s = \frac{P}{A} + \frac{Mc}{I}$ or $\frac{P}{A} = \frac{s_1}{(1 + ec/i^2)}$ applies).

Yet a reliable and accurate pre-determination of this eccentricity e is absolutely essential for an effective use of the formula. Possibly the author may be criticized for the inclusion of a formula in this paper which is well known and which he regards as futile. He stated that he regards the secant formula as worthless for design purposes. In this paper it serves a useful purpose.

The author has no difficulty in convincing his students. The less they are burdened with preconceived ideas about columns the easier they are to convince. It is his friends, the experts in the theory of elasticity who sometimes appear to have forgotten their elementary statics, that need convincing. Our proof of the secant formula is directly predicated on the identity of eccentricity or partial restraint and the L/l ratio. Therefore, if we base our proof of a recognized and accepted formula on this identity, we add further evidence toward the establishment of this identity.

Our primary interest lies in columns as they function in office buildings, bridges, transmission towers, aeroplanes and other engineering structures. Yet as a rule we do not study them as integral parts of complex structures, but instead we draw lines on paper and philosophize about these lines, and we take columns by themselves and test them in the laboratory. Tests on complete structures, if large, may be out of the question. Yet tests on complete transmission towers and aeroplanes are common practice. So far as the author knows, a systematic and rigorous analysis of column-functioning in such tests still awaits attention.

Column tests frequently suffer from two defects. They fail effectively to simulate the conditions prescribed by the assumptions on which the theory is based, and they also fail effectively to simulate end conditions of restraints—such as are met with in practice.

The tests recorded in the appendix are of specimens so small in size that to some they may appear as hardly worthy of being considered as columns. The special feature of these tests lies in the fact that they come quite close to

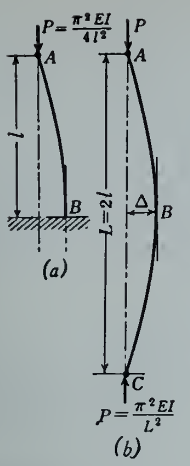

Fig. 8

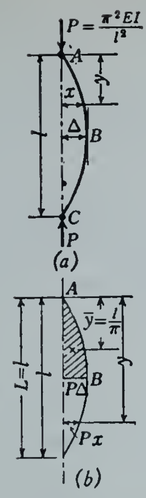

Fig. 9

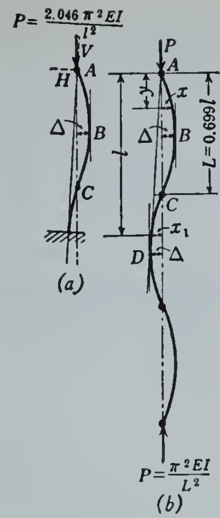

Fig. 10

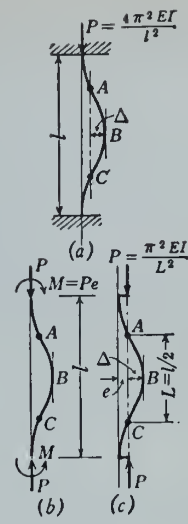

Fig. 11

Columns subject to various conditions of end restraint.

simulating theoretical conditions. They contribute toward establishing the fact that the column theory is as sound and reliable as any theory we have in the general theory of strength. The theory completely fits ideal, laboratory controlled, conditions. The major requirement is to make the theory fit ordinary practice conditions. Tests with million-pound capacity testing machines may give empirical data of value. They are not likely to contribute to a rational column theory because the laboratory machine does not provide conditions of end restraint as found in practice. Tests on actual structures such as transmission towers, many records of which are available, have already been suggested as a hopeful field of investigation with a view towards perfecting rational column theory. The column theory being accepted as basically sound and reliable, we offer in this instance a paper investigation of end restraint conditions as the most promising procedure.

Determination of Constant $n = L/l$

Figures 8a, 9a, 10a and 11a③ present four types of column loading in which the coefficient n may readily be determined. In Figs. 8a, 9a and 11a, n or L/l may be determined by inspection to equal 2, 1 and ½ respectively. In Fig. 10a the coefficient n or L/l may, with the aid of purely geometric considerations, be shown ⑩⑨ to equal 0.6992. The critical load for Fig. 10a, therefore, is

$$P = \frac{\pi^2 EI}{L^2} = \frac{\pi^2 EI}{(0.6992\ l)^2} = \frac{2.046\ \pi^2\ EI}{l^2}$$

These four cases of column loading are commonly treated in texts, but they are all quite hypothetical. They never occur in practice quite as represented. One of the major arguments of this paper is to the effect that all prismatic columns are but special cases of the ideal Euler, pin-ended, column. Our problem is to obtain some estimate of the value of n which is likely to occur in a column which acts as an integral part of a complex structure.

Columns generally are part of a complex structure. Loads ordinarily are transmitted to columns through floor beams, tie rods, diagonals, etc. In addition to forces coincident with the axis of the column these connections generally transmit moments. As we have seen the combination of a moment and a force gives rise to an eccentricity e. A vital point to keep in mind is that any load-moment or eccentricity relationship that may prevail under initial loading conditions generally has little or no bearing on the column-strength problem. The only exception is when the column is very short and stiff. This fact we elaborate upon later when we discuss Figs. 13 and 14.

Figure 12a represents a frame consisting of two horizontal 24-W.F.-74 lb. beams and two vertical 12-W.F.-25 lb. beams. The connections at the corners are not shown in detail but are assumed to be absolutely rigid. The horizontal beams are loaded with a uniformly distributed load. The vertical beams are placed with the minimum axis of moment of inertia perpendicular to the paper. The horizontal beam was purposely chosen heavy to insure column failure in the

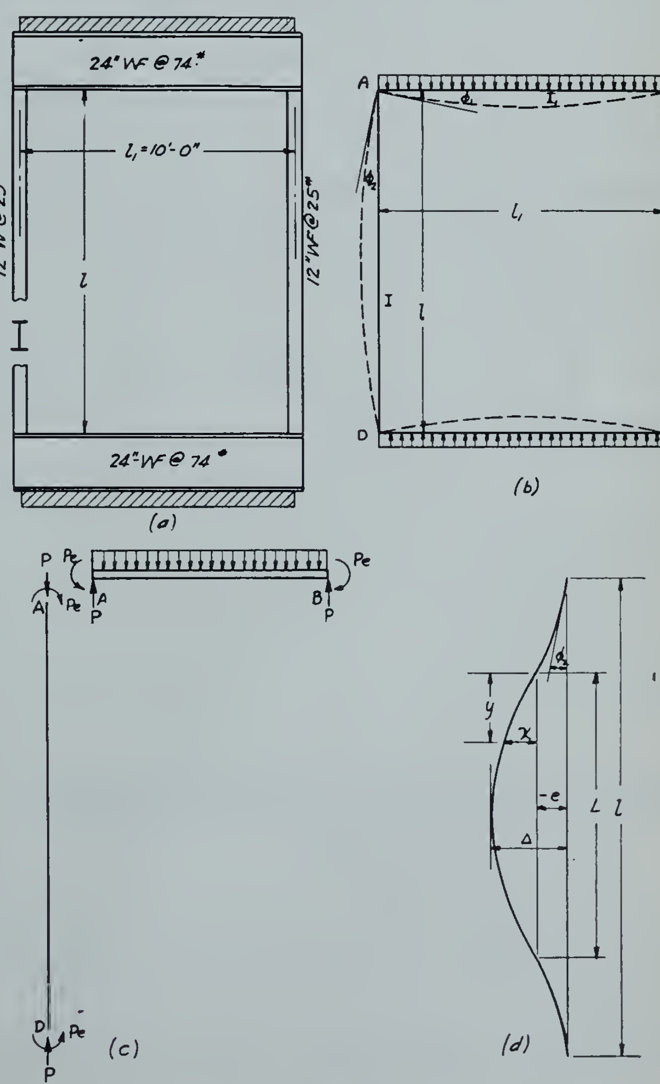

Fig. 12

vertical beams. As the loading over the horizontal beam is gradually applied the resultant load transmitted to the column is offset with a positive eccentricity. As will be shown for all values of $l/i \geqq 103$, this positive eccentricity decreases as the loading progresses and finally becomes negative. This tells us that, for all values of $l/i \geqq 103$, n is less than unity and the column is strengthened rather than weakened by the horizontal beams.

The dashed line in Fig. 12b shows the structure schematically in the deformed state. Figure 12c shows free body sketches of both beam and column, and Fig. 12d shows the deformation of a column under positive restraint or negative eccentricity.

From Fig. 12b it follows that $\phi_1 = \phi_2$

$$\phi_1 = \frac{1}{EI_1}\left(\frac{wl_1^3}{24} - \frac{Pel_1}{2}\right) \qquad (g)$$

From Fig. 12d we obtain an expression for ϕ_2 in the following manner.

$$x = (\triangle + e)\ sin\ \frac{\pi y}{L}$$

$$\frac{dx}{dy} = \frac{\pi}{L}(\triangle + e)\ cos\ \frac{\pi y}{L}$$

For small angles $\phi_2 = \frac{\pi}{L}(\triangle + e)\ cos\ \frac{-\pi(l-L)}{2L}$

$$= \frac{\pi}{L}(\triangle + e)\ sin\ \frac{\pi l}{2L} \qquad (h)$$

$$e = (\triangle + e)\ sin\ \frac{-\pi(l-L)}{2L}$$

$$= (\triangle + e)\ cos\ \frac{\pi}{2}\frac{l}{L}$$

$$\therefore \quad \triangle + e = +e\ sec\ \frac{\pi}{2}\frac{l}{L} \qquad (i)$$

Combining (h) and (i) we obtain:

$$\phi_2 = \frac{\pi e}{L}\ sec\ \frac{\pi l}{2L}\ sin\ \frac{\pi l}{2L} = \frac{\pi e}{L}\ tan\ \frac{\pi l}{2L} \qquad (j)$$

Since $P = \frac{\pi^2 EI}{L^2}$,

$$\frac{\pi}{L} = \sqrt{\frac{P}{EI}} \qquad (k)$$

Substituting (k) in (j) we obtain:

$$\phi_2 = e\sqrt{\frac{P}{EI}}\ tan\ \frac{l}{2}\sqrt{\frac{P}{EI}} \qquad (l)$$

Equating equations (g) and (l) we obtain

$$\frac{1}{EI_1}\left(\frac{wl_1^3}{24} - \frac{Pel_1}{2}\right) = e\sqrt{\frac{P}{EI}}\ tan\ \frac{l}{2}\sqrt{\frac{P}{EI}} \qquad (m)$$

From Fig. 12c we have $P = \frac{wl_1}{2}$, and Formula 1 gives us

$$s_1 = \frac{P}{A}\left(1 + \frac{ec}{i^2}\ sec\ \frac{l}{2}\sqrt{\frac{P}{EI}}\right)$$

In our problem, Fig. 12a, the following constants prevail:

s_1 = 18 tons per sq. in.
E = 15,000 tons per sq. in.
l_1 = 10 ft. = 120 in.
l = variable

For beam AB, Fig. 12, 24-W.F.-74 lb.—I_1 = 2034 in.^{4}; $\frac{I_1}{c}$ = 170.4 in^3.

For column AD, 12-W.F.-25 lb.—I = 14.5 in.^{4}; A = 7.39 in.^{2}; i = 1.40 in.; c = 3.25 in.

Substituting these values in (m) we obtain:

$$.00236\ w - .00000197\ Pe = e\sqrt{\frac{P}{14.5\ E}}\ tan\ \frac{l}{2}\sqrt{\frac{P}{14.5\ E}}$$

Substituting in this expression $\frac{2P}{l_1} = \frac{P}{60} = w$ it reduces to:

$$e = \frac{0.0000394\ P}{0.00000197\ P + \sqrt{\frac{P}{14.5\ E}}\ tan\ \frac{l}{2}\sqrt{\frac{P}{14.5E}}}$$

Substituting the constants of our problem in Formula 1 it reduces to:

$$e = \frac{133.0 - P}{1.66\ P\ sec\ \frac{l}{2}\sqrt{\frac{P}{EI}}}$$

The last two equations are solved by the trial and error method.

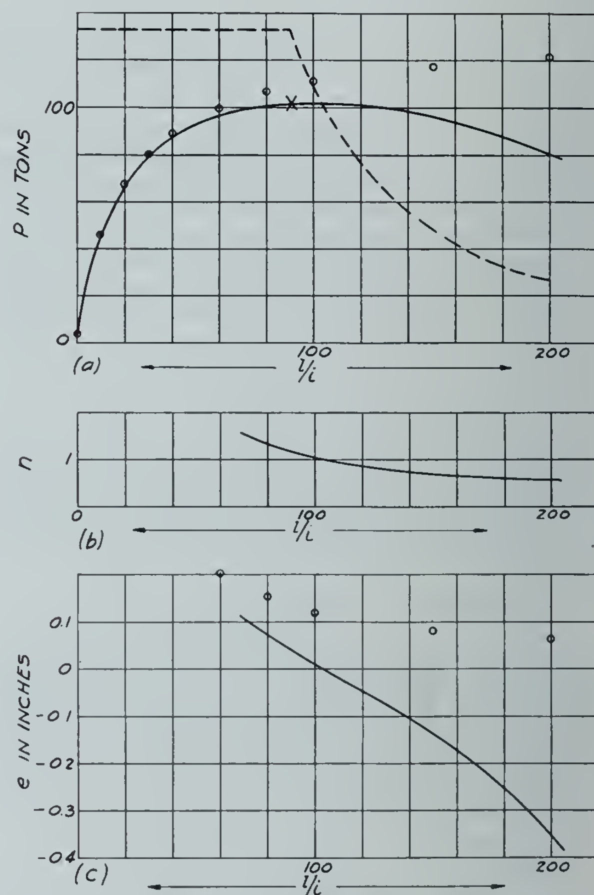

Fig. 13—Comparison between strength P, fixity ratio n, and eccentricity e, for side legs of a culvert analyzed, (1) as a column (superposition not applicable) represented by solid line, (2) as struts (superposition assumed applicable) represented by circles.

The result of solutions for varying values of l are shown graphically in Figs. 13a, b and c. The cross (x) on the solid line curve of Fig. 13a marks the value for $\left(\frac{l}{i}\right)_{cr}$ = 90.6. It appears from Fig. 13a that, for all values of $l/i > 103$, e becomes negative by the time the load grows to be large enough to induce in the column the elastic limit stress s_1. The graph of Fig. 13a is particularly elucidating. It shows that for a range of values for l/i extending from l/i = 70 to l/i = 150 the value of P varies no more than 6 per cent. The dashed line of Fig. 13a shows the Euler values for column AD (Fig. 12) based on the assumption that the column is ideally pin-ended. The values permitted by all design formulae lie below the ideal Euler curve. It would seem, then, that these design formulae for values of $l/i > 100$

are unduly conservative. This seems especially true in light of the fact that the example just discussed was selected with a view to giving to the column a loading pattern as unfavourable as we can imagine.

For small values of l/i the side legs of the culvert, Fig. 12, would be regarded as beams rather than as columns. That is, the principle of superposition would be assumed to apply, and some elementary strength theory, such as area moments or end moment distribution, would be used to find the moments which act at top and bottom of the vertical beams. If so computed, the moment at the corners of the culvert, Fig. 12, is:

$$M_1 = \frac{wl_1^3 I}{12\ (lI_1 + l_1 I)}$$

The elastic limit stress in the vertical beam is:

$$s_1 = \frac{P}{A} + \frac{Mc}{I} = \frac{P}{A} + \frac{wl_1^3 c}{12\ (lI_1 + l_1 I)} = \frac{P}{A} + \frac{Pl_1^2 c}{6\ (lI_1 + l_1 I)}$$

Therefore $$P = \frac{6s_1 A\ (lI_1 + l_1 I)}{6\ (lI_1 + l_1 I) + l_1^2 cA}$$

If we substitute the constants pertaining to the beams shown in Fig. 12, this expression reduces to:

$$P = \frac{133(2034\ \frac{l}{i} + 1243)}{(2034\frac{l}{i} + 1243) + 41170}$$

From the fundamental relation, $M = Pe$, we obtain

$$e = \frac{1}{6}\frac{Il_1^2}{(lI_1 + l_1 I)} \text{ or } \frac{24860}{(2034\ l/i + 1243)}$$

The graphs of these equations are represented by small circles on Figs. 13a and 13c respectively. It is thus seen that for small values of l/i the elementary theory, which assumes the principle of superposition to apply (small circles in Fig. 13a), and the more correct theory, based on the fact that the principle of superposition is not applicable (solid line Fig. 13a), give identical results for the limiting case when l/i approaches zero, give nearly the same results for values of $l/i < (l/i)_{cr}$, and give widely differing answers for values of $l/i > (l/i)_{cr}$. The graph represented by the small circles approaches the value $P = s_1 A$ asymptotically, while the solid line graph approaches the Euler curve asymptotically which in turn makes an asymptotic approach to the value $P = 0$.

Figure 14 shows curves similar to those of Fig. 13 for a culvert with longer and thus more flexible beams and with correspondingly lighter columns. The beams are 24-W.F.-100 lb. and the columns are 10-W.F.-21 lb. The proportions are again such as to insure failure in the columns rather than in the beams. Note that the maximum stress in the beam, when the column fails, is of the order of magnitude of 18 tons per sq. in.

The foregoing theoretical discussion is supplemented with experimental results presented in detail in the appendix. Figure 22 shows the results of tests on two columns that were identical except for the condition of end restraint. One column was tested under conditions simulating as closely as possible the ideal pin-ended column. Its strength experimentally determined agrees very closely with the value prescribed by Euler's formula which is marked x on the curve. The other column, identical with the first except that it was flat ended, manifests a strength three and a half times as great as that of the pin-ended column.

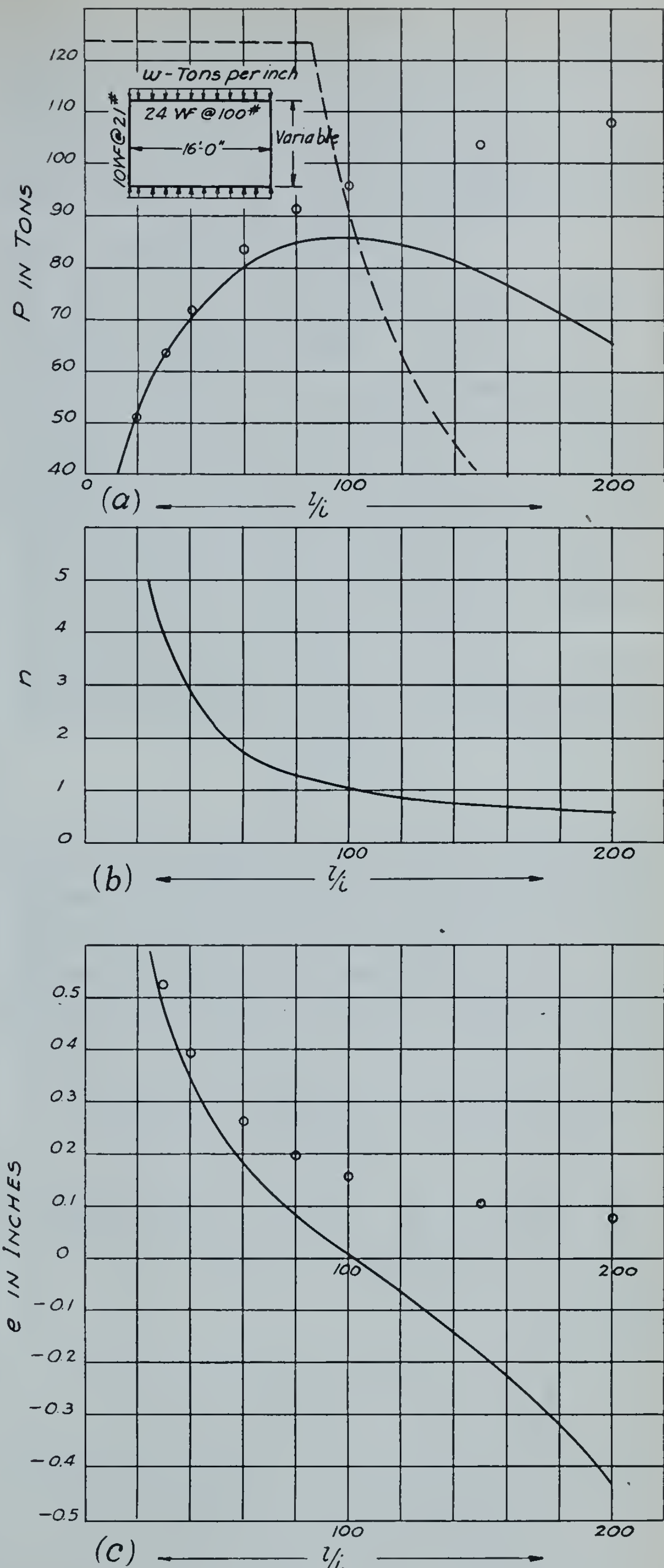

Fig. 14—Comparison between strength *P*, fixity ratio *n*, and eccentricity *e*, for side legs of a culvert analyzed, (1) as a column (superposition not applicable) represented by solid line, (2) as struts (superposition assumed applicable) represented by circles.

Elastic Deformations of Columns Subject to Critical Loading

When a prismatic, ideally pin-ended, column is loaded concentrically it remains substantially straight until the critical load is reached. Then it deforms unhampered under the action of this constant critical load. The load-carrying capacity of the column does not begin to diminish until the curvature becomes acute enough to cause the elastic limit stress s_1 to be induced in the column. When that condition is reached the column continues to deform under a decreasing load. The curves on Figs. 16 and 17, representing load-deformation curves for actual columns, illustrate this column behaviour. The author wants to direct particular attention to the curve on Fig. 16 which is labeled $l/i = 198$.

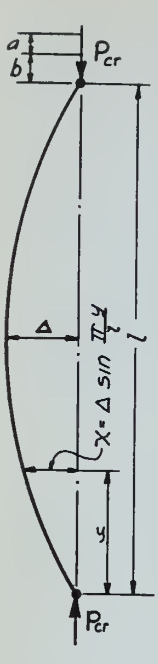

Fig. 15

The horizontal part of this curve is defined by two vertical lines labeled B and C. This horizontal distance BC represents the elastic deformation of the column under a constant load. This deformation is of vital importance in the theory of limit design. It is this quantity which we propose to discuss and for which we shall develop a formula.

As the concentric, axial, loading is applied to the column, illustrated in Fig. 15, the load waxes from zero to P_{cr}. During this stage of the loading the column remains substantially straight and the deformation marked a (Fig. 15) is $a = \frac{P_{cr}l}{AE}$. (The distance AB on curve $l/i = 198$, Fig. 16, represents the quantity P_{cr}/AE). Once the load P_{cr} is attained, the column assumes the shape of a pronounced sine curve. The column buckles, kicks sidewise, or a wow represented by $\triangle$ develops. Simultaneously the point of application of the load moves through a distance b. It is the relationship between b and $\triangle$ with which we are here primarily concerned. Note that, as both quantities b and $\triangle$ develop, the load P_{cr} remains constant. The work done by P_{cr} then equals $P_{cr} \times b$. The stress on any section of the column is given by the formula

$$s = \frac{P_{cr}}{A} + \frac{Mv}{I}$$

In this formula the term P_{cr}/A is constant while M varies as a function of $\triangle$. (v is the distance from the neutral axis of a cross section of the column about which the bending takes place, and is measured perpendicularly to this neutral axis. It varies between zero and c, the distance to the extreme fibre, and is positive when measured to one side and negative when measured to the other side of the neutral axis). The total elastic energy of the deflected column is

$$\int_A\int_l \frac{s^2}{2E}\, da\, dy = \frac{1}{2E}\iint\left(\frac{P_{cr}}{A} + \frac{Mv}{I}\right)^2 da\, dy$$

$$= \iint\frac{P_{cr}^{\,2}\, da\, dy}{2EA^2} + \iint\frac{2P_{cr}Mv\, da\, dy}{2EAI} + \iint\frac{M^2v^2\, da\, dy}{2EI^2}$$

Since $\int vda = 0$ the middle term is zero.

The first term,

$$\int_A\int_l \frac{P_{cr}^{\,2}\, da\, dy}{2EA^2} = \frac{P_{cr}^{\,2}\, Al}{2EA^2} = \frac{P_{cr}^{\,2}\, l}{2EA} = \frac{P_{cr}\, a}{2}$$

This is the energy stored in the column due to the direct compression effect. All that remains is the third term, or

$$\iint\frac{M^2v^2\, da\, dy}{2EI^2} = \int_0^l \frac{M^2\, dy}{2EI}$$

This, then, is that part of the total elastic energy stored in the column attributable solely to the buckling phenomenon. Since the load P_{cr} remains constant while the column buckles, the work done by this load equals $P_{cr} \times b$. By virtue of the law of conservation of energy, this expression for energy ($P_{cr} \times b$) must equal the elastic energy expression $\int_0^l \frac{M^2\, dy}{2EI}$ (Note that the principle of superposition is not involved in this logic. The only approximations here made are those commonly accepted in column theory. We regard l as constant and replace dl by dy).

$$P_{cr} \times b = \int_0^l \frac{M^2\, dy}{2EI} = \int_0^l \frac{(P_{cr}\, x)^2\, dy}{2EI} = \frac{(P_{cr}\, \triangle)^2}{2EI}$$

$$\int_0^l \left(\sin\frac{\pi y}{l}\right)^2 dy$$

$$= \frac{(P_{cr}\, \triangle)^2\, l}{4EI}$$

$$\text{Thus,}\quad b = \frac{P_{cr}\, \triangle^2\, l}{4EI} = \frac{\pi^2 EI\, \triangle^2\, l}{4EIl^2} = \frac{\pi^2\triangle^2}{4l}$$

The maximum curvature of a sine curve occurs at its midpoint and amounts to:

$$\frac{1}{R} = \frac{\pi^2\triangle}{l^2} = \frac{s}{Ec}\,.$$

Thus, $\triangle = \frac{sl^2}{\pi^2 Ec}$ in which s represents the stress increment in the extreme fibre at the midpoint of the column. This stress increment is due solely to curvature or to bending. The column already carries a stress equal to P_{cr}/A. The stress increment which it can suffer, therefore, without exceeding elastic functioning of the column is $s_1 - \frac{P_{cr}}{A}$ or $s_1 - s_{cr}$. Substituting this value for s in the above expression ($\triangle = \frac{sl^2}{\pi^2 Ec}$) we have

$$\triangle = \frac{(s_1 - s_{cr})\, l^2}{\pi^2 Ec}$$

Substituting this last expression for $\triangle$ in the expression $b = \frac{\pi^2\triangle^2}{4l}$ we obtain:

$$b = \frac{(s_1 - s_{cr})^2\, l^3}{(2\pi cE)^2}$$

The average axial deformation (not to be mistaken for strain), the distance BC shown in Fig. 16, is

$$\frac{b}{l} = \left\{\frac{(s_1 - s_{cr})\, l}{2\pi cE}\right\}^2 \qquad \text{Formula 6}$$

Computations given in Table I for the distance BC or b/l are made for the $1\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{1}{8}''$ angles. s_1 and E are taken to be 40,000 lb. per sq. in. and 29,500,000 lb. per sq. in. respectively. At the time of the test (before Formula 6 was developed) the particular direction of the buckling of each individual column was not noted. Thus in applying Formula 6 to the curves of Fig. 16, two values of c are possible and b/l values are computed for both c_1 and c_2, which have been calculated for the particular dimensions of each angle column. On the curve for $l/i = 306$ it may be noted that the large double circle is within the distance BC. That the horizontal portions of the curves on Fig. 16 appear to be longer than the calculations indicate may be due to the very gradual decrease of the load-carrying capacity of the columns after the elastic limit has been passed.

Table I

l	l/i	s_{cr}	c_1	c_2	b_1/l	b_2/l
45	149	13100	0.601″	0.483″	0.000116	0.000180
52½	172	9850	0.603″	0.483″	0.000200	0.000311
60	198	7420	0.601″	0.481″	0.000307	0.000480
75	251	4630	0.594″	0.468″	0.000581	0.000935
90	306	3110	0.585″	0.454″	0.000938	0.001558

Conclusions

The requirement that a theory, to be acceptable, should agree with practice is not only good business but it is the first requirement of sound philosophy as well. To substitute for practical conditions laboratory tests which fail to simulate accurately conditions of end restraint as they occur in practice, and to assign preferential value to such tests over theoretical analysis may be open to serious question. Our theory is predicated on the assumption that the columns are prismatic, homogeneous and elastic. The argument that such a theory does not rigorously apply to wooden columns or riveted columns is readily conceded. The vast majority of columns, however, are either H-sections, W.F. sections or tubes. The reliability of the theory of elasticity in connection with column tests, when the assumptions which are involved are rigorously satisfied, is too well established to be open to question.

We draw two major conclusions—one as to sense of value and the other as to theory. In regard to sense of value the bothersome question of eccentricity may be dismissed when we substitute its equivalent, namely the coefficient $n = L/l$. While we found that we could replace eccentricity e with a coefficient n, we cannot so replace initial crookedness e'. We thus find e' incorporated in our general Formula 5. The initial crookedness, e', seems to have received more attention in the literature on the subject than it deserves. Do we not inevitably introduce a factor of safety, which factor covers a multitude of uncertainties? It is supposed to neutralize our doubts concerning dimensions, material, workmanship, assumed loading, theory, etc. Is this factor, initial crookedness, so dominant that it demands special treatment? Are we not justified in covering the uncertainty of initial crookedness by a factor of safety? The committee on Steel Column Research of the American Society of Civil Engineers[6] apparently thinks this should not be done. Its final conclusion, No. 6 (Vol. 98, p. 1461), reads: "For columns bent in single curvature, an eccentric ratio of $ec/i^2 = 0.25$, to include both crookedness and eccentric application of load, and a free length of three-fourths the full length for riveted connected members are suggested as reasonable values for ordinary trusses". The author is inclined to interpret this recommendation as founded on empirical data and in contradiction to sound logic. To introduce one factor (ec/i^2) which would weaken the column and another ($n = L/l = 3/4$) to strengthen it, especially in the light of our claim of identity of the two factors, appears clumsy if not illogical. The author personally inclines to taking account of eccentricity by a proper selection of coefficient n and to ignore initial crookedness, or rather to cover any uncertainty as to initial crookedness by means of the factor of safety. Our test results appear to support this contention. We show, by crosses (x) on Fig. 4, the maximum values of P/A obtained from the tests on pin-ended 1½″ x 1½″ x ⅛″ angles as they are recorded in Fig. 16. Figure 21 shows another such curve obtained from run-of-the-mill specimens. Such initial crookedness as was present in the test specimens apparently did not materially affect the strength of the columns.

As to theory, we may have presented little new, unless it be a new sense of value of the theory. Everything we have said points to the supremacy, the all sufficiency, of Euler's equation. Our form of Euler's equation, which gives the value $P/A = s_l$ for all values of $(l/i \leqq (l/i)_{cr}$, may be unconventional, may even be new, but it is nevertheless Euler's equation. Since this paper is not directed to any special field of engineering, the author leaves to the engineer in any special field the problem of determining the coefficient n for his type of construction if he should wish to do so. We merely point out that this cannot be done in the laboratory. It could be done by testing actual structures to the point of destruction. It can also be done in many cases, with a high degree of precision, in the manner we have illustrated. The author is inclined to the opinion that for many types of construction our column design formulae are too safe, too conservative, which he regards as the greatest engineering sin second only to that of not being safe enough.

Acknowledgement

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[2] "Columns Subject to Uniformly Distributed Transverse Loads," by J. A. Van den Broek, *Engineering Journal*, March, 1941; Closure, September, 1941.

[3] Figures 1, 5, 8, 9, 10 and 11 are reproduced from "Elastic Energy Theory[4]" by courtesy of John Wiley and Sons, Inc.

[4] "Elastic Energy Theory," by J. A. Van den Broek, second edition, John Wiley and Sons, Inc., 1942.

[5] "Columns," by E. H. Salmon, Oxford Technical Publications, 1921.

[6] "Steel Column Research," *Trans.* Am. Soc. Civ. Engrs., Vol. 89, 1926; Vol. 95, 1931 and Vol. 98, 1933.

APPENDIX

The objectives aimed at in the tests herein described are two-fold. 1. To secure definite and predetermined eccentricities or concentricities which would remain constant throughout the entire loading range from zero load to well beyond the failing load. 2. To obtain load-axial deformation relationships for a load range extending from zero load to well beyond the maximum load.

The device used to obtain the first objective, that of definitely controlled eccentricities, consisted of partial spheres through which the load was transmitted to the specimen. As the column began to deflect the partial sphere rolled on the bearing block. The point of application of the load on the partial sphere naturally shifted, but so long as the partial sphere was not permanently deformed, so long as it remained perfectly elastic, the resultant of the load passed through the centre of the partial sphere. One of the problems was to locate definitely the centre of the partial loading sphere in a pre-determined position on top and at bottom of the test specimens. In the tests on one-inch round columns this was accomplished by making the partial sphere an exact semisphere and providing it with an extension into which a hole was drilled either concentrically or with a pre-determined eccentricity. The bottom of the hole coincided with the plane of the semisphere. Figure 17 shows the arrangement schematically, while Fig. 25 shows a photograph of an eccentrically loaded specimen in the testing machine. In the tests on angle irons the location of a predetermined eccentricity or concentricity was accomplished in the following manner: The outline of the cross-sectional area of the angle iron was first carefully located and then cut out of a brass templet of 6 in. diameter and ⅛ in. thickness. The templet was slipped over the specimen. A steel bearing plate of 6 in. diameter and ⅜ in. thickness was then placed on the column. Into this bearing plate was machined a concentric depression of a depth of ⅛ in. and of a size just big enough to contain the partial loa sphere.ding This partial loading sphere was not a semisphere, but had its centre located at the bottom of the bearing plate, that is, at the top of the specimen. The bearing plate was lined up by tightening a steel band around the templet and bearing plate jointly. Figures 16 and 21 show this arrangement schematically, while Fig. 24 shows a photo of a specimen provided with this loading apparatus.

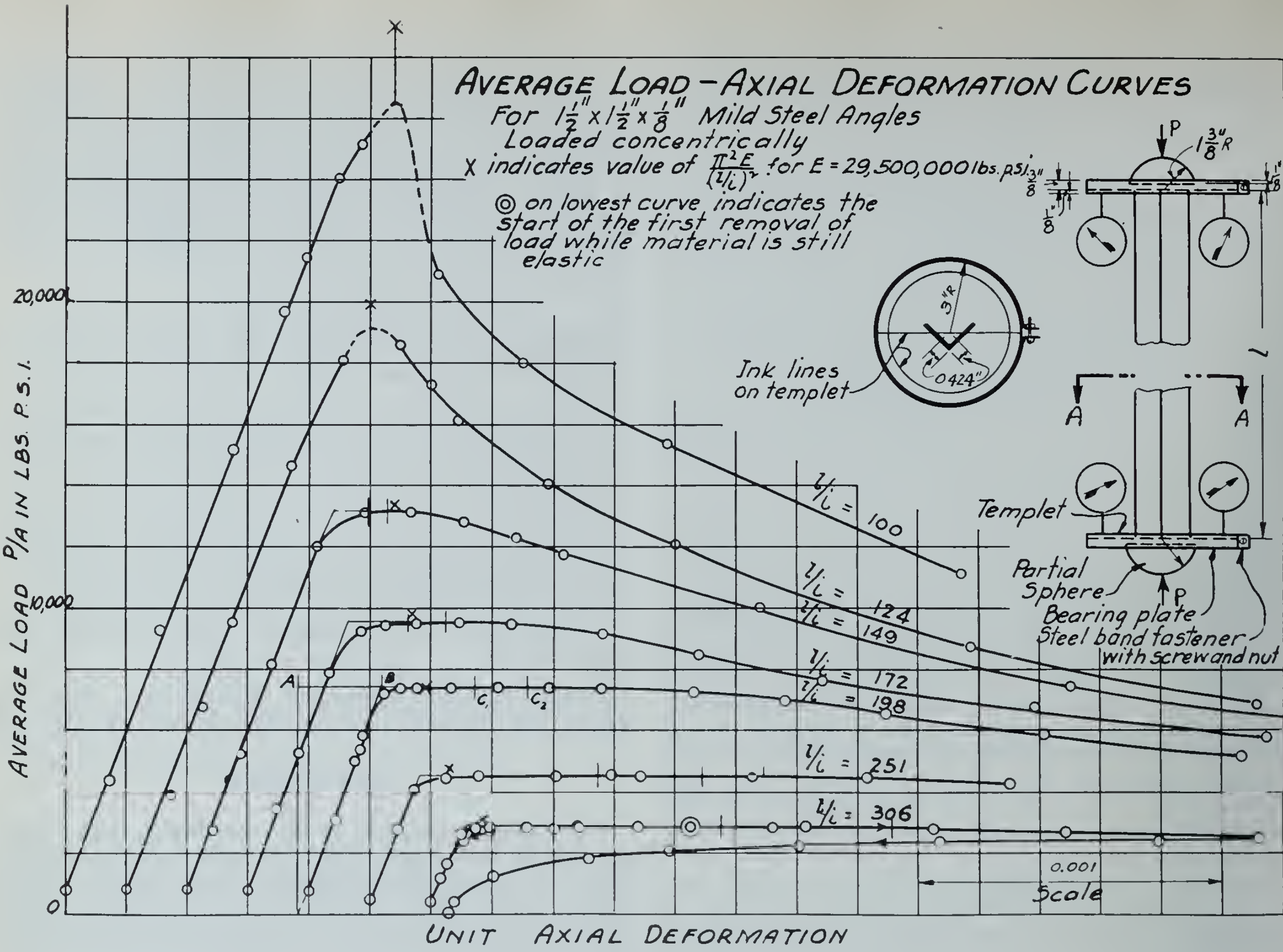

Fig. 16

The specimens tested consisted of one-inch rounds and 1½ by 1½ by ⅛ in. angles of mild structural steel and of 3 by 3 by 9/64 in. silicon steel angles. If these times had been normal we might have attempted to obtain specimens from the mill and be assured that they were from one rolling. As things were, we obtained the entire supply of one-inch rounds and of 1½ by 1½ by ⅛ in. angles from the University of Michigan storehouse, while the 3 by 3 by 9/64 in. angles were generously supplied by the Canadian Bridge Company of Walkerville, Ontario. The lack of special care in the selection of specimens is an important point to keep in mind in judging the test results. The specimens were literally common run-of-the-mill variety. Flaws such as dents and lack of straightness, it would seem, would likely be greater in our test specimens than they would be in specimens of more normal proportions. The one-inch round specimens suffered one defect common to hot-rolled stock in that, though they were nominally round, they were actually somewhat elliptical. The hot-rolled stock was nevertheless selected in preference to the cold-drawn stock because the annealing of cold-drawn stock ten feet in length appeared impracticable. Keeping in mind the inevitable imperfections of the specimens the results seem highly gratifying.

Figure 16 shows the test results on the 1½ by 1½ by ⅛ in. *angles concentrically loaded*. We were fairly successful in securing a very nearly zero eccentricity. This was apparent from the fact that, though all specimens naturally buckled about the minimum axis of moment of inertia, some failed with the outstanding flanges in tension and others failed with the outstanding flanges in compression.

Another and significant check on these tests are the theoretical values for the Euler load which are indicated by a cross on the curves of Figs. 16 and 17. Theoretically the slender column, after buckling, deforms under a constant load. This phenomenon is effectively illustrated by the horizontal part of the curves for specimens of $l/i \geq 150$. Once the load-axial-deformation curve begins to dip down, the elastic limit stress in the column is exceeded. On the curve for the specimen of $l/i = 306$, Fig. 16, the large circle locates a position in the test when the load was gradually removed. Under a decreasing deformation all the experimental results fell at first on the original horizontal line. The return curve seemed to cut corners slightly, which could possibly, though not probably, be explained by hysteresis. Under zero load there was no observable permanent set, not even as much as 0.001 in.

The device used for the tests recorded in Figs. 16 and 17 is illustrated in Fig. 24. A 2 by 6 in. wooden plank, with an elliptical hole cut out in its centre, was firmly bolted to the

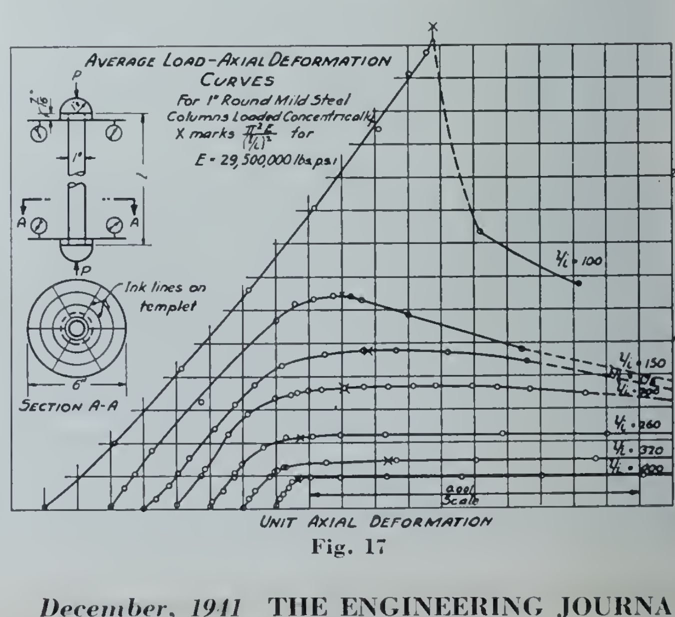

Fig. 17

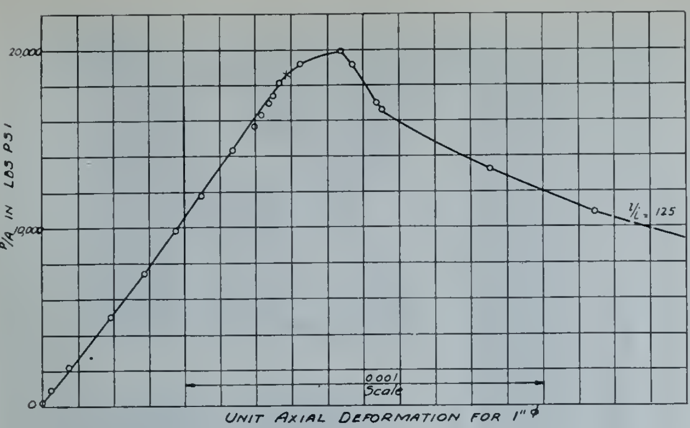

Fig. 18—Average load—axial deformation curve for one-inch round mild steel column.

rigid posts of the testing machine. This plank could be moved up and down and served as a table to support the top two dials. The dials were placed on a diameter of the brass templet, this diameter being initially bisected by the line of action of the load. After the column starts to buckle the specimen rolls away slightly from its original position, causing a shift in the application of the dial points relative to the diameter of the templet on which they were at first placed. This shift called for correction in the reading after buckling commenced. This correction has been incorporated in all curves shown in Figs. 16 and 17. It may be noted, however, that the curve for specimen $l/i = 125$ is not shown in Fig. 17. Through oversight the readings necessary to make the aforementioned correction were not taken for this specimen. This curve for the round bar of an $l/i = 125$ is shown separately in Fig. 18 because, even though its horizontal scale is slightly in error, its vertical scale is correct. This vertical scale shows a test load greater than Euler's load. This appears theoretically possible under only one of two conditions. Either, first, the loading spheres are permanently deformed, or, second, the column suffers a slight eccentricity at the end and at the same time suffers an initial crookedness which more than neutralizes this eccentricity. The end eccentricity and wow effects may be of the same or of opposite sign. When of opposite sign the effect may well be a test load greater than the theoretical Euler load. We believe this to be the explanation for the load in excess of Euler's load in Fig. 18, since there was no evidence of a permanent deformation of the partial loading sphere.

Figure 19 shows test results of one-inch round bars loaded with an eccentricity of 3/8 in. or an ec/i^2 ratio of 3. Figure 25 shows a specimen in the testing machine. The test results parallel the theoretical curve fairly closely. That there is not closer agreement between theory and test in this instance is the result of an error which was not discovered until after the test. The zero readings of the Huggenberger gage (shown in the photograph) were taken after the specimens in the machine were subjected to a slight initial load. The stresses, therefore, were all higher than those indicated by the gage, and this is why the experimental curve falls above the theoretical one. These curves would not be shown or discussed if Fig. 19 did not also contain a curve for the limit load, the load corresponding to the state of

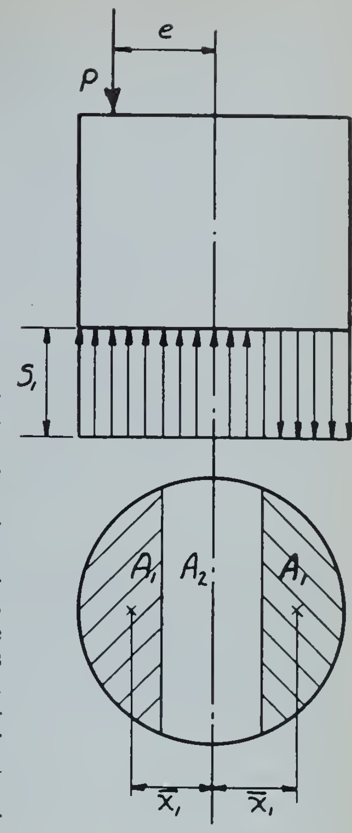

Fig. 20—Stress distribution over section of eccentrically loaded round column under limit load.

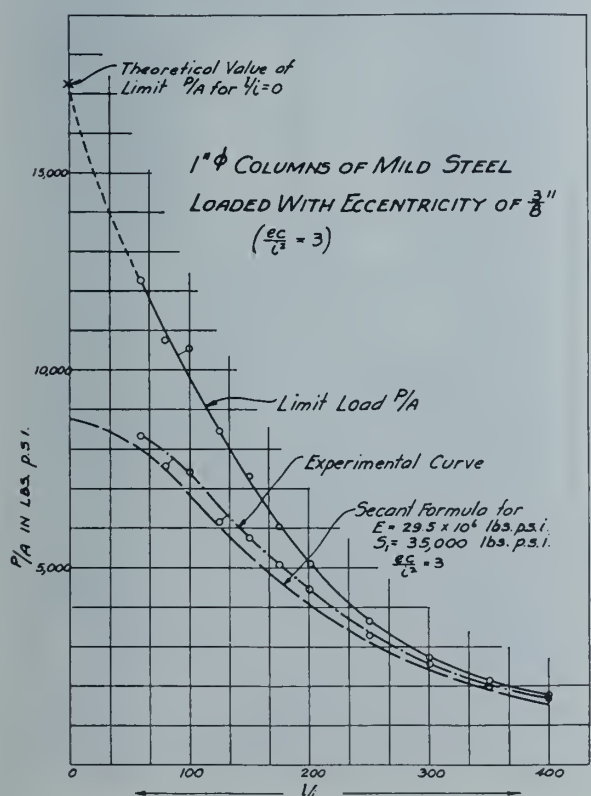

Fig. 19

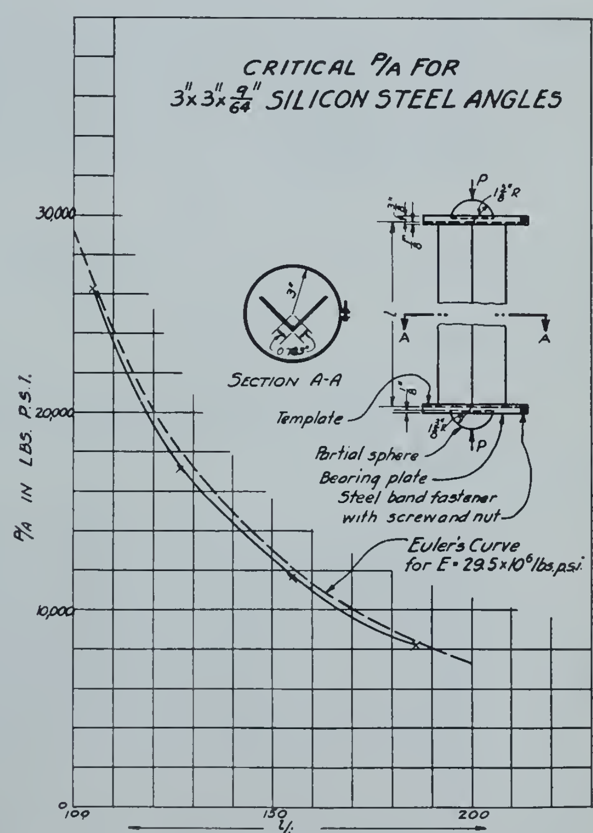

Fig. 21

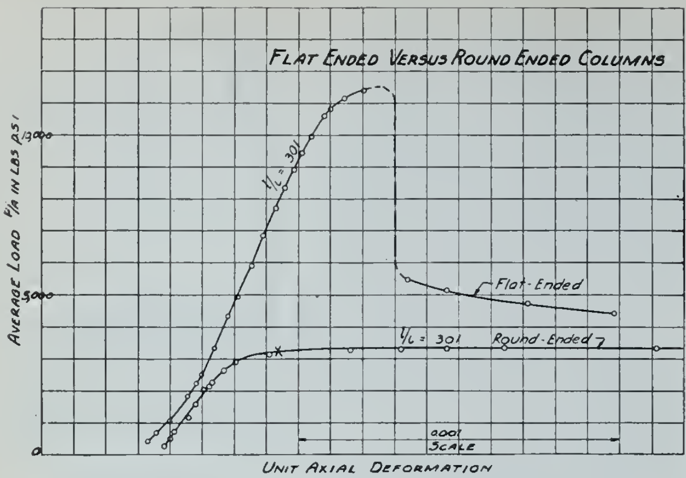

Fig. 22

completely ductile stress distribution in the columns. The limit load curve represents the maximum values of P/A obtained in the tests. This curve is not affected by any initial load readings. Of the three curves shown in Fig. 19 this is to us the most interesting one, and to the designing engineer the one of greatest significance. Only one value on the limit load curve could be theoretically determined, the value of P/A for $l/i = 0$. When $l/i = 0$ then the stress distribution over the cross section of the column appears as shown on Fig. 20. For this stress distribution the following conditions prevail:

$$s_1A_2 = P$$

$$2s_1A\,\bar{x}_1 = Pe$$

$$2A_1 + A_2 = A$$

Solving the above three equations simultaneously, we obtain

$$A_1\bar{x}_1 = (\frac{A}{2} - A_1)\,e$$

Fig. 23—Loading of flat-ended column after buckling.

In this last equation A and e are known, and A_1 and $\bar{x}_1$ form only one unknown, since either of them may be easily calculated if the other is known. The solution of these equations for a one-inch round column with an eccentricity $e = \frac{3}{8}$ in. yields the following result:

$$A_1 = 0.272\ A$$

thus $$A_2 = A - 2A_1 = 0.456\ A$$

and $$P = s_1A_2 = 0.456\ s_1A$$

Finally $$\frac{P}{A} = 0.456\ s_1$$

With the yield point of the one-inch round specimen at about 38,000 lb. per sq. in., the limit P/A is:

$$0.456 \times 38{,}000 = 17{,}300 \text{ lb. per sq. in.}$$

It appears, in agreement with theoretical considerations, that the critical load P, when the elastic limit stress is first attained, and the limit load P, when the state of complete ductility in the column is reached, are very nearly the same for slender columns. However, there is a very marked difference between them in case of short columns. This is a vital consideration in the theory of limit design.

Figure 21 shows Euler load values obtained from silicon steel 3 by 3 by 9/64 in. angle specimens. Under a full load of 20,000 lb. the

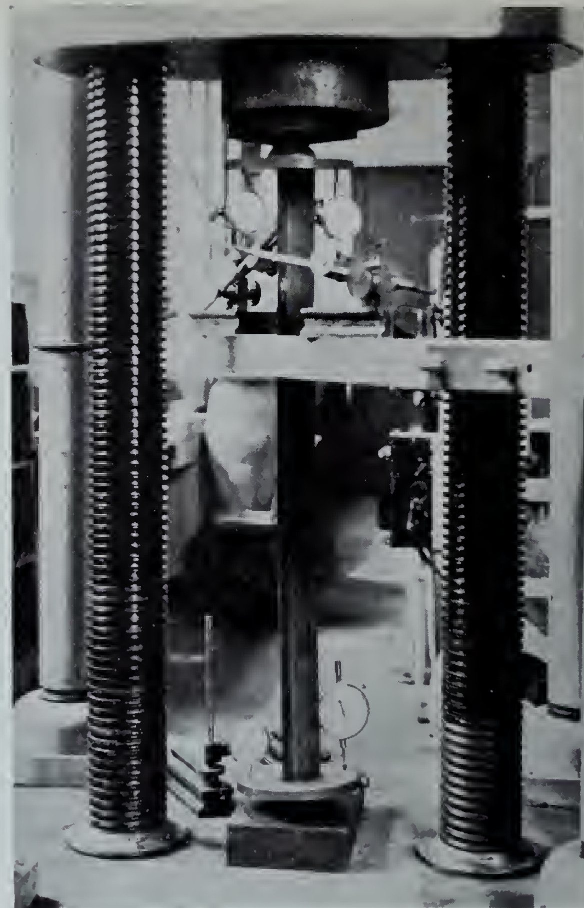

Fig. 24—Tests of steel angles.

Fig. 25—Eccentric-loading tests.

specimens could still be easily turned by hand about the axis of loading. Again we were successful in loading with an eccentricity which was nearly zero, as some of the specimens failed with the outstanding flanges in compression while others failed with the outstanding flanges in tension. All of those which failed with the outstanding flanges in compression manifested twisting, as may be observed in the photograph, Fig. 26. It is of interest to note that this twisting, this secondary failure of the flanges, did not commence until after the specimen had failed as an Euler column.

Figure 22 shows load-axial-deformation curves for two identical one-inch round specimens. *The one was tested with spherical ends.* The other specimen was tested with flat ends. So long as the flat ends remain parallel we have the equivalent of a fixed-ended column. Note that the maximum load of the flat-ended column is 3.5 times greater than that of the theoretical pin-ended one. The most striking feature of the test, to us, is that for the flat-ended specimen the load drops suddenly once the maximum load is reached, but for the spherical-ended specimen it remains constant while the deformation increases. After the flat-ended specimen fails the load drops markedly, to be sure, but it remains greater than the critical load of the pin-ended column of the same length. This fact is as theory prescribes. Once the flat-ended column fails the loading condition undergoes a sudden and radical change. The column then is neither flat-ended nor pin-ended, but definitely becomes a column loaded with a pronounced negative eccentricity (see Fig. 23). This column loaded with a negative eccentricity naturally offers greater resistance than the one loaded with zero eccentricity.

Under the heading Theory, Tests and Practice, we discussed the inadequacy of laboratory tests because of failure to simulate actual working conditions. The author wonders whether the common idea, that column load-carrying capacity is suddenly destroyed when the column buckles, is not due to an erroneous picture created by over familiarity with flat-ended column tests. Such flat-ended column tests give a wrong picture of characteristic column behaviour because the flat-ended column neither simulates assumed theoretical conditions nor actual conditions as met with in practice.

Fig. 26—Column failures.

MUNICIPAL MANAGEMENT AND THE ENGINEER

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Paper presented before the Montreal Branch of The Engineering Institute of Canada, on October 30th, 1941.

Only 25 per cent. of city managers are engineers. The remaining 75 per cent. is composed of men whose ability is not questioned. The city manager profession stands by itself. Even city managers would not accept in their association engineer members just because they are engineers. The question arises, why are there not more engineers in the field of government and specially municipal government? After all, the engineer is the link between capital and labour. Why then should he not be the link between government and the tax payers?

Engineers have been calculating, designing, translating facts into figures and figures into facts, with the result that steam, electricity, and gasoline have transformed the world we live in. They have done it so quickly that very few realize even the physical evolution of the community.

Mr. G. S. Mooney has recently described very clearly the growth and frantic progress which changed the nature of urban life in Canada.* He points out that the most important of our national resources, and the one in terms of which all others have to be judged, is human life. He remarks that the safety, welfare and happiness of the Canadian people are the end for which all these resources are merely instruments. The manner of life of our people, the problems they face, and the hopes and desires they cherish for improvement in their existence and the advance of our civilization, should be the supreme concern of government. In that spirit, let us discuss a special form of local government which has been in existence for the last quarter of a century.

There is no doubt that the inventions which characterize our age have changed our ideas of values such as space, time and money. Modern inventions being the product of a minority, it was quite natural that the philosophy of the majority could not keep pace with progress. While industry was improving its efficiency, government seemed to be lagging. Social internal strains followed. We saw industry wanting to industrialize government and government trying to democratize industry. The war has brought a truce. But we should not forget that engineers have some responsibility in this matter, because they have put in the hands of the masses tools which have brought havoc to the world.

Unfortunately, there is, amongst certain business men and politicians, a feeling that engineers, in their operations, forget about the human factor. Some of us have experienced that handicap. Not only do aldermen and members of Parliament think we are not practical; if they look at us as ingenious fellows, they also view us as very active spenders of public funds.

Some industrialists have mentioned this weakness of our profession. For example, Dr. Walther Mathesius, Vice-President, United States Steel Corporation, of Delaware, speaking last year at a sectional meeting of the Society for the Promotion of Engineering Education,** said " While these technical graduates can solve specifically assigned and difficult engineering problems, their trained engineering mind tends to focus narrowly upon their task in its designing, construction or production phases and it fails to grasp the importance of essential economic, sociological and other fundamental relationships. Yet it is frequently more important, in industry, and so much more in government, that the needs for an improvement and its consequences, if made, be carefully and intelligently analysed in their commercial, social and

* G. S. Mooney—Our Cities, Their Role in the National Economy —*Engineering Journal,* Aug. 1941, pp. 394-399.

** *Engineering Journal,* Sept. 1941, p. 439.

economical aspects rather than the mechanics of the proposal be designed to the highest degree of perfection and precision."

Even in our own society, the question has been asked why so few engineers concern themselves with public affairs. How many of us would dare step into the ring of organized politics? How many of us would consent to run or be run by party machines? Actually if an engineer showed himself on the hustings with his plans, and his reasoning as his only weapons, he would fall an easy prey to the foxy politician. Years of concentration on technical matters have tended to produce in us an inferiority complex towards the electoral side of public affairs.

There is another reason why engineers have kept away from government. We feel that democratic methods have been distorted in the hands of unscrupulous politicians, who rely too much on human nature and not enough on science in solving the problems of government.

The present world conflict has put our institutions to the test. Many of the flaws in our social set-up are more evident than in peace time. If public interest has now focussed on local government, let us take advantage of this, with the proviso that we, city managers, take for granted that democracy should be defended in peace as well as in war.

Before considering local government, we should agree on some general principles related to democracy. These are:

1—Democracy does not mean lack of power; it does not mean debate without decision.

2—There is no danger in power, if only it be not irresponsible.

3—Authority is commensurate with responsibility. In fact, the best form of democratic government, is one in which a man, to keep his office, must achieve open and honest success.

In municipal government a fundamental distinction between legislative, executive and judiciary activities, as defined in the constitutions of both Canada and United States, has been successfully put into effect in the council-manager form of government. Self government does not mean taking a hand in everything, any more than housekeeping means cooking one's own dinner.

The International City Managers' Association explains the plan thus:

" The central idea of the council-manager plan is a far-reaching attempt to resolve the apparent conflict between democracy and efficiency. Democracy is preserved in the popular election of a small council, on a short ballot which does not overtax the capacity of the citizen to understand his government. Efficiency is achieved by the employment of a manager professionally trained for the technical job of administration. The danger of bureaucracy, irresponsible and unresponsive to the will of the community, is met by giving the council complete control of the manager's tenure in office. It is definitely understood that the council deals with administration only in a formal manner through the city manager, and that administrative functions are at no time delegated to committees or individual members of the council."

" The city manager is appointed by the council as a whole. The exercise of administrative authority is concentrated in this appointed executive who is accountable to the council. He provides the council with information which enables it to determine municipal policies, advises the council in matters of policy if the council so desires, and executes the policies determined by the council. He introduces the best principles of advanced administrative organization and practice, and is held responsible for the proper co-ordination of all administrative activities under his direction."

The duties of the city manager, as set forth in most council-manager charters, broadly stated, generally require him:

1—To see that all laws and ordinances are enforced.

2—To exercise control over all departments and in accordance with civil service regulations, appoint, supervise, and remove department heads and subordinate employees of the city.

3—To make such recommendations to the council concerning the affairs of the city as may seem to him desirable.

4—To keep the council advised of the financial condition and future needs of the city.

5—To prepare and submit to the council the annual budget.

6—To prepare and submit to the council such reports as may be required by that body.

7—To keep the public informed, through reports to the council, regarding the operation of the city government.

In addition the charter generally states that the manager is to perform such duties as may be prescribed by the charter or required of him by ordinance or by resolution of the council.

To summarize, the underlying principles which make the success of the plan are: separation of functions, delegation of authority and respect of the public will in formulation and execution. The elected council rules, the chief administrator carries out the decisions within the charter. The charter should reflect the will of the people. The people, to make decisions, must be well informed. There we have the closed cycle essential to democracy.

Elimination of patronage and a ban on the spoils system, by killing petty politics, clear the atmosphere for true democracy.

Managers through their association which acts as a clearing house, have carried the technique of management to a point which enables cities like Cincinnati, Westmount, or Outremont to boast with good reason. City managers have adapted tools to municipal administration such as budgetary control, cost accounting, planning, merit system, reporting, and so forth. Of course, managers do not pretend to have invented these methods, but it is in the council-manager form of government that we find them used most effectively.

To use efficiently such means as engineering and accounting, and to enforce legislation, managers depend on an unbroken chain of authority down to the last garbage collector. They have also devised a tool which is entirely their own, at least in the municipal field, for they have, on the administrative side of government, drawn a distinction between staff and line functions. This may be explained as follows: A foreman may know the ins and outs of his job, he may be a good leader of men besides, but if he has to lose time in computing figures, or compiling statistics, his overall efficiency will be reduced, even if he were also a good mathematician. To preserve that efficiency and to improve methods, managers usually appoint men, whose duty is not to command, but to report, whose role is not to spy, but to translate into standard measurements the activities of the complex machine which the modern city constitutes. Then, if reporting is done in the reverse direction of the delegation of authority, that is from down up, we have a check on the whole of the operations. Budgetary control working only one way is pure dictatorship. It is unjust to the taxpayer as well as to the employee. Drastic cuts in the budget may be called government by some, but in themselves do not constitute real administration.

With his mastery of these tools, the manager is ready, under the control of the council, for the job of " resolving the apparent conflict between democracy and efficiency."

Since the days when the taxpayers used to gather around the stove of the general store to fix the course of destiny, the democratic system has become more and more complicated. Decades ago, the people were the government. They made the laws and enforced them, and the laws were very few. Gradually direct-participation democracy was replaced by representative government, and full-time officials took over the task of administration. As the village grew a gap opened between the people and the government. Popular interest and vigilance weakened with the widening of the breach between the public and its representatives. Correspondingly, council members lost their sense of responsibility.

One day a political boss, with amateur ability, through vast unplanned public works, steered the ship of state on the shoals of financial trouble. His successor, a hitherto unknown financial wizard, saved the ship by throwing the sinking fund overboard. (After this encouraging debut, he discovered the original plan of meeting bond issues. . . . with bond issues.) All that time the public works department had been resting on a comfortable routine. To satisfy some candid electors, laws and by-laws, ordinances and resolutions had been passed and have filled unread volumes. The venerable charter, so often amended that its patches overlap, had become a cosy retreat for lawmakers, solicitors, barristers, attorneys and lobbyists. By that time the village had become a large city, proud of its achievements, proud of its legal labyrinth, proud of its fiscal puzzles, proud of its haphazard city plan, proud of its vice rackets. That is a pessimistic view of the hypothetical city the manager has had to reform with a new council not yet informed as to the virtues of the " govern as you go " formula.

Let us follow the reform step by step. First, the manager must be satisfied that the council is not opposed to the necessary measures for success. Second, he must draw up a chart of the organization. Then, get the council to describe in short and clear, though legal, form, the duties and functions of the executive and department heads. Third, with the powers thus conferred, the chief executive, with each department head, including welfare's, sets a tentative detailed organization chart, checking on the ability of the personnel. Fourth, he draws up a plan of work for each department, beginning with the treasury. An inventory of revenue together with a survey of the debt and a compilation of fixed charges, until extinction of the debt, will permit a hit and miss budget for the coming fiscal year. The legal department is set to work boiling down the hundreds of by-laws to plain regulations to be approved later by the council and codified. Usually a general overhaul of the police and fire departments, together with a new line up in public works may be considered good practice, though much tact must be used in seasoning the dish.

It will be found that budgetary control, cost accounting, planning, personnel administration, and reporting will restore balance in services. The personnel and the public will develop interest and pride in the work. The prestige of government and its representatives will gradually build up. In practice this goal will appear out of reach, but it may seem closer after a period varying from five to twenty years depending on the manager, the council, industrial depression, war, elections, and many other factors.

Finally, managers are not machines. If we blame the engineer for having neglected the human aspect of efficiency, the manager should be very cautious to avoid the same pitfall. It does not mean that the manager should indulge in the good-natured generosity of the politician, but he should not forget that he is dealing with men, in the highest form of civilization, the democratic. Therefore city managers are very touchy on professional etiquette.

The manager is in no sense a political leader. In order that policy may be intelligent and effective, he provides the council with information and advice, but he encourages positive decisions on policy by the council rather than passive acceptance of his recommendations.

He realizes that it is the council, the elected representatives of the people, which is entitled to the credit for the success of municipal policies and leaves to the council the defence of policies which may be criticized.

He keeps the community informed on municipal affairs but himself remains in the background.

The council-manager form of government was first tried in 1908 at Staunton, Virginia. The plan as known today functioned as early as 1913, in Sumter, South Carolina. On September 15th last, the profession counted 504 recognized manager-members. In the United States, one city out of five over 10,000 population, and 22 per cent. of the 92 cities over 100,000 population, now operate under the council-manager plan. The largest proportion, 27 per cent., is to be found in the cities of 50,000 to 100,000 population.

The National Municipal League, headquarters in New York, incorporated the manager plan in its Model City Charter as early as 1915. Since then it has conducted dozens of surveys in different cities where this form of government has been in effect. Comparative reports between the old and the new system and comparisons between cities, convinced the League that the council-manager form of government is the best and most democratic way of solving the municipal problem. The office of the League, 299 Broadway, New York, can furnish a complete list of publications which should prove of great value to members of the Institute interested in the improvement of the community. For many reasons this form of city government should appeal to engineers. It attracts and retains the best candidate aldermen.

We should apply to city management the opinion of Dr. Mathesius which he expressed as follows: " It is obvious that engineers must be effective technologists, but it is also necessary that this profession, in order that it may render creditable services to the interest of the nation, be able to recognize and analyze correctly the many varied and complex economic, commercial or human problems which beset the majority of industrial developments today. . . It is not enough to drive for cost reduction and improved production methods, but that systematic attention must, of necessity, be given to public and industrial relations, to personnel administration and to research in these directions as well as in strictly engineering matters. . . . all of these subjects must be considered as rightfully belonging within the sphere of technological influence."

Here is a challenge so direct that it cannot be ignored.

Whether we like it or not, democracy, like all human ideas, must develop with time. Progress in its physical manifestations has been free-wheeling during the last half century. The engineer must do his share in adapting physical progress to human needs. Only after machines and methods have been set to work effectively from a social standpoint, can we say that civilization has progressed.

There is no reason why the men who built the modern city should not supervise its operation, or at least, take a large part in its management, utilizing the facilities which they have put in the hands of the masses; having in mind the happiness of all, materially and socially.

(In the compilation of this paper, the author has been indebted to many fellow managers, from whose literary work he has taken very liberally.)

THE PORTLAND-MONTREAL PIPE LINE

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Paper presented before the Montreal Branch of the Engineering Institute of Canada, on November 27th, 1941

The story of the pipe line began near Oil City, Pennsylvania, a few years after the famous Drake well was drilled in August, 1859. It was a primitive affair only a few miles long, made of two-inch wrought iron pipe, but it represented the faith and vision of its builders and from this humble beginning the pipe line industry has grown to 130,000 miles of main lines, moving close to 4,000,000 barrels of oil each day.

The early pipe lines were made of heavy iron with caulked and bolted joints but it was not long before steel pipe came rolling from the mills with threads and collars. This type of pipe was used for most of the lines that now serve every oil field on this continent and criss-cross the country in a binding network as an integral part of our national economy and defence.

The first pipe lines were limited to the movement of crude oil as the leakage through the various types of joints discouraged their use for gasoline and other refined products. This situation lasted for almost forty years but was finally changed by the development of the oxy-acetylene welding method, and it was not long before this new welding process was applied to pipe line construction in the field. Oxy-acetylene welding was introduced in 1914 with the electric method following a few years later and in a short time all lines throughout the country had welded joints from one end to the other.

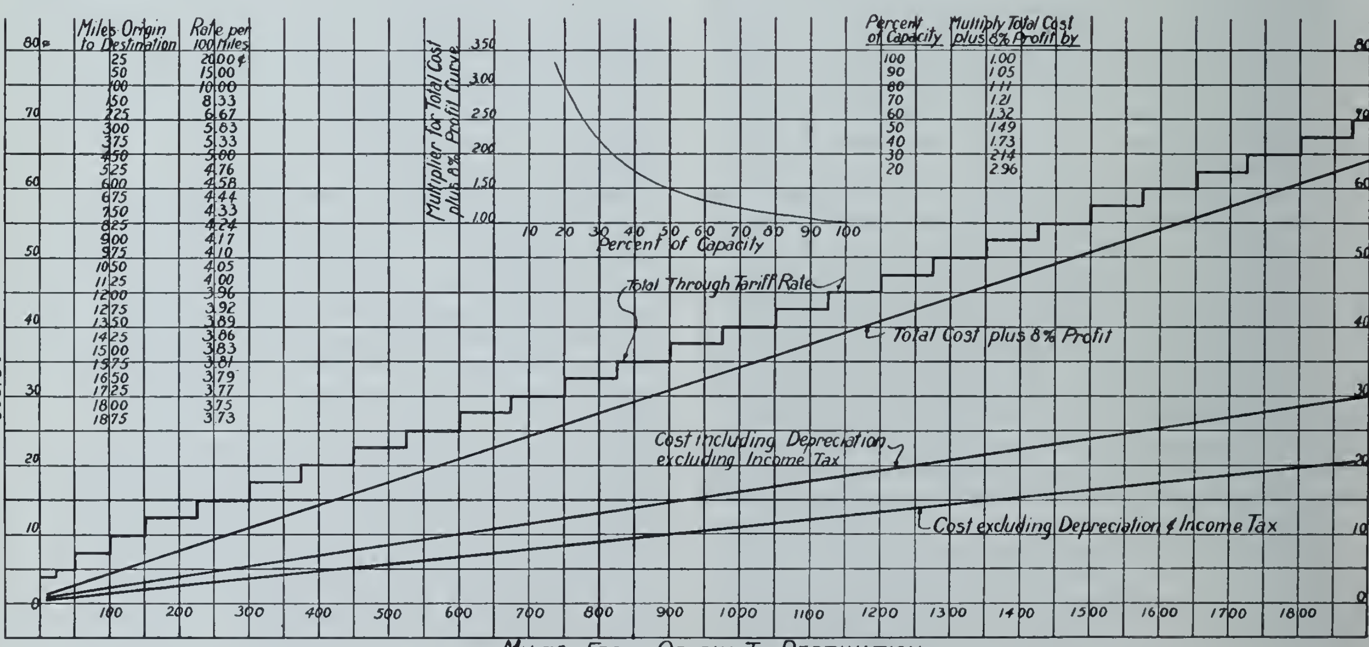
The success of welded lines led to their adoption for refined products. One of the first gasoline lines was laid in Wyoming in 1917 and while old pipe line men scoffed at the plan it was a complete success from the first and the pipe line loss which had proved such a problem in the early days was eliminated. From about 1920 it has been general practice to weld both crude and products lines and such progress led to the adoption of double-length joints of pipe to reduce the number of welds. This required improvements in actual welding technique to speed up the work and lower the cost, and while both gas and electric methods have certain things in their favour, the latter is more widely used.

Better welding required better steel which hastened the development of the specially rolled, electrically welded pipe made from plate, and was followed by the perfection of seamless tubing. With these improvements in material and workmanship it is now possible to lay a solid welded pipe line up hill and down, under rivers, and across plains without any fear of failures, nor is there any need to worry about the kind of joint as the plain beveled end, welded type is as strong as the pipe itself. These welds are free from metal intrusions, called icicles, and make a perfect joint.

The success of the welded pipe line allows the claim that it is a safe and satisfactory way to move crude oil and refined products across the country under almost any condition. This is especially true in times of trouble as a buried welded line is least subject to damage and interruption from outside causes.

The first pipe line in the early days of Pennsylvania was forced on the oil producers by the highhanded methods and exorbitant demands of the teamsters. This same competitive situation has existed through the years and even to-day no pipe line can expect to secure and retain any of the oil transportation business unless it can meet the competition of tankers, barges, railroads, tank cars, and trucks. This is a fundamental rule and determines the success or failure of any new pipe line project.

If we assume that a pipe line can meet competition, the next consideration is construction costs, then the probable operating expenses, and finally a return on the investment. The average costs of several different sizes of crude oil pipe lines together with the diesel engine-driven reciprocating pumps, are shown in Table I. These figures compiled in June, 1941, must be revised to meet the higher labour and material costs in effect to-day. They are on a basis of 50 per cent standby capacity in pumping equipment which is often required to meet the summer and winter fluctuations as well as to handle oils with different pumping characteristics. The deliveries in barrels per day, shown in Table I are based on 36 gravity A. P. I. Mid-Continent crude with working pressures up to 1,000 lb. per sq. in. and the usual station spacing of approximately 30 miles, with allowance



NOTE: These estimates were made in June 1941 and must be revised to meet increased Labour and Material Costs since then.

Fig. 1—Chart showing the theoretical tariff required for crude oil pipe line operation based on 10 in. pipe.

TABLE I

CRUDE OIL PIPE LINES—ESTIMATED CONSTRUCTION AND OPERATING COSTS

Diesel Engines Driving Reciprocating Pumps with an Allowance of 50% Spare Pumping Equipment

Pipe Size	Barrels/Day	Pipe Line Cost/Mile	Station Cost/Mile	Total Cost	Operating Costs per Barrel				
						100 Miles	500 Miles	1000 Miles	1500 Miles
4″	5,000	$ 4,400	$ 2,400	$ 6,800	Operation......	7.98c	28.19c	52.03c	77.30c
					Depreciation....	1.21	5.48	12.11	18.16
					Sub-Total......	9.19c	33.67c	64.14c	95.46c
					8% Return.....	2.98	14.90	29.81	44.71
					Income Tax.....	1.61	8.03	16.05	24.08
					Total.......	13.78c	56.60c	110.00c	164.25c
6″	10,000	$ 8,800	$ 1,950	$10,750	Operation......	4.47c	16.08c	29.18c	41.52c
					Depreciation....	0.96	4.79	9.57	14.36
					Sub-Total......	5.43c	20.87c	38.75c	55.88c
					8% Return.....	2.35	11.78	23.56	35.34
					Income Tax....	1.27	6.35	12.69	19.03
					Total.......	9.05c	39.00c	75.00c	110.25c
8″	20,000	$12,300	$ 3,700	$16,000	Operation......	2.95c	9.44c	16.71c	24.46c
					Depreciation....	0.71	3.56	7.12	10.68
					Sub-Total......	3.66c	13.00c	23.83c	35.14c
					8% Return.....	1.75	8.77	17.53	26.30
					Income Tax....	0.94	4.72	9.44	14.16
					Total.......	6.35c	26.16c	50.80c	75.60c
10″	40,000	$15,800	$ 5,700	$21,500	Operation......	2.07c	6.71c	10.81c	17.52c
					Depreciation....	0.48	2.39	4.79	7.18
					Sub-Total......	2.55c	9.10c	15.60c	24.70c
					8% Return.....	1.18	5.89	11.78	17.67
					Income Tax....	0.63	3.17	6.35	9.52
					Total.......	4.36c	18.16c	33.73c	51.89c
12″	60,000	$18,600	$ 7,150	$25,750	Operation......	1.70c	5.49c	9.18c	14.86c
					Depreciation....	0.38	1.91	3.82	5.73
					Sub-Total......	2.08c	7.40c	13.00c	20.59c
					8% Return.....	0.94	4.70	9.41	14.11
					Income Tax....	0.51	2.53	5.07	7.60
					Total.......	3.53c	14.63c	27.48c	42.30c

These figures were compiled June, 1941, and must be revised to meet increased labour and material cost since then.

for differences in elevation. Working pressures and wall thickness of the pipe depend on the grade of steel and, in this study, follow a factor of safety of four. The operating figures shown in the right half of Table I are based on using an average rate of depreciation of 3¼ per cent, which is generally allowed for crude oil pipe lines and the last figure in each case indicates the revenue necessary to return 8 per cent on the investment after an allowance for income taxes. This table shows that the cost per barrel for a single 100 miles is higher than the cost per 100 miles as a part of a 1,000-mile line. This is to be expected as overhead, office and general expense cost per barrel is lower for the longer distance. The figures given are estimates based on general experience with various size lines handling different crudes at many locations and must be modified by existing conditions if used as a guide for any new project.

The theoretical tariff required for crude oil pipe lines is shown in Fig. 1. The interpretation of this chart requires some explanation. For example, if oil is to be moved 500 miles the chart indicates that the revenue needed to cover operation expense, income taxes and profits will be 17.5c. per barrel. This serves as a guide in establishing the tariff but in so doing the varying load factor must be considered which makes it necessary to set the tariff slightly higher, at 22½c. per barrel. This has been worked out on a zoning system which allows a certain freedom in meeting the competitive rates of other pipe lines and carriers. This means that the tariff of 22½c per barrel can cover a zone from 450 to 525 miles, and the same pattern can be used for other distances. Various modifications on account of load factor, location, line size and kind of oil must be made.

There is one conclusion that can be drawn from the many years of pipe line operation and that is, they must meet competition and in so doing are entitled to a reasonable return on a fair valuation. This varies for different locations, and short-lived projects require a higher earning to prevent loss. Pipe lines should be allowed a liberal fluctuation in their net earnings to carry them through bad years and protect them against unforeseen difficulties.

The comments in the preceding paragraphs have applied to common pipe line practice and can be further amplified by a few remarks on the Portland-Montreal pipe line.

This project was first conceived because of the tanker shortage and was decided upon as a means of delivering crude oil to the Canadian refineries in Montreal without interruption during the emergency period brought on by the war. Therefore it can be properly classified as a defence measure. It has the additional advantage of providing year round service whereas the St. Lawrence is closed to oil-carrying tankers about five months each winter. The Portland-Montreal line has a further claim in that it eliminates the 12-day tanker haul of 2,000 miles around

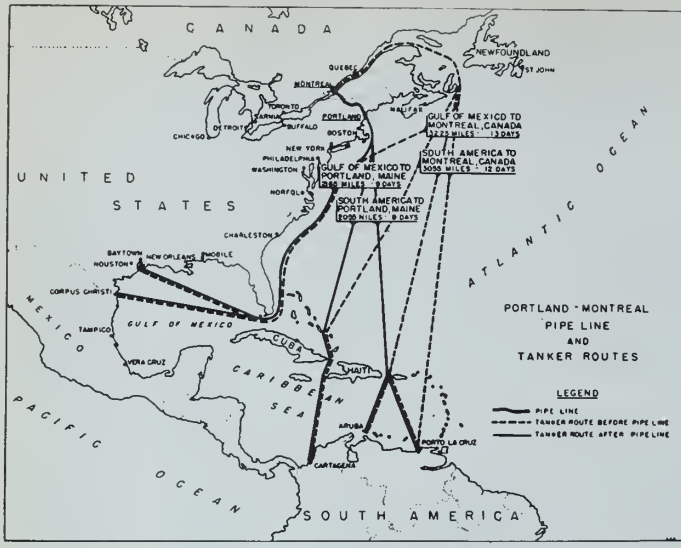


Fig. 2—Map showing normal tanker route from South America to Montreal.

Nova Scotia and results in a net saving of four ocean-going tankers. This is important when boats are needed for so many purposes. The normal tanker route from South America and the Gulf Coast and its relation to the Portland-Montreal line, and the St. Lawrence river, is shown in Fig. 2. The new line in relation to the existing pipe line system in the United States and Canada is shown in Fig. 3.

When the decision was made to build this line, the first step was to select the best route, and an aerial survey of the area from Portland, Maine, northwest to Montreal was made. This proved that a straight line could not be followed as it was necessary to work out a route through the mountain gaps to maintain reasonable difference in elevation. The early reconnaissance work was followed by the land survey and the mapping which was used in securing the right-of-way. The actual route of the line and the location of the pump stations are shown in Fig. 4.

While the route was being selected, the engineers in charge of the design and construction completed the specifications and placed the orders for all the pipe and equipment needed. It was decided to lay a 12-in. line, which has a normal delivery of 60,000 barrels per day when handling a light grade of crude oil. This system called for eight pump stations, two of which will be driven by diesel engines. The other six are motor driven as electric power is available at these localities. All of the pumps are of the reciprocating type as the line must handle several different

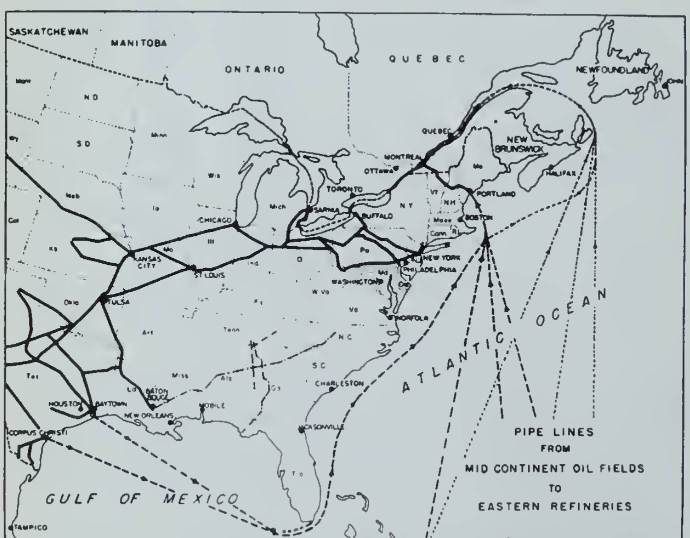


Fig. 3—Map showing Portland-Montreal pipe line in relation to the existing pipe line system in United States and Canada.

grades and gravities of crude oil, some with high viscosities which eliminate the use of centrifugal pumps, especially during the severe months of winter. The line will not be heated in the winter so the oil must have a cold test below 32 deg. F.

After all the new material and equipment was ordered it was a simple matter to let the contracts for the construction of the line. Pipe line contractors are a hardy lot and are willing, and at times even anxious, to take a contract at a flat price per foot to construct the entire line. This practice was followed and the two contractors hauled the pipe from the railroad stations, strung it along the route, dug the ditch, welded the pipe and laid it in the trench, then backfilled it, all subject to the usual inspection and supervision of the Pipe Line Companies' representatives. The pipe line construction programme, which was handled by Williams Brothers and the Oklahoma Contracting Company, was started in July and finished in October.

In addition to the pipe line which is 236 miles long and the eight pump stations referred to, the Portland Pipe Line Company was obligated to provide a complete terminal for sea-going tankers. Casco Bay, at South Portland, which has a channel open the year round was selected. This terminal necessitated dredging and the construction of a complete new pier, the erection of six 140,000-barrel steel

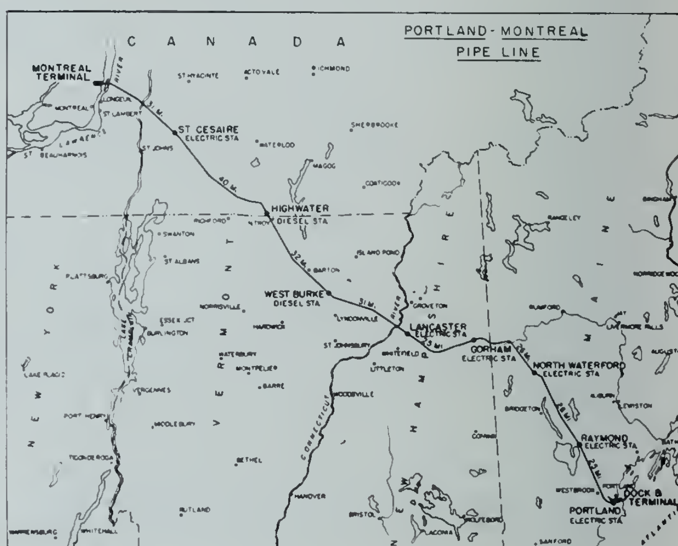


Fig. 4—Map showing the route of the new pipe line and the location of the pumping stations.

storage tanks together with a transfer pump at the water's edge and lines leading to the tank farm at the edge of the town where the initial mainline pump station is located.

All of the terminal work was done under the direction of Ford, Bacon & Davis, Consulting Engineers, and was planned and is being built to enable the Pipe Line Company to handle several grades of crude without delay night and day during the entire year.

The Pipe Line Company was also required to build a terminal at Montreal and made every effort to avoid interruption in service by laying double lines under the St. Lawrence river with separate distributing branches to each customer. This company will have its own complete office in Montreal and will function as an independent Canadian unit ready to serve the customers in every reasonable way.

The South Portland harbour, in its relation to the Atlantic Coast, is shown in Fig. 5, and the location of the pipe line across the St. Lawrence river and the several refineries in Montreal can be seen in Fig. 6.

The construction of the Portland-Montreal pipe line through the mountain country of Maine, New Hampshire and Vermont proved a difficult task. It is a beautiful country but a large part of it has solid granite only a foot or

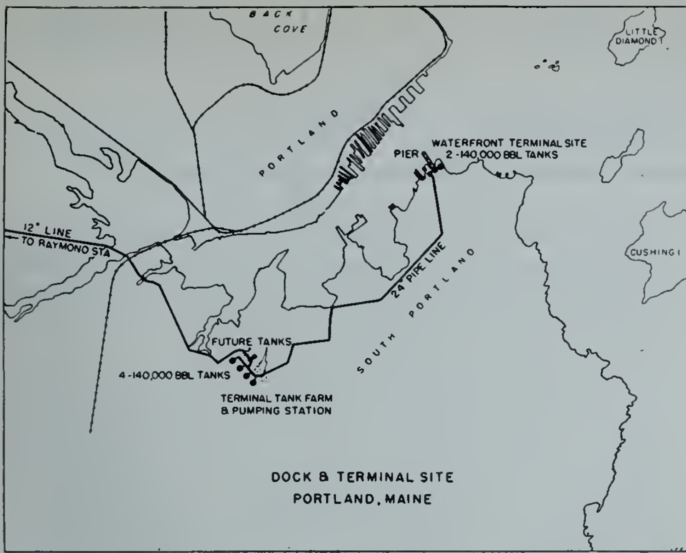


Fig. 5—Map showing the layout of the South Portland harbour.

two under the surface so when the contractors came through the country to dig the pipe line ditch it required rock work and blasting about 80 per cent of the way. The reverse was true in Canada as most of the route was through level productive farming country. In addition to construction problems there was a considerable delay in obtaining pipe line equipment. This was especially true of the large reciprocating pumps which forced the company to borrow motor-driven centrifugal units for temporary installation. The many difficulties in construction and installation were gradually overcome one by one by the experienced staff of pipe line engineers and contractors so that the entire line was welded and the pumps set in the record time of four months. This required long hours every day in the week and extra expense, but the effort was justified.

The first boat arrived in Portland harbour on November 4th, carrying a light grade Colombian crude oil but the new pier was not complete so it was tied up to the Pan-American dock and started pumping out its cargo into the Portland Pipe Line Company's storage tanks. The main line pumps were put into service on the morning of November 5th to test the pumping facilities and the pipe line leading to Montreal. The trial run was continued with some losses of oil and minor troubles for a number of days until the line was declared officially open at a ceremony in Portland on November 10th which was attended by Governor Sumner Sewell of Maine, and other notables. The oil reached Canada on November 16th and the line is now in steady service.

The Portland-Montreal pipe line is now in a position to serve the refineries in the Montreal area with crude oil, the products of which are so vitally needed in Canada's industrial life and defence activities. This transportation unit will make every effort to handle different grades of crude for all customers without delay or loss and stands ready to meet competitive methods of transportation at all times.

In our efforts to complete this economic link of defence between the United States and Canada we have had the

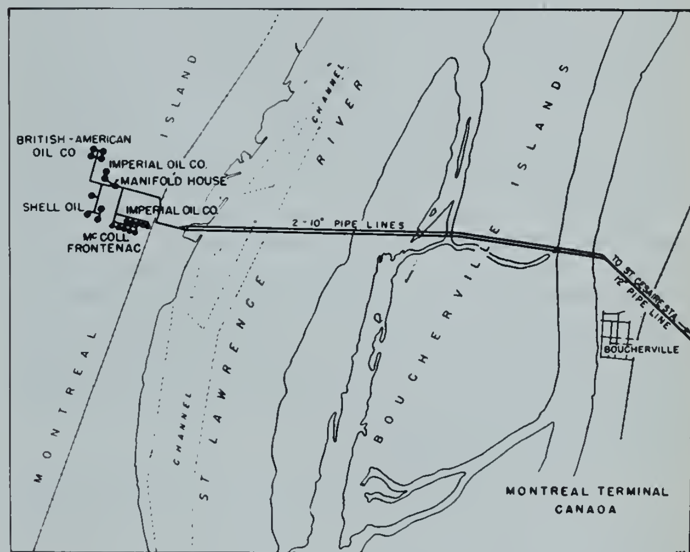


Fig. 6—Map showing the location of the pipe line across the St. Lawrence and of the refineries at Montreal.

wholehearted support and co-operation of all local, state, and national agencies of both countries, for which we are duly appreciative. This is especially true of the river, harbour and customs officials. Likewise, the author wishes to offer tribute to his company associates, Messrs. H. M. Stevenson, George Lee, J. H. Slaughter, A. H. Chapman, and all the others who made this early completion of a difficult task possible. We also are grateful to Mr. F. C. Mechin, M.E.I.C., Mr. Jack Simpson and our many friends in Montreal and Canada who have done so much to help us bring this project to a successful conclusion.

PLASTIC LAMINATED WOOD IN AIRCRAFT CONSTRUCTION

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Paper presented before the Toronto Branch of The Engineering Institute of Canada, on October 16th, 1941.

Wood is a natural grown material which has fine structural properties, but also some serious defects. Wood was the only material used by aircraft constructors at the earlier stages of aviation, but towards the end of the first world war other materials made their appearance. Mild steel in tubes and wires was always used in small quantities in aeroplanes; with the development of the art of welding, steel became a serious competitor of wood.

Soon after the first war chrome molybdenum weldable steels of high strength were developed, and competition between steel and wood increased. It became usual to make fuselages, undercarriages and engine mountings of welded steel tubes; wings and control surfaces were made of wood. This state existed until about 1925. At that time, light alloys made their appearance in the aircraft industry. Aluminum and magnesium alloys were known much earlier, but their application had not been extensive. When steel had replaced wood in fuselages light alloys began to push wood out of the wing structure. This struggle between wood, steel and light alloys resulted in victory for the latter when the so-called stressed skin construction was developed.

In earlier aeroplanes, there was a main structure or frame and a skin which existed only for streamlining purposes and did not contribute to the strength. It was found that the total weight could be reduced, if the skin and frame both participated in the structural strength of the aeroplane. The separate frame disappeared and the stiffened skin transmitted all forces. Light alloys were particularly suitable for this stressed skin construction, which started about 1930, developed very quickly especially in the United States, then was adopted on the European continent and was accepted in England rather reluctantly and quite lately. In fact, even today several well-known English aircraft are not of the stressed skin type, for instance the Vickers " Wellington " and the Hawker " Hurricane." It may be said that since the beginning of the second world war light alloys have almost entirely eliminated wood from aircraft construction except in some types of light planes and in the Italian aircraft industry where wood was used because of the shortage of aluminum.

This temporary passing of wood out of aircraft construction may be explained by the defects of wood which limited its use in modern aeroplanes. About 1935 new methods in wooden aircraft construction made their appearance. Certain new synthetic resins were applied in wooden construction with great success, opening an era in which the employment of wood has been revived.

In order to better understand the influence of synthetic resins on wooden construction we may note some properties of wood. One of its main advantages for aircraft construction is high strength-to-weight ratio. Spruce, one of the best aircraft woods, has a tensile strength parallel to grain, 9400 lb. per sq. in., and specific gravity 0.40. Thus its strength-to-weight ratio is 23500; for high tensible steel the figure is 22900 and for duralumin 22100. One of the most valuable properties of wood is its excellent shock and vibration absorbing quality. Unfortunately, wood is not homogeneous. Its cells are arranged in longitudinal fibres and the molecular bond between cells is greater along the grain than normal to the grain. The strength of wood in tension is considerably higher than in compression and the strength parallel to the grain is higher than that normal to the grain. These directional variations of strength create considerable difficulties in aircraft construction. The greatest disadvantage of wood is change of volume and strength caused by variation in atmospheric conditions and in its moisture content.

The crushing strength of green or wet spruce is increased over fourfold merely by drying. In addition, timber changes its dimensions and tends to warp or crack with variation of its moisture content. Alternate shrinking and swelling causes unpleasant working of the wood. Radial shrinkage averages about three fifths as great as tangential shrinkage, but is many times greater than longitudinal shrinkage. Many physical defects diminish the structural value of wood. These defects are: knots, pitch pockets, wavy, curly and interlocked grain, mineral streaks, etc.

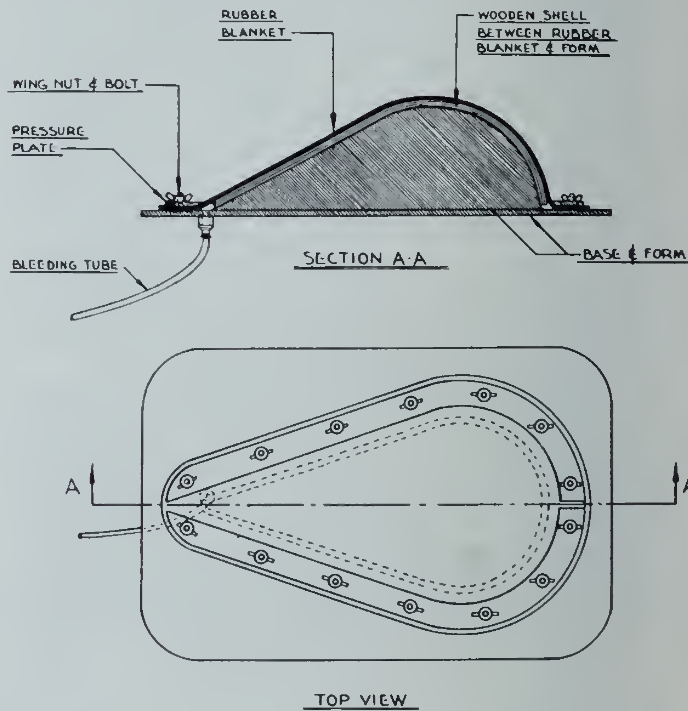

Fig. 1—Diagram showing method of moulding with male die.

Wooden structures in aircraft construction are held together mainly by glue. The average engineer is apt to treat glues and gluing with contempt. Even the aeronautical engineer often considers glue as being rather unreliable. Actually, there is no reason to doubt the reliability of a properly glued joint which has been designed with sufficient gluing area to take ultimate stress.

There are two main types of adhesives, reversible and irreversible. The former has the peculiarity that the bond produced may be loosened at any time by dissolution or softening of the bonding agent, because no setting takes place. Adhesives of this type are, for instance, gum arabic, fish glues, hide glue and thermoplastic cements such as acetyle cellulose.

The irreversible type is characterized by a chemical reaction within the adhesive during the gluing process which results in a setting of the glue. This type is represented by animal albumen glues (coagulation of albumen at the gluing temperature), by casein cold glue (chemical

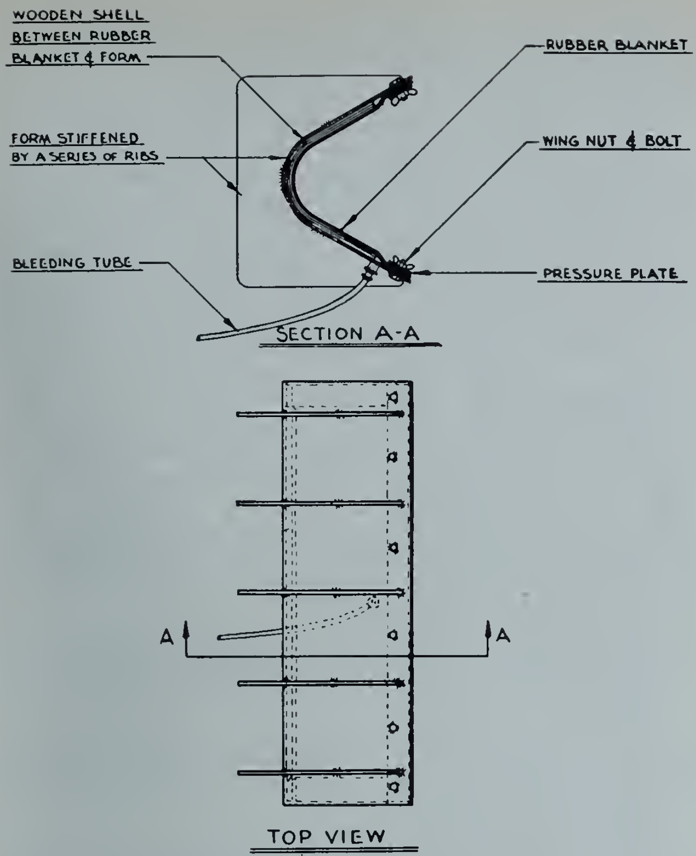

Fig. 2—Diagram showing method of moulding with female die.

bondage of protein by alkalies), and by phenol formaldehyde (resin stage C reached through condensation and polymerization). When gluing timber the bonding forces existing in the glue joints are forces of molecular adhesion between the closely contacting surfaces (specific adhesion) and a purely mechanical connection caused by the interlocking of minute glue pillars which become imbedded in the open pores and cells of the contacting surfaces (mechanical adhesion).

Adhesives used in earlier periods of aircraft construction were albumen glues and casein glues. Joints made with these adhesives were quite strong but not resistant to water and bacterial decay (mould), a great disadvantage of wooden aeroplanes in the competition with metal aircraft.

Wood is a very easy material to work with. It does not require highly skilled labour and costly tools and where only a small quantity has to be made wooden construction is much cheaper than metal. But considerable difficulties arise when great quantities of aeroplanes are needed and a quantity production method has to be devised.

The greatest difficulty in applying quantity production methods in wooden construction was the impossibility of forming wood by presses, hammers, etc., methods easily applicable to sheet metal materials. This, with such disadvantages of wood as non-homogeneity of strength properties, variation of volume and strength properties with the moisture content, physical defects, unreliability of animal glues and unsuitability for quantity production hindered the development of wooden aircraft construction for many years.

The most serious obstacle was the unreliability of the glues then available, but when this difficulty was overcome others could be easily dealt with.

The return to the use of wood began with the advent of adhesives made of synthetic resins, which are either based upon phenolic formaldehydes (so-called bakelite), or upon urea formaldehydes or carbamides. During their transition period from the soluble stage (stage B) to complete condensation or polymerization (stage C), these synthetic resins make excellent adhesives for timber.

Synthetic resins are the only glues which are moisture resistant after solidification and are immune to bacterial and mould attack. Their inherent strength may be used for improving the natural strength of timber.

The advent of synthetic resins started a new era in wooden aircraft construction and after considerable efforts made by engineers most of the disadvantages of wood have been eliminated. The lack of uniformity of strength of wood, its susceptibility to variation of moisture content and lack of homogeneity because of physical defects, are remedied by employing laminated wood. This material is made of wooden veneers sliced or rotary cut, assembled with a proper adhesive under pressure. In modern wood construction synthetic resins are used almost exclusively. By a suitable arrangement of veneers, combining different thicknesses, using different kinds of wood and disposing grain at suitable angles it is possible to build wooden panels and beams of fairly uniform strength and of constant shape and volume; the strength and moisture resistance of this material is greatly improved by the presence of synthetic resins.

The experimental work in modern wood construction is carried on by several organizations in this country, for instance, in the National Research Council by Mr. W. T. Reid, under the supervision of Dr. Parkin; in the Massey Harris Company by Mr. Lezier and Mr. McIntyre, and by the Experimental Department of de Havilland Aircraft of Canada. The author's connection with the latter company enables him to describe some of its work.

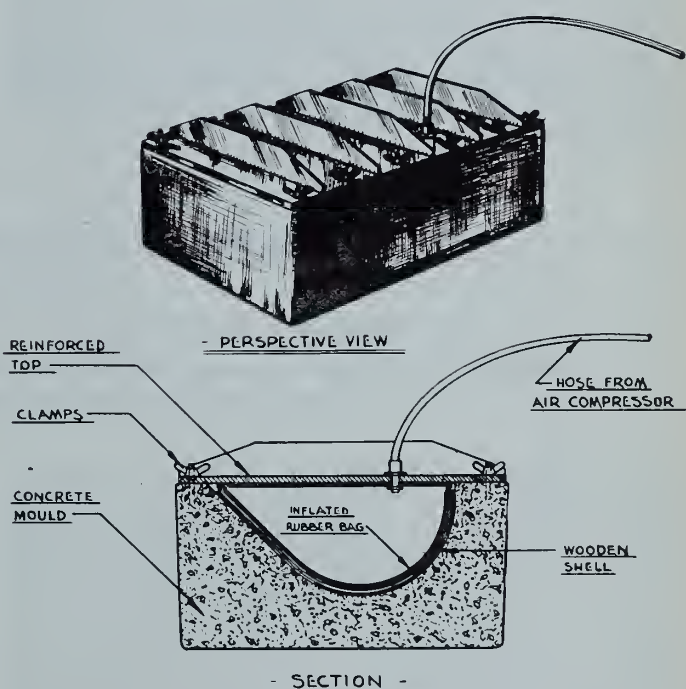

Fig. 3—Diagram showing method of moulding with "cold set" adhesive.

Experiments are carried out with three objects: finding the best arrangement of veneer in composite laminated panels, determining the most suitable adhesive and developing production methods comparable to methods used in metal construction.

A series of systematic tests have been made on composite panels made of Sitka spruce and yellow birch veneer. The effect of different factors has been investigated and among them the influence of angle of grain with the direction of main force applied, thickness of veneer, etc. Composite panels of very satisfactory and

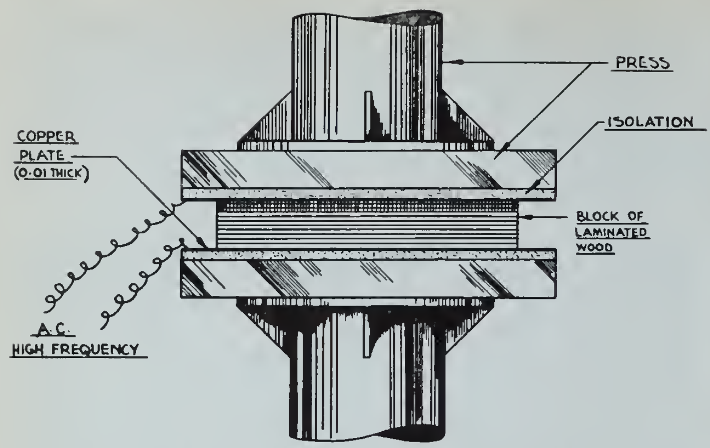

Fig. 4—Diagram showing method of moulding with high frequency electrostatic process.

uniform strength have been developed. The tensile strength of spruce panels was raised from 9,400 to 12,000 lb. per sq. in. and the compressive strength from 5,000 to 8,000 lb. per sq. in. Tests were made on adhesives of different kinds. Phenol formaldehyde or bakelite resins of Canadian make have given good results. All phenolic adhesives tested were of the hot setting type. A solution of fusible resin is used for assembling veneer. In order to pass into the final insoluble stage the resin must be cured at about 300 deg. F., after which it becomes insoluble and when heated again does not melt. After extensive tests it has been found that bakelite resin TR. 9066 is very suitable for manufacturing composite laminated panels.

A large family of urea formaldehyde resins was investigated and it was found that glues manufactured by the Plaskon Company, Toledo, Ohio, give very good results. There are cold setting Plaskon glues which do not require hot cure and are very convenient for the assembly of aeroplane components.

Considerable work has been done in elaborating processes which may make large production of wooden aeroplanes possible. A method which is being extensively tried is that of moulding in a pressure tank.

Let us assume that a double curvature surface, for instance a part of a streamlined fuselage skin, is to be manufactured. A wooden form of the required shape is made. Strips of skin veneer 1/32-1/16 in. thickness are laid in several layers on the form, and are spread with a solution of resin and dried. The form, with veneers, is put in a rubber bag with a valve. The bag is closed and the air is exhausted from the bag. Then the bag, with the contents, is put into a pressure tank (autoclave). The interior of the bag remains in communication with the atmosphere. Steam under pressure of about 70 lb. and temperature about 300 deg. F. is admitted to the tank, supplying the pressure and heat necessary for curing the resin. After a suitable interval of time the bag is removed from the tank and the form taken out of the bag. The veneers laid on the form are found to be moulded into a smooth rigid surface of the desired shape. Another method of forming laminated surfaces makes use of a female die and the result is much the same.

If urea resins are used, only 220-230 deg. F. temperature is needed and in that case, a combination of steam and compressed air is used.

Another very promising process is in preparation, in which the curing heat is generated by a high frequency electro-static field of about 50,000,000 cycles. The pressure is applied by a hydraulic press.

The Experimental Department of the de Havilland Company is making a wing for one of the metal aeroplanes in production in this country using moulded plastic wood construction. Other experiments are under way and there is reason to suppose that there will be a new branch of aircraft industry based on the product so abundant in this country contributing to the war effort and helping to put an aeroplane within the reach of the average man.

CO-OPERATIVE ENGINEERING EDUCATION*

DOUGLAS F. MINER

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An address delivered at the Sixth Annual Meeting of the Allegheny Section of the Society for the Promotion of the Engineering Education, Pittsburg, Pa., on October 26th, 1940.

The preparation of engineers for positions of responsibility in industry involves training in two steps. The first step covers the learning of general principles of technical and allied subjects, chiefly through recorded and spoken means, or in other words from formal teaching. Hereby the mental tools of the profession are provided, and instruction given for their use. Knowledge is imparted by telling or demonstrating what other people have found out or are at present doing. Laboratory and shop practice emphasize and supplement this information by having the student gain manual and visual verification of the findings of his predecessors. Knowledge then becomes a part of his own experience. So far he has made no productive contribution to society. As a physical analogy, he has been practicing in a gymnasium by lifting weights, swinging clubs, and flexing his muscles, acquiring strength and skill in their use, for later application to useful pursuits. He has not yet shoveled any dirt or hoisted a load or felled a tree.

The second phase of training, just as necessary as the first, is learning through actual work how to apply the knowledge acquired. Such development may be a planned procedure under educational guidance, or it may be the trial and error and observation method of the individual in growing up in a job. Here what he does counts in dollars and cents for good or bad. When the exercise is over, the elements cannot be taken apart and put back on the shelf, as with laboratory equipment or the familiar constructional toys. The result stands as an irretraceable event. In this phase the student learns by doing and as his judgment and experience increase, his responsibilities grow. He learns to select and choose from the tools he has forged and sharpened in school to suit the problems presented.

The two parts of this educational problem are both essential and must be acquired either formally or by self-effort. The fundamental instruction can best be done on the college campus, where facilities and staff are available for this kind of work. It seems unnecessary and a duplication of facilities for industry to set up engineering colleges within the factory gates. Likewise, it is somewhat futile for the engineering college to maintain up-to-date shops and production facilities in which comprehensive instruc-

* Reproduced by special arrangement with the Society for the Promotion of Engineering Education.

tion can be given. Such equipment in industry is constantly changing, as are the engineering and manufacturing procedures that go with it; and what is the latest word to-day may be obsolete next year. Design procedure also changes rapidly, so that the materials and methods of to-day are gone to-morrow. Only the essential principles are of permanent value to the student. This part of the job, of adjusting the man to his work and teaching him to get desired results that are measured for good or bad in dollars and cents and not in A's and F's, can be left to industry for the most part. In fact, the detailed training desirable for one factory may be useless in another. Studying the methods of a foundry may be wholly unnecessary for a man entering a textile mill.

While it is clear that there are two distinct phases of technical training, it must not be concluded that the two are independent and unrelated. Co-ordination is useful and productive of best results. If the two parts of education are locked in separate brain compartments, the one will not supplement the other. The student must on one hand know why he is learning the principles of static mechanics, and in what kind of situations his knowledge may be applied. On the other side, he must " spot " in every new or puzzling practical problem, its breakdown into simple parts and must recognize into what classification the elements of the unsolved difficulty can be placed. Then he will be able to select the principles to apply, from his accumulated knowledge. Let us illustrate. The laws of heat dissipation by conduction, radiation, and convection will take on new significance when the young engineer goes through the process of calculating temperature rise in an electrical machine. And on the other side, when the engineer is confronted with failures of high-speed turbine blades, he will first consider that here is a combination of heat, alternating stress, impact stresses, and erosion of steam, which may all be in the picture. He will find methods of measuring the stresses and vibration amplitudes, will study how his chosen materials behave at the temperatures observed, and will then begin to apply principles of static and dynamic mechanics, thermal behavior of metals, and the metallurgical facts he may require, all resulting in a better design.

If he is having trouble with drying a lacquer, he will start brushing up on vapor pressures, rates of evaporation, and how these vary with temperature and humidity.

To bring about this element of co-ordination, between scientific principles and their use, the various known plans of co-operative education have been devised. Interspersed or concurrent school and factory work have been thereby combined to give the needed twofold training.

The historical development of co-operative engineering courses was very interestingly related by Professor K. L. Wildes,* who states that the alternating or " sandwich " system of education existed in Scotland a century ago. The six months' university term was followed by a six months' work term, because of financial necessity. Any correlation between the work and school was incidental. In 1824 in this country Rensselaer Polytechnic Institute supplemented classroom work with inspection trips to selected factories as a means of illustrating classroom subjects. In 1868, Worcester Polytechnic Institute was established to teach skill in the industrial arts, along with training in science; and for that purpose a factory was built on the campus which manufactured articles for sale. Student apprentices supplemented the skill of journeymen artisans. This shop is still in operation, the students using the commercial facilities but no longer producing goods for sale. Then in 1880, Massachusetts Institute of Technology established a shop on the campus in which manufacturing methods could be seen and tried as laboratory practice by the students. Subsequently, most engineering schools included more or less campus shop practice in the courses offered.

There have been many types of co-operative courses in successful operation, each designed to follow a definite plan for the accomplishment of certain objectives. It should be recognized that the immediate purposes may not all be the same in co-operative education. Some plans have been expressly designed as a standard type of course for all or most students entering the institution. Courses and shop assignments must then be adapted to handling large groups of students. Other plans have been directed toward special training of a limited group of selected students, aiming at the development of the best that a combination of good human material and good special training can attain.

A description of the Cincinnati Plan and the Massachusetts Institute of Technology Plan will illustrate the principles of the two types, the standard course and the selective course.

The Cincinnati Plan, originating in 1906, started with a 6-week cycle of work and study, which was later changed to 4 weeks. The basis is an alternating four weeks of school, followed by four weeks of shop work, throughout the year, which is divided into three terms, 18 weeks, 16 weeks, and 18 weeks, with two vacations of one week each during the last week of each of the two 18-week terms. The course involves a total of five years' training, comprising 120 weeks of shop experience and the same amount of classroom work, all leading to a B.S. degree. The campus time is thus reduced from the usual 144 weeks to 120. This general plan with modifications has been adopted by more than twenty colleges, including Antioch, Georgia Tech, University of Tennessee, Alabama Tech, University of Akron, Newark, and Case. In some, the periods are lengthened to 13 weeks, or even as long as a semester (Alabama Tech). In all these plans, the students are grouped in pairs, having alternate schedules. One of each pair works, while the other is in school. In this way, a given factory job is continuously filled.

The Massachusetts Institute of Technology Plan was started in 1917 with Professor Timbie in charge, to develop selected men for top industrial positions. In this scheme, the selection of certain outstanding men taking the regular courses is made at the end of the second year. Co-operative work begins with the third year and continues for three years, at the end of which the student is granted two degrees, B.S. and M.S. The schedule for the three co-operative years is divided into three sections, the two school semesters and the summer. Each of the co-operative years comprises an average of 23½ weeks' work, 23½ weeks' school, and 5 weeks' vacation. The work periods are of term length, varying in length from 15 to 19 weeks. During the last term of the fifth year, the two alternate groups are reunited at school to complete the requirements for the M.S. degree.

Instruction is continued during the work periods by classes conducted by the school staff. The work periods are given all by one company for a given student, although several companies have entered the Plan. The students are thus trained for the business and usually enter the concern at which they obtained their experience. During the work period, two school subjects are conducted after working hours and are completed for credit in four work cycles. This permits enough credits to obtain the two degrees at the end of five years. The hours spent total 11 per week in two periods per week.

The M. I. T. Plan, keeping in mind its aims, offers the advantage of a trial period for the candidates. Only those who successfully complete the first two years, thereby demonstrating their interest in and adaptability for, an engineering career, are eligible for the co-operative train-

* Co-operative Courses: Their Development and Operating Principles. A.I.E.E., July, 1930.

ing. Selections are the joint responsibility of the college and the co-operating company.

It is the practice at some colleges to broaden the outlook of the student during his work periods by supervised reading and report writing. At Drexel, this plan has been admirably worked out. During each of the seven work periods, three books must be read and reported, ultimately covering all twelve selected subjects such as economics, history, travel, religion, psychology, biology. In other words, the fields are chosen deliberately outside of engineering. It is reported that 80% of the students read more than the required minimum, and in addition have formed an Industry Club for the discussion of cultural subjects.

Some schools have recognized the 15 months' plan, in which the student leaves school after the junior year and spends 15 months in industrial practice, returning to finish the final year. This procedure is sometimes followed by the student for financial reasons, apart from any educational motive. Taken by itself, the 15-month work period can hardly be called a co-operative plan of education, unless there is real co-ordination between school and factory.

There are inherent virtues in both the Cincinnati and M. I. T. types of plan, and both have been successful in several schools. This has been attested both by the college and by the co-operating industry. Representative of the many favourable opinions of industry is the paper by A. S. Hotchkiss, Director of Training, Tennessee Coal, Iron, and Railroad Company, " Our Purposes and Aims in Employment of Co-operative Students."* He states that the present improvements in educational methods can be greatly aided by the tremendous facilities of industry used as a laboratory for co-operative learning. Co-operative work shows up what a diploma does not. It brings out the following bad points, if existent, in sharp relief: the wrong attitude toward work, habits of carelessness, tendency to absences, lack of mental and physical alertness, abuse or waste of equipment, slow learning rate. On the other side, it will show energetic attack, acquisition of poise, discipline of mind and body, appreciation of the feelings of others, refraining from " frank " criticism, and a co-operative spirit.

We wish now to present a description of a new co-operative plan devised by the Westinghouse Electric & Manufacturing Company and the Carnegie Institute of Technology, and put into operation in 1938. Before starting, let us re-examine the goals of engineering education aimed at industrial positions.

Much has been written on the subject of engineering education, setting forth the proposed objectives. We will not now repeat an extensive treatment of the subject, but give a few high points which have been found important. A negative approach might conceivably be made to what is wanted in young engineers by listing what we know that we want to avoid. Thomas Spooner** analyzed the apparent causes for failure of young engineers from a large number of case histories and found only a small proportion of failures were from lack of technical training. He notes the following negative attributes: lack of co-operative ability, diffidence, unimpressive personality, lack of initiative, inability to sell one's self, lack of ambition, lack of resourcefulness, lack of analytical ability. The opposites of these defects seem to be remote from the content of an engineering curriculum, but are of vital interest to industry, particularly for leading positions. Admitting that the reverse of these characteristics is desired, can they be produced by engineering courses or by any type of education? Some believe that a man either has acceptable qualities or does not have them, and that no amount of training will create something that does not exist. Carl Snyder in his book, *Capitalism the Creator,* devotes considerable space to proof of the universality of inequality—that resources of nature and abilities in man are inherently poorly distributed, according to Pareto's Law, and no amount of human muddling can change the unequal division of nature's bounties. If we were to accept this fully, all we can do, then, is to develop a satisfactory means of selection of the leaders and relegate the rest to mere existence. But most of us are not quite that despairing of human intelligence. Frequently human minds remain incompletely developed until some impulse stirs the native abilities most of us possess. Snyder admits that each of us has some ability, probably, to do some things better than the average person can; and the hope of civilization lies in discovering what each of us can do best. This is relevant to the square peg and round hole concept. The very word " education " implies a " drawing forth," presumably of something we already have. And so, technical education involves first the selection of men having innate abilities above the average in technical fields and then a drawing out or developing by various means of encouragement and stimulation. If there is sufficient exposure of the promising student to industrial conditions and problems and a guidance in tying in the formal study with its application, more rapid development of the man is attained, provided that a suitable subject has been selected in the first place.

One thing a co-operative course can accomplish is a prompt adjustment of the student to industrial life. Often a student entering his first job is bewildered by the situation in which he finds himself. The routine of school life with direction at every point is cast aside. He is thrown in with people who know the job better than he does and know short cuts through daily practice. He has to make his own decisions, small ones at first, but nevertheless by his own thinking, and is hesitant to act thereupon. He begins to work with things that count in dollars and cents. No longer are the problems mere exercises or play. It is the difference between a child's world and a man's world. He is often bewildered by the complexity of the daily picture, why things are done in a certain way and how the complex organization functions. Recognizing this state of affairs, many firms hiring engineering graduates have a training programme designed to bridge this gap, a procedure long ago proven to be worth its cost in time and money. If this readjustment can be made during the school years through co-operative training, much is to be gained. Such a plan permits a gradual and controlled initiation into the ways of industry, to the advantage of all.

Another advantage of co-operative education is the mutual education of the educators. Often industry understands little of the process of administering a college; and likewise, many college staffs have slight acquaintance with the " work-a-day " world, a condition less marked in engineering colleges, however, than in other types. When both sides have a hand in preparing a student for his job, entering into the plan with whole-hearted understanding, the best known to both sides can be effectively combined.

The Westinghouse-Carnegie Co-operative Scholarship Plan, inaugurated in 1938, was patterned after the selective scheme. Representatives of the Westinghouse Company and the Carnegie Institute of Technology undertook an extensive study of possible alternatives and developed the present plan of procedure. The aim is to select and train a limited number of exceptional students, with the hope that several will rapidly develop into the leaders of the future. Some people have claimed that there can be an excess of opportunity which turns young men's heads, creating a sense of snobbish superiority. This might happen with some students, but such a result would cast suspicion on the method of selection of

* S. P. E. E., June, 1938.

** " Characteristics of a Group of Engineers," A.I.E.E., Dec. 1934.

candidates. If the best that can be offered in the curriculum, supplemented by the best that can be given in industrial experience, fails to produce superior men, the blame can be placed on a lack of knowledge of how to select candidates, a possibility which cannot be ruled out when we consider the inexactness of our methods of mental measurements.

The financial obligation the Westinghouse Company undertook in this programme consisted first of an endowment sufficient to establish a professorship of engineering for the supervision and correlation of the Plan. Second, the Westinghouse Company offers ten co-operative scholarships each year, with a total value of $3,420 each. In addition, responsibility is assumed for placing the students in work which is adapted as far as possible to the training planned by the George Westinghouse Professor of Engineering, for the individual student.

The Carnegie Institute of Technology assists in selection and rating of the candidates and enrolls the scholars in the regular engineering courses. It accepts the summer factory experience as substitution for any summer shop or laboratory work usually required on the campus.

The scholarships, ten of which are awarded each year, cover a period of five years, during which time a four-year engineering course is completed and two years of industrial experience accumulated. Each summer, including the months between graduation from high school and entering the Carnegie Institute of Technology, the scholar spends at a Westinghouse plant. In addition, he leaves school in the middle of the junior year and spends a full year in the factory, returning to finish the remaining one and one-half years. During the whole period of five years, the Westinghouse Company pays the scholar a monthly stipend starting at $50 per month. At graduation there is an expectation that the engineer will enter the employ of the Westinghouse Company if he so desires, but there is no stated obligation on either side. When the plan is in full operation there will be fifty men in training, for which the Westinghouse Company is paying $34,200 a year as an investment to produce future leaders.

Early each year announcement of the scholarships is publicized through Westinghouse offices all over the United States. The process of selection of ten boys from the hundreds of applicants then starts with a comparison of high-school records. Most of the boys stand near the top of their high-school classes, and a choice on this basis only is difficult to make. One straight-A record looks about the same as another. Considerable attention is given to participation in student activities and outside interests such as publications, sports, etc. In the application the boy is asked to describe some technical device as an indication of his aptitude in engineering subjects. After all the records are collected and compared, about 150 of the most promising candidates are selected for an examination. This test is of the mental aptitude type and is given on the same day at as many as 50 locations over the United States under the supervision of a Westinghouse representative. These two criteria (high-school record and examination) constitute the basic means of selection; but to these are added several others. Letters of recommendation are considered, and personal interview of each candidate is used as an essential procedure in bringing out some personality factors. Some effort is directed toward obtaining good geographical distribution of the candidates, other factors being equal. It is advantageous to both the Company and to Carnegie Tech to have representation from many sections of the country.

Among the present 30 scholars, 6 are from Pittsburgh and vicinity, 8 from Pennsylvania outside of Pittsburgh, and the remaining 16 from 10 states spreading from Washington to New Jersey and from Wisconsin to Georgia and Texas.

The selection of courses by the successful candidates has embraced most of the engineering courses offered, as segregation of the present 30 students shows:

Chemical Engineering	5
Electrical Engineering	8
Management Engineering	5
Mechanical Engineering	8
Metallurgical Engineering	2
Physics	2
	30

We come now to an attempt to evaluate the results attained thus far. One tangible criterion is the scholastic grades made by the scholars. By that standard, the record is good. Translated into factors (4.00 maximum), the first two groups have established the following averages:—

1938 Group	
First Year	2.85
Second Year	2.81
1939 Group	
First Year	3.44

At the end of the first year, the 1939 Group captured the four top places in their class, and all ten were in the highest 20%.

The campus activity interests of the Westinghouse Scholars have been varied and many. Encouragement has been given to active participation in something for every man, in accordance with his natural talent or tendency.

Activities of 1938 and 1939 Groups (20 Men)

Activity	No. of Men Participating
Class officer	1
Dormitory officer	4
Fraternity offices	3
Undergraduate honoraries	3
Y. M. C. A. Cabinet	4
Publications	13
Musical Organizations	7
Camera Club	2
Debating	2
Rifle Team	2
Hockey	1
Basketball	1
Tennis	2
Swimming	2
Misc. Social Activities	4
Intramural and Dormitory Athletics	12

The industrial assignments during the summers have covered three general locations: laboratories, engineering offices, and factory offices. Several students have had interesting experiences in the Research and other laboratories. One worked on the Westinghouse atom-smasher, helping make adjustments and measurements during its assembly. The job ranged from setting up electronic measuring circuits for counting electrons to cleaning soot out of the tank after an accidental fire occurred in some insulation. Although the metallurgical knowledge of a high-school student is obviously limited, one boy found himself in the summer before entering Carnegie preparing single metal crystals. Measuring the electrical properties of new organic compounds rather had one fellow in over his depth, but after he returned to school the principles of Physics and Chemistry took on new meanings. The uses to which Analytical Chemistry can be put in the inspection of incoming raw materials occupied the time of a young Chemical Engineering student. Another job was to follow through in the shop the trial of a new insulated wire and see what troubles were encountered.

Some of the Management students have helped study costs of manufacture. What are the parts of which a device is made, and how much does each operation cost? Is there a means of eliminating a machining operation, or can two parts be fastened at one operation? Another factory job was finding possible applications for newly discovered or developed methods. A new type of brazed joint was thought to be excellent for making tips for contactors. Would it be satisfactory and save money?

Students in the engineering design offices have acted as messengers, going all over the shop for drawings, correspondence, or information. Some have had experience in drafting and others in working with drawings, learning how they are made and used, and how the necessary clerical system of numbers on drawings functions. Translating experimental data on new designs into quickly comprehended curves helped another student to learn the language of expressing engineering facts. Some design experience included the calculation of critical speeds of machines, using some of the short-cut methods that have been evolved. Estimating the weight of machine parts from the drawing proved to be an interesting job.

This last summer, six of the students were sent to Westinghouse plants in other cities to get experience on specific subjects. Two were interested in large quantity production. Another wanted to find out how transformers were built. From such assignments the organization and operation of a large company can be studied.

In all this work the department heads at the plants have taken a keen interest and have paved the way for a maximum of useful experiences; but the boys obtain no special favours and are expected to put out a day's work the same as regular employees. Adjustment to the ways of industrial life is gradual, and the students get to feel at home among factory and office surroundings.

It has been noted that this practical experience has motivated the subsequent school work. The uses to which technical information is put become apparent; and, more important, the need for more training is emphasized. Every day a new problem is met, and the answer requires information the student does not have. He feels he wants to learn more on specific subjects, so he will know why certain devices behave the way they do. Perspective is increased notably, and all the various subjects become integrated into a harmonious picture. The effect of some of the summer work has been decisive in steering the students' programmes. Some have found confirmation of their original interests, and others have had an awakening in new channels sufficient to warrant a change of course.

Four of twenty scholars changed courses at the end of the first year because of new interests brought out by their experiences.

We feel fully confident after two years' operation of the Carnegie-Westinghouse Scholarship Plan that we have embarked on a successful venture, and that some of the admitted difficulties in engineering training may be solved by a process of learning which includes us all. Carnegie Institute of Technology will have a more adequate appreciation of the problems and needs of an industry, and Westinghouse will learn that the education of engineers is not all football and vacations.

DISCUSSION

J. Harrison Belknap*

Dr. Miner's paper is so complete that I shall not attempt to cover more than the mechanism of the plan.

Each year as we make our arrangement for the selection of the ten scholars, we seek the help of our district offices —located in all principal cities—in spreading the announcement of the opportunity to the high schools of their areas. In this action we obtain a remarkably large coverage but, through the personal effort of our Westinghouse associates and others, a still larger spread of information concerning the scholarships is had.

Applications received from all sources by Westinghouse are next sent to the Registrar's Office at Carnegie Institute of Technology. The grades as reported on the transcripts are weighted in terms of the high school standing and, after due consideration of all points in connection with the student's academic record, a numerical value is affixed to the application.

The first elimination of application papers is on the basis of the Carnegie requirements as agreed upon when the plan was developed. During the past year we considered only those applicants whose grades were above 3.4, 4.0 representing a straight A record. This plan without question eliminates all who would not be found in the upper 15% of their respective classes.

Dr. Miner has briefly mentioned our consideration of the extra-curricular activities of the student. We do give the participation in significant high school student body and class activities a very careful examination and look to the testimonials submitted by the applicants' teachers and others for supporting evidence of well-rounded characteristics. The high scholastic standing of the great majority of the applicants justifies critical consideration of other characteristics, aptitudes and interests.

After the second step in eliminations mentioned in the foregoing, competitive examinations are arranged for as many geographical locations as are necessary to meet the requirements. Last year groups of from 1 to 95 were given the examination in 42 different cities. The examinations were administered in accordance with a carefully prescribed plan by a Westinghouse representative assisted by a local high school principal.

The careful comparison of examination papers, high school records, outside activities, aptitudes and interests results in the appointment by Westinghouse of 10 George Westinghouse Scholars. In the final selections consideration is given to the interests of the candidates as related to the typical Westinghouse requirements from the various classifications such as electrical engineering, mechanical engineering, metallurgical engineering, etc.

I may emphasize that we operate with meticulous care as we proceed through the various steps leading to the appointments. All applications are acknowledged and all candidates are advised of their standing. Notices of acceptability for appointment are made by telegraph and confirmed by letter with complete advice as to reporting. The parents have a part in the final arrangements.

It may interest you to know that all out-of-town scholars are met by a Westinghouse representative upon their arrival. Assistance is given as they locate rooming accommodations and finally a wire is sent to the parents advising of their son's location in our community. I can assure you a definite personal interest in the welfare of the newcomers is evident.

The first day at the East Pittsburgh plant is given over to an explanation of the initial assignment, a trip through the factory, a group meeting with the older scholars, a luncheon and finally a personal introduction to the one under whom each will serve during the first summer.

A little later the several groups are called together for a garden party at which time the individual scholars give a short report of their activities on their first assignment. Assemblies for the purpose of "seeing what the other scholars are doing" continue throughout the summer. These informal meetings are of real benefit as a part of the plan of orientation. Facts uncovered as the "work and learn" programme continues, together with counsel with

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the "older heads," enables the scholar to judge as to the correctness of his choice of engineering field. Changes in programme may be made, and factory experiences may be altered accordingly. There is complete flexibility in the plan.

Finally as the plan continues into the 3rd, 4th and 5th years, there will be complete co-ordination with our graduate student programme, as the groups, upon the completion of their academic preparation at Carnegie, will indeed become an additional source of technical personnel. We believe that the scholars will be entirely oriented and definitely productive after graduation. Westinghouse is very glad indeed to be associated with Carnegie Tech in this new co-operative arrangement.

THE ENGINEER AND THE POST-WAR PERIOD

E. R. JACOBSEN, M.E.I.C.

The Atlantic Charter

Prime Minister Churchill failed to show up for a christening and President Roosevelt had gone fishing. For three days they conferred somewhere in the "gray reaches" of the North Atlantic. True, their general staffs also conferred, but the announced result of this historic meeting was the now famous "Charter of the Atlantic." Previously, it had not been considered quite the thing to discuss war aims beyond the patent necessity of winning. But ordinary people everywhere had not forgotten the frustrations and disillusionments of the last twenty years. They knew that we must do more than win. We did that much last time. And so the Atlantic Charter is the promise, for free and conquered peoples alike, not only of victory but of a better world. It is the recognition of the fact that men and women will fight better and endure more if they are given a vision of a brighter future and the assurance that practical steps are being taken to implement that vision. Serious and detailed discussions of our post-war plans are now coming to be recognized as an essential part of our war effort and an important contribution to our morale.

Quite apart from the psychological value of starting our post-war planning now, there are also the most urgent practical reasons. We dare not wait for victory before starting the foundations for a better world. By the time victory is won, much of the world will be exhausted, depleted and embittered. The tension and unity and enthusiasm of a great effort to meet a great emergency will be lost. The problems of survival may eclipse all others and the chaos which would attend an unplanned transition might well provide the opportunity for which extremists with no love of democracy are even now laying their plans. Further, the problems which will await the decisions of free peoples will be so unprecedented and so far reaching that only a long period of education and preparation will make correct decisions more sure and prevent the hesitation and division which would open the way for the demagogue.

A Job for Engineers

The post-war period may be divided into two phases. The first has to do with the transition from war to peace. This phase includes the most obvious and immediate problems which, to a certain degree may be studied from a national or even local point of view. Upon the success with which these problems are solved will depend our opportunity to join with others in facing the second phase—the great task of producing a better world. Local economic collapse and dislocation would immeasurably complicate the more important long term problem. Further, there is the danger that such collapse and dislocation might be used as a pretext for converting the extensive governmental controls made necessary by total war into the permanent machinery of a totalitarian state.

It is becoming more and more clear that only a carefully planned programme of capital expenditure on a scale at least commensurate with our war-time expenditure will suffice to tide us over this dangerous period. At this point, it should be repeated emphatically that the problems of reconstruction will demand solutions far beyond a mere physical construction programme. What is being urged in this article, however, is the suggestion that such a programme if properly planned, will bridge a chasm into which all our more important plans might otherwise collapse.

Such a programme of capital expenditure should arise in part from governmentally inspired public works, in part from capital expansion on behalf of private investment, and in part as the result of enterprises springing from technological advances or pioneering ventures.

It is very probable that in the early stages of the post-war period, the state will be called upon to assume the major portion of the burden. But it would be unwise to rely entirely upon the conventional type of public works programme, especially if it were improvised at the last moment. Such a solution might tend to prolong governmental bureaucracy; it would delay the return to normal peace economy; it would increase the burden of taxation; and it would be at least subject to the dangers of patronage and partisan short-sightedness. Nevertheless, the government and the public who support it should be persuaded that public expenditure must continue with little diminution from the war-time level for several years after the war. This expenditure should be so skilfully planned and directed that it will then taper off in such a manner that private business may be encouraged to take up the difference.

Private industry, once assured of this type of co-operation, should be willing to start planning its own capital expansion now and to begin putting it into effect as soon as the war is over. The extent to which such private initiative can be persuaded to supplement governmental initiative will be a direct measure of the speed of our return to normal conditions of peace-time production.

Apart from capital expenditures for the extension, improvement, maintenance and repair of our present plant and equipment, what new developments will Canada need and support? What technological advances in Canadian engineering might contribute to her advantage? How are we to use our unharnessed water power? How are we to open up our great North West? How can we use synthetics and plastics and the soy-bean to bring industry and farming closer together? Are we to try to attract the bombed industries of Britain to rebuild in Canada? What special development in low-cost housing might result from the conjunction of Canadian weather and Canadian ingenuity? What are to be the peace-time products of our greatly expanded chemical industry? What are the engineering implications of the Hyde Park and Ogdensburg agreements? Writing in the Carnegie Report,[1] Eugene Staley

[1] Report of the Commission to Study the Organization of Peace, *International Conciliation*, April, 1941.

says, "All over the world there are tools to be made and installed, roads to be built, swamps to be drained, rivers to be controlled, waterfalls to be harnessed. It is probably in concerted efforts to do this job that the peoples of the world stand the best chance of finding what William James called the moral equivalent of war." Now Canada is one of the great exporting nations of the world. Are Canadian engineers technically and psychologically prepared to take a commensurately important place in the international field?

Public works and private investment and technological advance cannot and should not be considered in separate categories. All of them require long and careful advance planning and their very interdependence adds to the problem. Committees and reports and recommendations on reconstruction, valuable as these are, are not enough. By the time the peace is signed, there should be in vaults across Canada—in the vaults of architects and engineers, government and municipal departments, engineering and contracting firms—completed plans and drawings for all manner of necessary projects. Sites should be chosen and surveyed; land purchased or appropriated; estimates made; methods of financing worked out and even the allocation of work planned in advance.

The Problem of Control

Another very important aspect of the problem which will demand careful thought and pre-arrangement is the constitution of proper controlling authorities. Problems of control will be far beyond the capacities of the town council or the local politician. Just in this connection, it may be that the discovery of the proper type of decentralized control board, with specialized functions, working autonomously within a given framework, will furnish the middle way between the extremes of an unplanned chaos and the despotic centralized state. The British Electricity Board, the B.B.C., the London County Council, the Port of New York Authority, the Ontario Hydro, or the Tennessee Valley Authority may well be sign posts pointing the way to a new type of democratic control. If so, it is significant for engineers to note that they are all primarily engineering undertakings.

Of course, it would be very foolish to underestimate the difficulties involved in the above recommendations. The author's indulgence in dogmatic statements—far from being a measure of the simplicity of the problem—is directed merely to the ends of brevity and provocation.

British and U.S. Plans

It is not the purpose of this paper to pursue this subject much beyond the stage of easy generalities. We might, however, sketch in a few outlines.

The first step which suggests itself is the critical examination of all projected non-war work with a view to seeing whether it could possibly be postponed. Indirectly, this is being done through the medium of the various material control boards. A study of the rate of deterioration and obsolescence would be a useful guide in laying future plans. In listing new works which might be embarked upon with profit or social advantage, the whole field of both public and private enterprise should be canvassed. In Britain, where this problem is being taken very seriously and where no fewer than three cabinet ministers are charged with post-war planning responsibilities, they are laying down construction programmes ranging up to thirty years in the more severely bombed sections. In the United States, the National Resources Planning Board was set up by the Executive Order of President Roosevelt who has recently called upon it to work out a six year "post defense" programme. The *Engineering News Record* quotes its basic objectives as follows:

"In order to provide a 'shelf' or 'reservoir' of public construction projects of tested value, the National Resources Planning Board recommends:

1. Continuous and invigorated efforts to secure the preparation of six year programs or capital budgets by federal agencies, state governments, and other agencies, public and private, anticipating a large volume of construction activity.

2. Development of alternative lists of projects included in the six year programs according to size of the project, types and location of skilled and unskilled labor involved, materials needed, rapidity of beginning, and flexibility of termination.

3. Immediate inauguration of surveys, investigations, and preparations of engineering plans and specifications for selected projects through allocation of aids to federal and non-federal agencies from a revolving fund to be administered by the President through his executive offices; and reimbursed to the revolving fund as part of the cost of contruction of the project."

More specifically charged with the task of "post defense" planning is the newly formed Public Works Reserve Board.

Financing

The cost of financing post-war planning might be regarded as a legitimate part of the cost of our war effort. Compared with the vast cost of the war, it would be a very small part and might well pay for itself many times over as a sheer investment in morale. The "revolving fund," mentioned above, is a self liquidating scheme. There is also a bill at present before the U.S. Congress which would authorize the making of financial advances for future planning.

Engineers Too Busy

One of the most obvious difficulties is that engineers already have more work than they can manage. About the only answer to this is that we usually have to choose the busiest man to do the extra job. In the past, engineers have either been too busy to worry about their responsibilities to themselves and society or they have had nothing to do except reflect that opportunity had again passed them by. It is said that this is an engineer's war.

Problems Being Closely Studied

In closing, it should be pointed out that leaders in Canadian life are keenly aware of these problems. As chairman of a national committee on post-war reconstruction, it has been part of the author's task to find out what is being done in official, semi-official and private circles in respect to post-war planning. His bibliography of books, reports, publications and articles on reconstruction already covers four closely typed sheets. An entire article could be written on the important beginnings already made in what may prove to be a movement so essentially democratic that the very future of democracy will depend upon it. But the most inspired leadership is powerless under democracy if it has not the support and encouragement of an educated and a roused public opinion. This time, leaders with vision must not be repudiated by their own people, nor should the leaders be allowed to proceed in ignorance of their peoples wishes and intentions. This article suggests that engineers should take an important place in helping to build an educated public opinion; it carries the implication that engineers will be called upon to be the shock troops in our own "peace offensive" and makes the plea that they be not found wanting.

Editor's Note:—The author has made available to Headquarters a limited number of copies of a bibliography on the subject of this paper. A copy will be sent, upon request, to members of the Institute who may be interested.

Abstracts of Current Literature

Abstracts of articles appearing in the current technical periodicals

THE 40-mm. ANTI-AIRCRAFT CANNON

By Major Daniel J. Martin, Ordnance Dept., U.S. Army

From *Army Ordnance*, Nov.- Dec., 1941

The funnel-mouthed Bofors 40-mm. " automatic field gun " has inspired international acceptance probably quite beyond any dreams of its designers—if cannon designers may be said to dream hopefully for popularity of a product. The gun already was in production by Bofors in Sweden when the Spanish War demonstrated the truth of a long-held military conclusion: that intermediate calibre automatic cannon would be a requisite in future action for defence against low-flying aircraft.

Great Britain has continued to be partial to the 40-mm. Bofors gun, and there have been many published reports attesting its efficiency and reliability. There have been stories that it was this gun in great numbers which enabled the British to make their successful withdrawal at Dunkerque. There are others which attribute the loss of Crete to absence of these weapons. Still others report that German fliers shy away from areas known to be protected by 40-mm. Bofors guns.

In 1940, the 40-mm. Bofors gun was the subject of exhaustive tests at Aberdeen Proving Ground, Md. Results of these tests, together with authoritative information on their European performance against low-flying aircraft, combined to effect standardization of a gun of this type by the Ordnance Committee early last spring as the " U.S. Army 40-mm. gun M1."

Contracts for manufacture of the gun have been awarded and the first pilot models were turned out in early summer. The Chrysler Corporation of Detroit has the prime contract for the gun and the Firestone Tire & Rubber Company of Akron, a prime contract for the carriage. Chrysler is sub-contracting its work throughout its large organization, and Firestone has spread its work among 368 subcontractors.

It has been widely known for some time that aircraft most dangerous to field forces do not fly high. Moreover, bombardment of cities and industrial areas has been conducted for months at low and intermediate altitudes, as well as from greater heights. Higher aircraft speeds and aircraft armor also are considerations. The 40-mm. Bofors antiaircraft automatic cannon (termed by the manufacturers the " 40-mm. automatic field gun ") has proved itself under these conditions of aircraft attack. The object of its fire is to put aircraft out of action by direct hits. Its shells are detonated instantly on impact. " Point-blank " fire is made possible by tracking aircraft with reflecting sights and adjusting the corrector with great accuracy. Use of tracer shell permits making necessary corrections and observation of the shell group near the target.

Fire is usually in bursts of four to five rounds, full automatic. The gunner may use further continuous automatic fire if his observations show it can be effective. High muzzle velocity, 2,850 ft. a second, results in a virtually straight trajectory up to about 3,280 yds. Short firing time makes it possible to regulate the fire quickly. This is now necessary because the faster bombers remain within effective range for not more than ten seconds. The sooner the bursts reach the target, the more rapidly can any necessary corrections be made. The 40-mm. Bofors gun can be aimed with great rapidity before an attack made at extremely short range can accomplish all the intended results.

General data of the 40-mm. gun are as follows: Rate of fire, 120 to 140 rounds a minute; weight of gun in firing and travelling position, 4,300 lb.; maximum range, 11,000 yd. horizontal; weight of projectile, 2.205 lb.; weight of powder charge, 0.628 lbs.; weight of fixed cartridge, 4.63 lb.; muzzle velocity, 2,850 ft. a second; vertex for time of flight of 11.5 sec., high-explosive tracer shell, 5,391 yd.; range for time of flight of 11.5 sec., high-explosive shell, 5,413 yd.; gas pressure, maximum, 42,630 lb. per sq. in.; elevation field, minus 5 deg. to plus 90 deg.; traversing field, 360 deg.; length of recoil, 7.874 in.; wheelbase, 125.98 in.; maximum vertical range for 11.5 sec., 5,391 yd.

Following are the general characteristics of the gun: the barrel is provided with a counter-recoil spring and flash hider. The latter prevents the flash from blinding the crew, particularly during night firing. The barrel has no water jacket, and the counter-recoil spring consists of a cylindrical coil spring installed around the barrel. The front of the recoil spring bears against a nut screwed to the barrel and the rear of the spring bears on a washer housed in the front casing. The muzzle is conical and its exterior is provided with a screw thread for the flash hider. The bore consists of the chamber, the transition cone and sixteen rifling lands.

"WITH GOOD CONFIDENCE"

From Robert Williamson, London, Eng.

Mr. Winston Churchill has written to the Federation of British Industries expressing the Government's gratitude to all sections of industry for their war effort.

The Prime Minister was congratulating the Federation upon the twenty-fifth anniversary of its formation during the Great War. A message from the Grand Council of the Federation expressed their sincere and heartfelt admiration for Mr. Churchill's leadership and courage during these stern months.

" They assure you," it ran, " that the F.B.I., which came into being in the midst of the last Great War, is proud once again to help in the marshalling of the forces of production to the single end of victory.

" They recognize that in this great struggle for liberty the ' workshop front ' has a vital contribution to make. Industry is determined, under your inspiring leadership, to carry out its part in the double task of equipping the fighting forces with the instruments of war and maintaining in health and all possible safety the normal life of the nation."

In reply, Mr. Churchill said: " Thank you for your kind message, which I greatly value, and which will be a source of encouragement both to myself and my colleagues.

" In conveying to the Grand Council of the Federation of British Industries my warmest congratulations upon the 25th anniversary of the foundation of the Federation and upon its many achievements in the industrial field since it was first set up, I shall be glad if you will also express the gratitude of H.M. Government for the magnificent contribution which all sections of industry have made and are making to the war effort.

"We value their counsel, we welcome their advice and assistance. Our fortunes in the struggle in which we are engaged depend no less upon the industrial than upon other aspects of our effort, and if we all pursue our course in the spirit of co-operation which animates your message, we may march forward with good confidence."

PERSONNEL AND WAR PRODUCTION

Excerpts from a speech by Mr. Ernest Bevin, Minister of Labour and National Service, at the Institution of Production Engineers' luncheon, Friday, September 26th, 1941

From *The Engineer*, (London), October 3rd, 1941

I was very interested to note that you have adopted as one of your principles that, as a scientific organization hours and conditions of labour were no concern of yours, but that the training and the use to be made of labour were matters to which you could properly devote your attention. In so far as the payment of wages is concerned, it is no doubt a wise decision, but I should like to have seen more attention paid by the production engineering organizations to the working out and application of an optimum labour effort. In my view, sufficient attention has not been paid to this subject, neither has there been due consideration of the fact that workers have had to carry on through two "black-out" winters with long hours on intense production. What has been proved, however, is that serious difficulties have been caused in the world of production during this past year by irregular hours, some of them necessarily due to the circumstances of the moment, but others enforced and operated without regard to the most precious and valuable of all machines —the human. I have done my best to get industry to pay more attention to this matter, for I was convinced that the long hours that were expected of the workers were having a bad effect on our total production. It seems to me that in war this question of optimum hours is not so much one of bargaining but one demanding a scientific approach which takes account of all the factors involved at any given time, and recognizes the need for adjustment as those factors change. Those responsible for the direction of production should quickly, energetically, and scientifically deal with the problem and make such adaptations as are necessary in order to preserve the physical strength of the human being, his morale, and create the feeling that the well-being of the industrial army is being properly taken care of. I have been reluctant to make Orders on this question of hours because they tend to become inflexible, and cannot be changed quickly enough in wartime to meet necessary changes—changes which may not apply universally, as legal Orders, of course, must.

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I particularly want to place before you my conviction that in designing, planning, and working out the proper utilization of our productive units there is an imperative necessity for much closer collaboration between the personnel manager and the rest of the executive, including the production engineer. The functions are equally important; the best of plans can be totally upset and much effort vitiated if the important human factor is not adequately considered and measured as a part of the general plan of production. In fact, there should be constant collaboration, owing to the changes that war produces.

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In the lay-out of this war effort there was not sufficient attention paid to the personnel problem. It took us a long time to get industry as a whole to appreciate the need for proper canteens, to imagine what "blitzes" would be like, or to have regard to the very severe nerve strain that would follow air attacks. I emphasize this now because, although we have had a respite, we shall have to face it again, and the longer the war goes on the more necessary it becomes to pay greater regard to this personnel side of the industry. The absence of a proper understanding of the problem has been one of our greatest handicaps in this great struggle. Remember, thousands of people have had to be moved, their homes broken up, and billeted sometimes under conditions that were not too good. All these factors have a bearing on the inevitable human problems which are bound to arise; hence my additional plea for the personnel manager, who should be specially trained, to have an equal position in industry with other members of the executive. Indeed, I am sure that our post-war position will be materially helped and the future of British industry enhanced by a full appreciation of this important fact.

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It is well to remember in this mechanized war that our factories and productive capacity are pitted against not merely those of Germany, but also those of the countries the Nazis have over-run. We have a smaller population, our raw materials have to be brought from overseas, and, in addition, the enemy had many years' start. Therefore, if this deficiency on our side is to be made good and parity reached, spasmodic effort is not enough. It may serve as a momentary stimulus, but its effect is not usually lasting. The factors that will count are the timing, flow of materials, components, and the sustaining of effort over a long period with a continuously increasing rhythm. Nothing, I suggest, is so irritating to the workpeople as to be screwed up to a great pitch and then have a period of reaction and slack work and idling. A study of the curve of production over a period of months reveals that the final result achieved by spasmodic effort is not so good as that resulting from well-organized and sustained effort.

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It is sometimes not appreciated that we started this war with a dearth of really skilled people, and we have been compelled to ration them out so that we can maintain production and at the same time open up new factories and train more workers. We created labour supply committees, training establishments, labour inspectors, and everything that human ingenuity could devise to try to make good our deficiency. As the programme expands, and it must expand more and more, I must ask everyone responsible for production to turn his attention to getting the greatest possible use out of our total available skill. The differences in achievement in this direction are very striking. The ratio of skilled people to trainees and others in one works doing the same operation may be much larger than at another, and it is essential to establish a standard that will guide our inspectors. This is an aspect of our problem which production engineers might profitably consider in the light of the war development, and the great need for distributing our skilled labour to the best advantage, and thereby give us the advantage of any recommendation they care to make.

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I am sure, to a gathering of this kind, there is no need for me to emphasize the imperative necessity for more training. At this point I would like to say how much it has been borne upon me since I have had to deal with this man-power problem what a great mistake the State made in maintaining such a low school-leaving age for the last twenty years. How valuable it would have been to the State now if those children had been kept at school and under the control of the educational institutions of the country for another couple of years, and a portion of that period devoted to some form of training in order at least to give a basic knowledge of production, not merely in industry, but in agriculture.

* * * * * *

We have shown to the world in this war that there is virtually no such thing as an unemployable person, unless really mentally and physically incapable, if proper training is given to him and opportunity for employment afterwards. Hence the importance of the medical and nursing services as part of the production organization, and this should be linked up with treatment outside and a great national rehabilitation service. This will see to it that no producing unit is allowed to be wasted and no person who is injured as a result of enemy action or is a victim of an accident in our great industrial arena is left with a hopeless outlook for the rest of his life. It may lead to the necessity of adapting machines to the man, instead of the man to the machines, but that is not difficult, and I would ask you specially to study this problem.

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One gets a little tired of the constant demand for the return of people from the Army, and the resistance to the call to make up units to a proper fighting strength. If we listened to all the demands we would never have an Army and certainly it would never be properly trained. I assert, having regard to the task which we expect will have to be performed before this war is over, that the numbers allocated to the Services is not too large.

* * * * * *

We hear constantly of wasted efforts in industry. To what extent there is truth in it, it is impossible accurately to say, but the demand made in the productive field for man-power is just colossal. It must be remembered that when working in buildings and factories your man-power is static; you do not get a drain away continuously to provide drafts to make up wastage as you have in the Services. In other words, you do not give six months' training and then draft your people out to the Middle East or some other theatre of war, and then have to train another lot. Industry has a better chance of progressive improvement in the skill and further simplification of operations in order to make up any deficiency. Therefore I would urge that everyone responsible for production in the country should endeavour, first, to foster the co-operative spirit in the works, and, secondly, to make the fullest possible use of all available labour, and to consider, having regard to the claims made upon us, how far you can by change of methods, adaptation or adjustment reduce the demand and so facilitate the building up of a properly balanced force for a total war. In this connection I would urge that the most tremendous efforts should be made to get the full twenty-four-hour use of machine tools. I know the difficulties and the problems that confront you, but I believe if all divisions between management and labour could be broken down, the whole factor of production regarded as one service, and a right leadership developed—a leadership which produces confidence in the minds of the humblest worker—even better results than we have yet achieved would result.

* * * * * *

I am convinced there is a great untapped reserve of managerial and productive energy and drive in this country that must now be called out. It is like bringing up your reserves and this drive must be directed to a great objective. We must sustain at least a six to twelve months' drive, so as to enable us during that period to hand to Russia out of our own production, and the addition we can create, a great flow of equipment to aid her in her defence and our mutual final victory.

THE VIEWS OF INDUSTRY

From *Trade & Engineering* (London), October, 1941

The executive council feel that in view of the steps which are being taken in other directions it is essential that those who are responsible at present for the direction and control of industry should be in a position to present to the country a considered policy for the solution of the difficulties with which the industrial community, employer and employed, will be faced after the war is won. While it cannot be denied that there is a general desire to discuss the policy to be adopted after the war, it has to be remembered that no one can predict what the position will be and anything in the nature of a hard and fast policy is out of the question. Last month we drew attention to the experience of the London Chamber of Commerce in the War of 1914-18. That body set up a strong committee in 1916 to consider the policy to be adopted after the War. Three reports were issued, but in view of the unexpected turn of subsequent events it was found necessary to reconstitute the committee in 1918 to revise the original findings. We are entirely favourable to the idea of collecting all relevant information and putting it into a form in which it can be used, but it is too early to arrive at conclusions as to the form that post-war policy should take. Probably the greatest benefit will be derived from clearer definition of the nature of the problems to be solved and their extent. It seems clear that far-reaching changes are inevitable in almost every direction and it is well that men should be prepared to adapt themselves to new conditions.

FURTHER DEVELOPMENT IN FIGHTER DESIGN

By Dr. Ing. Aurelio C. Robotti. From *Revista Aeronautica*, Roma, Sept., 1940

Abstracted by *The Engineers' Digest* (London), Eng.

The impetus for a new design of fighter aircraft can be derived and justified by the needs of to-day's air warfare. In meeting these needs the designer is facing many new problems.

The advantages and disadvantages of monoplanes as compared with biplanes are now well known. Monoplanes are aerodynamically superior, while biplanes offer greater structural strength combined with lower empty weight and greater manoeuvrability. As the chief task of the fighter aircraft is to destroy the enemy bomber its speed is dictated by the bomber in both types of fighters, i.e., pursuit planes and interceptors. This requirement of superior speed necessitates the adoption of the monoplane design.

Future bombers will undoubtedly be fitted with more powerful engines and will be aerodynamically still more refined. It is strategically justifiable to reduce the safety factor, and thus to build the bomber lighter and faster.

On the other hand it is by no means an easy matter to reduce the weight of a fighter, or achieve improvements by reducing the drag. An increase in speed obtained by increasing the power of a single-engined fighter cannot be achieved without dangerously lowering its stability and lateral manoeuvrability. Neither does higher engine speed together with reduced air-screw diameter give a satisfactory solution, as the speed of sound is at present assumed to be the limit for the air-screw tip speed.

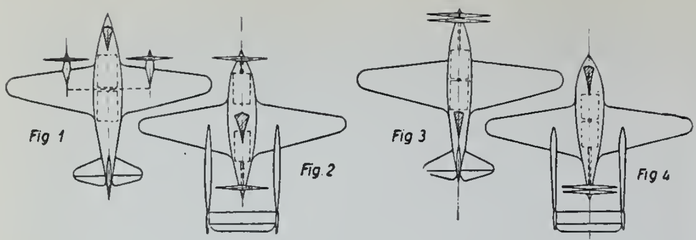
These considerations appear to indicate that the modern fighter must be two-engined, and the engine power must be utilized so as to free the aircraft from undesirable yawing and rolling which would be experienced with a single-engined fighter of the same power.

Although two-engined fighters are being manufactured by many countries, the question of engine location is far from being settled.

There are four immediate possibilities, several of which are already adopted in practice.

Fig. 1. Both engines located in the fuselage, and the power is transmitted to two counter-rotating air-screws arranged symmetrically about the rolling axis. Such a design is free from great lateral inertia which would result if the engines would be mounted in the wing.

Fig. 2. Two engines fitted so that the " contra props " are at the nose and stern respectively of the " centre-section " to which the fuselage shrinks, while booms are necessary to carry the elevator and rudders.



Figs. 3 and 4. These solutions are principally the same; two co-axial oppositely rotating air-screws are used, fitted as tractor or pusher unit respectively.

To a successful realization of these designs a great deal of development work on engines, aircraft and propellors has to be carried out.

Actually the problem of this research is that of "high speed flying" and controlability, and in the design all features affecting aerodynamical efficiency must be retained, such as retractable undercarriage, high-finish surfaces, flush riveting, and utilization of exhaust and duct propulsion.

NEW "CONTRA-PROPS"

From *Trade & Engineering* (London), October, 1941

Following the recent announcement by Rotol Airscrews, two other firms have now revealed that they have produced contra-rotating airscrews. The Fairey contra-rotating variable-pitch airscrew is the first of its type in the world to be flight tested. America, Italy, and other countries have flown aircraft with contra-rotating airscrews, but these were with fixed and not variable pitch. It consists of two airscrews which rotate in opposite directions, and the technical achievement of incorporating variable-pitch is of very considerable importance.

The Fairey Aviation Company is the pioneer in contra-rotating airscrew development in this country. Five years ago it began investigation and design, and the following year manufacture was started. On completion of manufacture hangar testing was carried out, and by October, 1939, the airscrew was through its "teething" troubles and was operating satisfactorily. The next stage was flight testing, and this began in February, 1940. Since then valuable flying experience and knowledge have been gained.

The Fairey Aviation Company, well known for its Fleet Air Arm aircraft, was from its knowledge of this type of machine fully aware of the advantages to be obtained by using contra-rotating airscrews. These advantages are even greater in the case of ship-borne aircraft, which must operate from the confined space of a deck, than for land craft. The airscrew has been designed chiefly for Fleet Air Arm work, as the contra-rotating principle enables the following advantages to be gained:

(1) A smaller diameter airscrew disk can be used, constituting a valuable asset for aircraft which have to take off, land, and be stowed in the limited space of an aircraft carrier.
(2) A shorter chassis with consequent structural gains can be employed.
(3) Swing is eliminated by the absence of torque, thus facilitating a straight take-off; this is also a great advantage when the machine is taking off cross-wind. The contra-rotating airscrews also give a straight slip-stream over the fuselage with consequent aerodynamic gain and better manoeuvrability in flight.

The Fairey airscrew is electrically operated by a single reversible electric motor. It is possible to constant-speed or stop the airscrew at any intermediate pitch. At the end of the pitch range a clever electrical device is incorporated for automatically switching off the motor. This scheme has worked very satisfactorily. The general operation is by means of gears. There is nothing complicated, as the whole unit is so designed that production presents no problems. Another point of interest is that the front and intermediate gear boxes and the airscrews can be removed as complete units. Thus, from a servicing point of view the Fairey contra-rotating airscrews are as easy to handle as other types of airscrews now in use by the R.A.F. and Fleet Air Arm. The difficult problem of lubrication has been successfully solved, and designs are available for obtaining a rapid rate of pitch change, full feathering, and hydraulic operation as an alternative to electric.

The airscrew was originally intended for a type of engine still on the secret list, but designs are available to make it adaptable for Service types of engines.

A number of test and Service pilots have flown behind this airscrew and they have all been very impressed with the performance. They have also been able to compare the flying qualities of a standard machine with that of one fitted with the contra-rotating airscrew, and they have found the rudder, elevator, and ailerons much more positive in operation. This contra-rotating airscrew has been produced for the same weight as a single airscrew which absorbs the same engine power.

PROTECTING CABLES FROM INCENDIARIES

From *Electrical Review*, London, Eng., October 17, 1941

During an air raid on Erith an incendiary bomb fell through the roof of an electricity substation, which consisted of asbestos sheeting, and dropped into a position within a few inches of the electric cables shown in the picture. The bomb remained in this position until it was completely burnt out, without causing any damage to the cables.

The interesting point is that until the war these particular cables were untreated and were carried below ground level in a trench with a wood batten cover. Shortly after the outbreak of war when the fire danger was fully realized the wooden covers were removed and the trench was filled to ground level with moist sand. The cables themselves were treated with gypsum plaster and hessian. The hessian simply forms a binder, of course, and does not contribute to the fireproof qualities.

It is remarkable that, although the incendiary bomb completely burnt itself out almost in contact with the centre cable, the cable covering is quite undamaged. The dividing box shows a deposit of magnesia from the burning of the bomb. The whole method of cable protection is extremely cheap and was carried out by the Erith Electricity Department's own workmen. No special rights of any sort are claimed for the method, and Mr. E. A. Logan, the borough electrical engineer, tells us that the idea of using gypsum plaster arose from seeing a demonstration of the ignition of thermite charges upon plaster boards. The plaster board in these demonstrations resisted the extreme heat of the thermite very well indeed, and it was explained that this was due to the fact that gypsum plaster contained a large percentage of water of crystallization which prevented the raising of the temperature on the side remote from the heating agency until the whole of the plaster had been calcined; calcination of the plaster proceeded very slowly from the outer to the inner surface.

Fifty-sixth

ANNUAL GENERAL MEETING
AND
GENERAL PROFESSIONAL MEETING

THE ENGINEERING INSTITUTE OF CANADA

MONTREAL - Thursday and Friday
February 5th and 6th, 1942

The Montreal Branch has set up a special committee under the chairmanship of W. G. Hunt, M.E.I.C., to handle all arrangements.

All sessions will be held at the Windsor Hotel.

Preliminary Programme

THURSDAY, FEBRUARY 5TH

9.00 A.M.	- -	REGISTRATION
10 00 A.M.	- -	ANNUAL MEETING
12 30 P.M.	- -	LUNCHEON—CHAIRMAN, J. A. LALONDE SPEAKER, HON. C D. HOWE
2 30 P M.	- -	TECHNICAL SESSIONS
8.00 P.M.	- -	MONTREAL BRANCH ANNUAL SMOKER

FRIDAY, FEBRUARY 6TH

9 30 A M.	- -	TECHNICAL SESSIONS
12 30 P M.	- -	LUNCHEON — CHAIRMAN, deGASPE BEAUBIEN
2 30 P.M.	- -	TECHNICAL SESSIONS
7 30 P.M.	- -	ANNUAL DINNER - CHAIRMAN, DEAN C. J MACKENZIE
10.30 P.M.	- -	DANCE

Full details will be found in the January Journal

From Month to Month

News of the Institute and other Societies, Comments and Correspondence, Elections and Transfers

THE FIFTY-SIXTH ANNUAL GENERAL MEETING

Notice is hereby given in accordance with the by-laws, that the Annual General Meeting of The Engineering Institute of Canada for 1942 will be convened at Headquarters at eight o'clock p.m. on Thursday, January 22nd, 1942, for the transaction of the necessary formal business, including the appointment of scrutineers for the officers' ballot, and will then be adjourned to reconvene at the Windsor Hotel, Montreal, at ten o'clock a.m. on Thursday, February 5th, 1942.

L. Austin Wright, *General Secretary.*

BALLOT ON THE NEW BRUNSWICK AGREEMENT

Publication of this issue of the Journal was delayed in order that the results of the ballot on the proposed agreement between the Institute and the Association of Professional Engineers of New Brunswick could be announced. The report of the scrutineers for the Institute ballot, which closed on December 5th, is as follows:

Ballot of members of Council:

Total ballots received		33
Valid ballots	32	
Invalid ballot	1	
Votes approving agreement		32

Ballot of corporate members in New Brunswick:

Total ballots received		47
Valid ballots	47	
Votes approving agreement		46
Contrary vote		1

The secretary has reported the following results for the Association ballot, which closed on December 6th:

Total ballots received	87
Votes approving agreement	80
Contrary votes	7

ANNUAL MEETING

Attention is called to the page elsewhere in this number which gives information on the annual meeting for February 5th and 6th, 1942. The decision to hold the meeting has been based on the thought that if confined to certain fields it might aid materially in the country's war effort. Accordingly, the papers are restricted to war topics.

The committee has obtained the support of the Minister of Munitions and Supply, the Honourable C. D. Howe, Hon. M.E.I.C., who has agreed to open the proceedings by speaking at the first luncheon. Papers will deal with the manufacture of war implements and *matériel,* and will emphasize the new fields into which Canadian industry and Canadian engineers have entered with success.

A feature of the meeting will be discourses on the effects of bombing and gun fire on utilities and structures. It is expected that discussion on this important topic will be led by an engineer who will have investigated the whole problem right in England. The engineering phases of civil defence in Canada have not been given the consideration which their importance would seem to justify. The Institute's decision to investigate this field is important. First hand information will be invaluable, and leadership thus provided should be helpful to the country as a whole as well as to individual communities and corporations.

The Montreal Branch extends a warm invitation to engineers all over Canada to attend this important professional meeting. Their attendance will be the reward for "a good job well done." There will be much to learn, and to enjoy. Make a note of the dates, and a resolution to attend.

INVITATION FROM THE MONTREAL BRANCH

To all members of the Institute,

On behalf of the Montreal Branch of the Engineering Institute of Canada I extend a cordial invitation to all members of the Institute and their friends, to attend the annual meeting in Montreal, February 5th and 6th, 1942. They will receive a hearty welcome.

This meeting will be of special interest at this time, since the technical portion of the programme will deal mainly with certain engineering features of the country's war activities, many of which are along lines new in Canada.

Arrangements are being made for distinguished speakers, including responsible officers from departments and organizations concerned with wartime research, manufacture of guns, instruments and aircraft, air-raid precautions and civilian defence. It is expected that those who attend the discussions will hear much that will enable them to assist in the nation's war effort.

Details of the various events arranged for this occasion will be found elsewhere in this issue of the Engineering Journal.

It should be noted that 1942 will be a good year to visit Montreal—it is the 300th anniversary of the foundation of the city—

Plan to attend this important meeting.

R. E. Heartz, *Chairman.*

REGIONAL MEETINGS OF COUNCIL

The November meeting of Council was held in Quebec city. Meetings at other times this year have been held at Hamilton, Toronto, Kingston and St. Johns, N.B.

The practice of Council meeting frequently at places other than Montreal has met with general approval. This year fifty percent of all meetings were at branches. In the last four years a similar percentage has obtained, and in that time, meetings have been held at twelve different centres. Already there are discussions about a further expansion for next year.

Regional meetings have much to recommend them. Not only are they good for Council but they are good for the branch. To such meetings are invited past councillors of the branch, past officers resident in the district, members of the branch executive, and any others who have shown a special interest in Institute affairs.

They bring together many people who are still interested but who get few chances to know of the workings of the governing body.

The excellent attendance indicates the popularity of such meetings. Not infrequently it runs to over fifty. The advantage of having the opinions of so many people on problems that affect the whole membership is great and the opportunity to give consideration to local problems is very helpful.

It is a source of satisfaction and inspiration to see so many officers of the Institute journey long distances at their own expense to attend regional meetings. At a meeting held in Halifax there were present three officers from Quebec and at meetings held in Calgary there have been as many as four officers from the east. At the latest meeting in Quebec city, there were four officers from Ontario as well as several from other branches within the province.

A continuation of this policy will do much towards reminding members all over Canada that the Institute is really national in scope.

AERONAUTICAL PAPERS

The Institute has an agreement with the Royal Aeronautical Society whereby certain special privileges are available reciprocally to members of each organization. The agreement calls for the Institute to publish, from time to time, in reprint form its papers on æronautical topics, which are then distributed by the Royal Aeronautical Society to its members.

Another "Aeronautical Reprint" is now ready. Members of the Institute may also secure copies by applying to Headquarters. All papers have been published in the *Journal*, but it may be advantageous to some members to have them in booklet form.

Herewith is a list of titles and authors:

Practicable Forms for Flight Test Reporting
Elizabeth M. G. MacGill, M.E.I.C.

Factors Affecting the Mass Production of Aeroplanes
Elizabeth M. G. MacGill, M.E.I.C.

Aerodrome Construction for the British Commonwealth Air Training Plan
J. A. Wilson, M.E.I.C.

Aircraft Engineering in Wartime Canada
Elizabeth M. G. MacGill, M.E.I.C.

Estimating Production Costs in Aircraft Manufacture
A. T. E. Wanek, M.E.I.C., A.R.Ae.S.

Air Traffic Control
Ewan D. Boyd

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

The annual meeting of the Engineers' Council for Professional Development is an important occasion. This year the Institute participated for the second time, as a member, and sent to New York a delegation which included the president, the three members of Council, and representatives on four committees.

A detailed account of the meeting is printed in this number of the *Journal*, which gives a good idea of the nature of the proceedings. From time to time as space permits it is proposed to publish the reports of various committees.

Without doubt the work of E.C.P.D. is one of the most important endeavours in the profession today. Representing as it does the senior engineering societies of North America, the Council is in a position to give great weight to all matters that concern the profession. With this backing it can call to its committees the best minds to think out the problems of professional development, and the most useful persons to place these findings before the societies where they may be used to advantage.

Already E.C.P.D. in its eight years of existence has done a great work. It has entered boldly into fields which hitherto resisted approach, and has brought order out of chaos in many matters that previously confused the minds of engineers and public alike. Perhaps its greatest achievement, in that it made all other achievements possible, is that it represents "the first wholly successful co-ordinated, co-operative institution in the engineering profession in America." The quotation is from the Chairman's Report for 1939.

The interests of the Council are shown by the names of the Committees, i.e.,

Committee on Engineering Schools
Committee on Professional Recognition
Committee on Professional Training
Committee on Student Selection and Guidance
Committee on Information
Committee on Principles of Engineering Ethics.

In reporting on behalf of the Engineering Institute of Canada, Past-President Challies who represents the Institute on the executive, called attention to the work already done in Canada towards the objectives of E.C.P.D. All Council's objectives are of great concern to Canadians, although the accrediting of curricula has not seemed necessary because of the high entrance requirements of our universities. Mr. Challies pointed out that the membership of the Engineering Institute in proportion to population was equal to the membership of all the seven other constituent organizations put together. He introduced the members of the Institute party and received great applause when he pointed out that the Institute had in attendance at this meeting every representative on E.C.P.D. and, in addition, its president and an additional past president—a total of nine.

The work of E.C.P.D. is far from finished. Ground has been broken in several fields, but it may take years of patient, intelligent endeavour to complete the selected tasks. Its interest in the finer things of the profession gives greater promise to the future of engineering than anything hitherto attempted.

"SPURIOUS"

Recently Headquarters has received several letters inquiring about an organization calling itself the Canadian Institute of Engineering Technology. The use of words almost identical with the title of the Engineering Institute has brought other letters to Headquarters that were intended for the outfit just referred to. An inquiry has revealed a deplorable state of affairs, and the purpose of commenting on it in the *Journal* is to assist in the circulation of information that may be helpful in bringing this thing to an end.

The so-called Institute of Engineering is offering correspondence courses in engineering and allied subjects. Our information is that a man named Marsh is soliciting business in parts of Quebec where there are industrial developments, such as at Arvida. Subscribers have complained that the courses were not satisfactory and they have declined to continue payments.

Inquiry at the Better Business Bureau of Montreal has elicited a reply that leaves no doubt. We quote, "Their status as a school is ill-defined and they appear to have no permanent address other than a post-office box. . . . . We have received complaints charging non-fulfillment of contract and also from persons who have been sued for the balance of their contracts."

The same organization or individuals have operated in Ontario as well, but we have before us a report from an Ontario official which shows what happened there. Again we quote, "Re your inquiry about the Canadian Institute of Engineering Technology, this is a spurious organization being promoted by Mr. J. H. Marsh. For a time Mr. Marsh attempted to do work in Ontario under the name of the British Canadian Institute of Engineering Technology but was never given registration and after some difficulty we were able to eliminate him from this Province through the working of the Trade-Schools Regulation Act. In this Province we had to resort to the use of the Courts and even the Provincial Police to put an end to his activities. As far as we are able to find out he has nothing reliable to offer and those who pay him money simply throw it away. Behind him there is no reputable organization or even facility to provide for what he claims to sell. It may be necessary for the Province of Quebec to deal with him as has the Province of Ontario."

Letters have been written by Headquarters to provincial officers urging that some action be taken to protect the citizens of this province from such persons and methods. It is suggested that members circulate this information as quickly as possible in order to curtail these harmful activities.

ANNUAL MEETING OF ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

Representatives of Constituent Bodies Report Favourably and Offer Suggestions at 1941 Annual Meeting of the Council

Most significant of the many features of the 1941 Annual Meeting of the Engineers' Council for Professional Development, held at the Engineering Societies Building, New York, N.Y., on October 30, were the reports of representatives of the constituent bodies of the Council on its effectiveness and its accomplishments. These reports were gratifying because of their favourable nature and because they afforded opportunity for individual assessments and for suggestions for future action. An attempt will be made later in this review to present the highlights of these reports.

By far the largest attendance ever recorded at a meeting of the Council was attributed to a number of guests who found opportunity to attend because of the annual meeting in New York earlier in the week of the National Council of State Boards of Engineering Examiners, one of the eight constituent bodies of E.C.P.D. Another notable fact in connection with attendance was the delegation of nine representatives of the Engineering Institute of Canada, headed by C. J. Mackenzie, president of the Institute.

Officers and Committees to Serve in 1941-1942

Officers for the year 1941-1942 were elected as follows: chairman, R. E. Doherty, president, Carnegie Institute of Technology, reelected; vice-chairman, H. T. Woolson, member American Society of Mechanical Engineers (A.S. M.E.), executive engineer, Chrysler Corporation reelected; secretary, H. H. Henline, national secretary American Institute of Electrical Engineers (A.I.E.E.); and assistant-secretary, A. B. Parsons, secretary American Institute of Mining Engineers (A.I.M.E.).

Chairman of the Council's committees for the coming year will be as follows: Committee on Engineering Schools, D. B. Prentice, member A.S.M.E., president Rose Polytechnic Institute; Committee on Professional Recognition, C. F. Scott, member A.S.M.E. (reappointment); Committee on Professional Training, E. S. Lee, member A.S.M.E., engineer, General Engineering Laboratory, General Electric Company, Schenectady, N.Y.; Committee on Student Selection and Guidance, R. L. Sackett, fellow A.S.M.E., (reappointment); Committee on Principles of Engineering Ethics, D. C. Jackson, member A.S.M.E. (reappointment).

The personnel of the Executive Committee for the ensuing year will be as follows: George W. Burpee, consulting engineer, Coverdale and Colpitts, New York, N.Y., American Society of Civil Engineers (A.S.C.E.); A. R. Stevenson, Jr., staff assistant to vice-president in charge of engineering, General Electric Company, A.S.M.E.; James F. Fairman, Consolidated Edison Company of New York, Incorporated, A.I.E.E.; C. C. Williams, president, Lehigh University, Society for the Promotion of Engineering Education (S.P.E.E.); B. F. Dodge, professor of chemical engineering, Yale University; American Institute of Chemical Engineers (A.I.Ch.E.); Charles F. Scott, professor-emeritus of electrical engineering, Yale University, National Council of State Boards of Engineering Examiners (N.C.S.B.E.E.); and J. B. Challies, vice-president, The Shawinigan Water and Power Company, Montreal, P.Q., Canada, The Engineering Institute of Canada (E.I.C.). The representative of the A.I.M.E. on the Executive Committee has not yet been announced.

Standing Committes Report Progress

Reports of the committees, which had been mimeographed and distributed in advance of the meeting, were not read, but were briefly summarized in order to afford time for the presentation of reports of delegates from the sponsoring organizations. In view of the fact that the highlights of these committee reports are mentioned in the report of the chairman to the Council, which will be reproduced in an early issue, no attempt will be made at a summary in this review. The reports were accepted and will be published by the Council in its Ninth Annual Report.

Unified Engineering Profession in Prospect in Canada

What the constituent bodies of E.C.P.D. think about its work, what their own societies have been doing in forwarding the purposes of the Council, and what might be done in the future formed the general scheme of reports presented by the representatives of those bodies.

The Engineering Institute of Canada was greatly impressed with the Council's accomplishments, said Mr. Challies, first of the representatives to report. He gave a brief summary of what the Institute had done and was planning to do to enhance the status of the engineering profession. He doubted that members of the Council had full knowledge of the Institute, which was an all-embracing engineering society, the only one of national scope in Canada. On the basis of comparative populations of Canada and the United States the membership of the Institute was equal to the combined membership of the other constituent bodies of E.C.P.D.

Registration and licensing of engineers in Canada had been initiated by the Institute. A "model act" had been drafted. Provincial associations of registered engineers worked closely with the Institute and concerned themselves with administration of the registration acts, leaving the Institute to foster the technical interests of engineers. Relationships between the associations and the Institute were cordial and further co-operation was being actively undertaken with the result that a truly unified engineering profession in Canada was imminent.

Of present activities, Mr. Challies said, there was little to report owing to the war economy. A committee had been set up to investigate "the servicing of young engineers," and a Canadian edition of E.C.P.D.'s guidance booklet "Engineering as a Career," was in progress under the title "The Profession of Engineering in Canada." As to the future, he concluded, engineers could count on the Engineering Institute of Canada pulling its load, the first duty now however being to help Britain win the war.

A.I.Ch.E. Looks Forward to Further Co-operation with E.C.P.D.

Relations with E.C.P.D. were valued highly by the American Institute of Chemical Engineers, Mr. Kirkpatrick reported, and it was their hope that that appraisal was reciprocated. Although differences of opinion, viewpoint, and procedure might have been disturbing, chemical engineers who had worked intimately with both organizations believed that better understanding and greater co-operation were fast developing.

As to the future, Mr. Kirkpatrick expressed the hope that the Institute and E.C.P.D. would work together more closely. The Institute would welcome an opportunity for a joint meeting along the lines of the A.S.M.E.-E.C.P.D. programme at Kansas City in June, 1941.

A.S.C.E. Serves Notice of Charter Revocation on Chapters in Unaccredited Schools

Reporting for the American Society of Civil Engineers, Mr. Burpee stated that that society's Committee on Engineering Education had suggested that E.C.P.D. might well limit its work of accrediting curricula to the five major fields and general engineering. This committee's views had been reaffirmed by the A.S.C.E. Board of Direction in April, 1941. The committee agreed with Dr. Jackson's report that "undergraduate curricula should be made broader and more fundamental through increased emphasis on basic science and humanistic and social studies," including "the abandonment of effort to develop the stabilized skills that are now emphasized."

The A.S.C.E., Mr. Burpee said, had continued its active participation in the programme of student guidance, and through its 121 student chapters and junior branches of local sections was attempting to foster the development of a professional viewpoint. Student chapters had been furnished copies of the E.C.P.D. bulletin, "Suggestions to Juniors."

At its recent meeting, Mr. Burpee continued, the A.S.C.E. Board of Direction had voted that "student chapters at institutions where civil-engineering curricula had not been accredited by E.C.P.D. would have their charters withdrawn on January 1, 1944, unless these curricula had been accredited by that time."

A.S.C.E. members, he concluded, were greatly concerned with the solidarity of the engineering profession during these times and looked to E.C.P.D. to stimulate the consciousness of the profession at large and particularly to devise tools to use in the development of young engineers in their technical training, their engineering experience, their objective and scientific approach toward their problems, and their ethical attitude toward their undertakings.

Suggests Greater Publicity for E.C.P.D.

A "vote of confidence" in E.C.P.D. was extended by Mr. Fairman speaking for the American Institute of Electrical Engineers. The Institute's faith in E.C.P.D. had taken concrete form, he said, by the doubling of its annual contribution toward the Council's activities. As one of the Institute's representatives he had secured approval of the publication in *Electrical Engineering* of President Doherty's report "E.C.P.D. Should Look Ahead."

Booklet for Engineering Graduates Proposed

Stating that as incoming American Institute of Mining Engineers representative on the E.C.P.D. he had been asked at the last moment to prepare a report, Mr. Chedsey said that what he had to say had not been approved by his colleagues because of lack of time.

The activities of A.I.M.E. which lay in the field of E.C.P.D., he said were mostly covered by its Mineral Industry Education Division. There was also a Student Relations Committee which concerned itself mostly with relations with undergraduates and worked mostly through student chapters and affiliated student societies. The central committee aided by securing speakers for student meetings, by arranging for visits by A.I.M.E. officials, and by establishing contacts for field trips. No workable method had as yet been found to cover the need for systematic contact with young engineers after graduation, although the subject had been given consideration.

Two suggestions as to what additional activities E.C.P.D. might undertake were made by Mr. Chedsey. The first was a booklet for engineering graduates "setting forth why and when they should consider becoming registered as professional engineers, with a brief summary of the laws or regulations of the various states that would be of help to them in this procedure." He also outlined other matters that the booklet might cover. His second suggestion was the encouragement, and possibly some aid in direct development, by a committee of E.C.P.D., of personnel methods, through the use of scientific and engineering aids, in other words, assisting in the development of so-called "Human Engineering." During the year, Mr. Chedsey said, the A.I.M.E. had contributed in several ways toward furthering the objectives of E.C.P.D.

What E.C.P.D. Might Do and What N.C.S.B.E.E. Has Done to Help

The report of N. W. Dougherty for the National Council of State Boards of Engineering Examiners was divided into two parts: (1) What E.C.P.D. might do that it is not doing to make the programme of professional development, and (2) what the National Council had done during the year, or plans to do, toward furthering the objectives of E.C.P.D.

Dean Dougherty summarized his suggestions as follows:

"1. Determine causes or reasons why students select different fields of engineering.

2. Accredit graduate curricula.

3. Closer co-ordination between E.C.P.D. and N.C.S.B.E.E. in the field of professional training. E.C.P.D. is looking toward the right kind of mental activity, N.C.S.B.E.E. is primarily interested in the right kind of experience. Both are needed to develop the young engineer.

4. Might gather information and publish a booklet for students and junior members. "Engineering, a Career" is for parents and the beginner. A booklet for professionally orienting students and for directing recent graduates would be a great help.

5. By aiding in securing uniform laws by raising the quality of weaker laws; and by supporting efforts to maintain high standards in their administration."

What the National Council has done was summarized as follows:

"1. On professional training the National Council has been very active. Emphasis has been placed on qualifying experience rather than education. Studies are being made of examinations as measures of education.

2. On professional recognition a committee has tried to appraise the effects of registration on the engineering profession.

3. The Committee on Legal Procedure has made study of legal practices used in protecting the engineer and the public against the unqualified.

4. What more may be done. (a) Assist with the guidance programme. (b) Revive the Committee on Engineering Education. (c) Take a broader attitude toward the young engineer. Boards are not trying to prevent registration; they are trying to see that applicants are competent. (d) Cause every member of State Boards to thoroughly inform himself about E.C.P.D."

Dean Sackett Announces President Doherty's Address on E.C.P.D. at 1941 A.S.M.E. Annual Meeting

In the absence of the American Society of Mechanical Engineers representative, A. R. Stevenson, Jr., who was to have reported for the Society, Dean R. L. Sackett reviewed briefly what had been done during the year to further the objectives of E.C.P.D. He told how the A.S.M.E. had increased its annual appropriation to E.C.P.D. in common with other constituent bodies and about the joint sessions of the Society and the Council at the Kansas City meeting in June, 1941, under the sponsorship of the Committee on Education and Training for the Industries. Copies of the eighth annual report of E.C.P.D. had been sent to chairmen of the Society's local sections with the request that they study it and transmit questions and comments to the Committee on Education and Training. Articles relating to E.C.P.D. and its work, including President Doherty's report "E.C.P.D. Should Look Ahead,"[1] had been published in *Mechanical Engineering*.

At the 1941 A.S.M.E. Annual Business Meeting, to be held at the Hotel Astor, New York, N.Y. on Monday, December 1, at 2 p.m., Dean Sackett announced, President Doherty would deliver an address on E.C.P.D.

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[1] See *Engineering Journal*, September, 1941, pp. 446-447.

Recommends More Practicing Engineers on E.C.P.D.

The Society for the Promotion of Engineering Education had had a large part in the activities of E.C.P.D. said Dean Seaton in reporting as representative of this Society, and this included the services of five members of the E.C.P.D. Executive Committee. He pointed out that on a per capita basis the S.P.E.E. was making a larger contribution financially than any of the constituent bodies.

Dean Seaton's major suggestion was that an effort be made to appoint a greater number of practicing engineers to E.C.P.D. inasmuch as educators had made up a major part of the Council's membership to date. The services of practicing engineers were particularly desirable on the accrediting committees, he asserted. They were also greatly needed as lecturers in engineering schools and as members of boards of regents and trustees. In some institutions practicing engineers had been helpful in fostering research programmes. In his opinion E.C.P.D. should urge participation of practicing engineers in such institutional relationships.

The S.P.E.E., he announced, had limited its institutional memberships to engineering schools whose curricula had been accredited by E.C.P.D., with the exception of Canadian schools where E.C.P.D. accreditation had not been undertaken.

Professional training had been advanced by the schools' participation in the Engineering Science and Defense Training programme of the U.S. Office of Education which had an enrollment of 150,000, of whom 90 per cent were engaged in in-training courses. It was his hope that ways would be found to continue this type of adult education of men in industry after the emergency should have passed.

In Dean Seaton's opinion, uniform admission requirements and membership grade qualifications of engineering societies were desirable. He favoured the extension of industrial-employment opportunities for engineering school undergraduates between their junior and senior years and for young instructors of engineering schools. Engineering registration should be promoted also.

In closing, Dean Seaton characterized E.C.P.D. as practically the only co-ordinating agency in the engineering profession.

Annual Dinner Surveys E.C.P.D. Programme

The 1941 Annual Dinner was held at the Engineers' Club, New York, on Thursday evening, October 30, with President Doherty acting as toastmaster. Addresses were delivered by N. W. Dougherty, dean of engineering, University of Tennesse, who spoke on " Relation of E.C.P.D. to Registration Boards "; by A. H. White, president S.P.E.E., whose subject was " Relation of S.P.E.E. to E.C.P.D.; " and by James F. Fairman, Consolidated Edison Company of New York, Inc., who analyzed the " Relation of E.C.P.D. to the Engineering Societies. "

President Doherty also introduced Dr. C. J. Mackenzie, president of the Engineering Institute of Canada, C. R. Young, dean of engineering, University of Toronto; Virgil M. Palmer, retiring president, N.C.S.B.E.E., and E. A. Holbrook, president National Society of Professional Engineers, all of whom responded briefly.

Dean Dougherty Praises Work of E.C.P.D.

Asserting that there must be some idealism in engineering, Dean Dougherty cited the addresses of W. E. Wickenden, " The Second Mile,[2] " before The Engineering Institute of Canada, and that of Vannevar Bush,[3] before the American Engineering Council in 1939, in which it had been stated that " if there is no central organization which had as its creed the best service of the profession to the society of which it forms a part then there will be in the end no engineering profession. "

It was the function of E.C.P.D., he said to admit desirable young men to the profession and to keep out the undesirable ones, and it was the function of the N.C.S.B.E.E. to cast out of the engineering profession all unqualified engineers who attempted to practice in it.

In the accreditation of engineering curricula, Dean Dougherty pointed out, E.C.P.D. and N.C.S.B.E.E. had a common objective. Registration boards had benefitted by the accrediting programme because they made effective daily use of the list of accredited curricula.

The National Council, he said, had set up a committee on professional training to parallel the E.C.P.D. committee on this subject. It had also inquired into the question, " What is qualifying experience satisfactory to the board? " and had arrived at a definition of the term " satisfactory to the board. " In the work of the boards, he continued, it was often difficult to distinguish between " eminent " and " beginning " qualification, and it was the board's duty to deal with minimum qualifications.

He paid tribute to the E.C.P.D. Committee on Engineering Schools for the effect of its work on the schools, and concluded by stating that E.C.P.D. must secure the same recognition of the value of the work of its other major committees that had been accorded the work of the Committee on Engineering Schools, so that all engineers would feel that they were a party to the E.C.P.D. programme.

Growing Importance of Engineering Education Acclaimed by White

In speaking of the relation between education and engineering, President White said that the history of the beginnings of the E.C.P.D. deserved to be recorded as the Council had become a co-ordinating factor in engineering development. The engineering schools, he argued, were like a factory. Partially fabricated material was received, inspected, shaped, tempered, and passed on so that it could be fitted into the organization of the engineering profession. In this process the E.C.P.D. was the " boss " of S.P.E.E. and the colleges inasmuch as it set the specifications for the college president.

Engineering colleges dealt with adolescent engineers, he pointed out, while the National Council dealt with their admission to the profession. There had been a time when the engineer had been called a " roughneck. " This was not so to-day. Engineering had come into its own because it had been recognized that engineers thought clearly from cause to effect. It had been his observation that many arts students did not think clearly and did not work hard. There was too much " Do as you please and we hope you will do what is right, " and not enough stress on the discipline of accuracy and every day work.

Engineers must look to the future, he continued; E.C.P.D. had indicated what must be done. Twenty-five years ago engineers had worked 12 hours a day and seven days a week. They had been too tired to engage in other activities. But to-day, with a 40-hour week, they had time and energy for constructive work, and E.C.P.D. had laid out for them a programme for continued growth not only in technical but in cultural fields as well.

Fairman Tells of Experiences on E.C.P.D.

Making it clear that he was speaking solely for himself and not for the engineering societies, Mr. Fairman developed a " master and servant " analogy of the relations between the engineering societies and E.C.P.D. in which the societies were the master and E.C.P.D. the servant. He likened the professional development to a beautiful mansion which the masters seldom inhabited but which was well staffed with servants who were accustomed to

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[2] *Engineering Journal,* March, 1941, pp. 111-114.

[3] " The Professional Spirit in Education," by Vannevar Bush, *Mechanical Engineering,* March, 1939, pp. 195-198.

send an annual greeting to their masters. Apparent indifference of the masters, he said, had led some of the servants to dream about how nice it would be if they owned the mansion, so that they forgot their places as servants and became guilty of insubordination. It would be better, he asserted, if the servants were to stop dreaming and get back to their jobs.

Turning to what he termed his conclusions, Mr. Fairman asserted that great care should be exercised in the selection of representatives to make up the E.C.P.D. These should be made on the basis that appointment was to a job, not an honour. It must be ascertained that the appointee had time and capacity to do the job. It was a failing of bodies like engineering societies to assign too many jobs to the same man, on the theory that a busy man had the most time, but he for one felt that there was a limit to the wise application of this theory.

Officers and directors of participating bodies, he declared, should review what they were getting for the money contributed to E.C.P.D. He criticized the practice of setting up new organizations to handle new tasks on the theory that a new group would best do the job, when, as a matter of fact, he said, continued interest and sustained effort were essential.

In conclusion, Mr. Fairman emphasized again the statement that he was expressing his personal opinions and not those of any group and his conviction that "we are not doing what we might do."

WARTIME BUREAU OF TECHNICAL PERSONNEL

Monthly Bulletin

The distribution of questionnaires to research and science workers which was announced previously is practically complete. The establishment of a satisfactory mailing list for this group has been more difficult than in the case of engineers, chemists, and architects, because there are no societies to which they belong in quantities that adequately represent the group. However, through universities, the National Research Council, and the Royal Society a list of over two thousand names has been set up which it is believed covers the field.

Under war conditions the importance of research work is multiplied many times. The need of attacking the many new problems and of completing the details of those already under way is great. More problems mean more workers. The Bureau is now in a position to aid in this expansion by furnishing information on the availability and qualifications of most persons experienced in this field.

The demand for mechanical engineers continues. It is difficult to see how the hundreds of openings can be suitably filled under the present method of distribution. It is the opinion of the Bureau that many qualified persons are still engaged in non-essential work, and that others while employed by an essential industry are themselves not wholly engaged in war work that uses their abilities to anything like capacity.

The fact is being slowly evolved that new measures will be necessary if anything like an even distribution or an efficient utilization of mechanical engineering skill is to be obtained in this country. Beyond a doubt engineering ability is being wasted right now. Groups which are crying for more men are competing with each other in their search and yet none seems to be utilizing efficiently those already in its service.

It is the opinion of the Bureau that a survey of the work being done by engineers will reveal the fact that such persons are being used in great numbers for work which is not engineering at all. For instance, an officer of the Bureau was shown by an engineer in the employ of a large industry where in one office two engineers out of seven were being wasted. The men themselves made the survey. They found that between them they were spending almost thirty per cent. of their total time in work which could be equally well done by clerks. Here is a specific case which probably is repeated over and over in plants all over the country. Perhaps similar surveys by all employers would yield similar results, and would assist in solving their own problem of engineering shortages.

The Bureau is impressed with the serious shortage of technical help in many vital activities including the armed forces, and believes that present methods will not solve the problem quickly enough. Under any conditions it will not be solved easily, and may never be solved entirely, but there are things which can be done now that will help a lot. The total supply of technical help—limited as it is—should be spread out in proportion to the needs. This will require the sympathetic co-operation of engineer, employer, and government, but it should not be impossible of attainment.

MEETING OF COUNCIL

A regional meeting of the Council of the Institute was held at the Château Frontenac, Quebec, on Saturday, November 15th, 1941, at four o'clock p.m.

President C. J. Mackenzie (Ottawa) was in the chair; Past-President J. B. Challies (Montreal); Vice-Presidents K. M. Cameron (Ottawa) and deGaspé Beaubien (Montreal); Councillors J. H. Fregeau (St. Maurice Valley), A. Larivière (Quebec), W. R. Manock (Niagara Peninsula), H. Massue (Montreal), J. A. Vance (Woodstock), and General Secretary L. Austin Wright were present.

There were also present by invitation—Past-Presidents A. R. Decary and O. O. Lefebvre; Past-Vice-Presidents Hector Cimon (Quebec), J. H. Hunter (Montreal), W. G. Mitchell (Montreal), and A. B. Normandin (Quebec); Past-Councillor B. Grandmont (Rimouski); Dr. A. H. Heatley, chairman of the St. Maurice Valley Branch; Dr. Paul E. Gagnon, past-president of the Canadian Chemical Association and honorary treasurer of the Canadian Institute of Chemistry; L. C. Dupuis, chairman, E. R. Gray-Donald, councillor-elect and vice-chairman, Paul Vincent, secretary-treasurer, T. M. Déchêne, A. Laframboise, P. Méthé and Gustave St-Jacques, members of the executive of the Quebec Branch.

The general secretary reported that the amount received from the branches towards the building fund to date was approximately $7,000.00, of which more than $5,500.00 had been contributed by the Montreal Branch. Several of the branches were continuing their campaign, and it was understood that further amounts would be received. The president felt that the Institute should be very grateful to the Montreal Branch, and expressed his own personal appreciation of their splendid effort on behalf of the fund. He also described his pleasure at the success of the efforts of the other branches.

The general secretary reported that as the annual meeting committee of the Montreal Branch desired to have a paper or papers dealing with the engineering phases of civil defence he had cabled the Institution of Civil Engineers in London to see if there was any possibility of one of their members who was familiar with this work coming to Canada at that time to participate in the meeting. The secretary of the Institution replied that it was not expected that any of their members familiar with this important subject would be so situated that they could assist with the annual meeting, but suggested that the Institute might send a member to England to investigate the field for himself, and that in such circumstances the Institution would afford every facility.

The secretary reported that from conversations with President Mackenzie and Vice-Presidents Beaubien and Cameron it appeared that it might be possible to carry out such a proposal, and that in view of the Institute's desire to give leadership in this matter it was advisable to bring the proposal before Council for further consideration and decision.

In the discussion which followed several councillors and guests expressed themselves as favouring such an activity. The president announced that Vice-President Cameron had offered to make available one of the engineers in his department who was competent to do the work. The advantages of having a government engineer undertake the work was apparent to everyone, and it was unanimously agreed that Mr. Cameron's offer be accepted, and that the Institute do everything possible to secure for the use of government and civilian bodies throughout Canada the information which would be helpful in protecting and repairing public utilities and structures which might be subject to attack by bombing or gun fire. It was also agreed that the representative, while in England, should gather the latest information on anti-sabotage methods for the protection of utilities. The arranging of details was left with the president, Vice-President Cameron, and the general secretary.

The general secretary reported that a list of engineers and scientists of German and Austrian origin, who are now in refugee camps in Canada, had been furnished to the Wartime Bureau of Technical Personnel with the information that such men could be released for war work in Canada providing satisfactory positions were offered to them. A subsequent proposal had been reported to the Bureau wherein it was indicated that the government was considering setting up a manufacturing plant in which all these refugees could set to work on the same or similar projects.

In view of the fact that such persons, if competent, could readily find employment, it was agreed that the need of writing Institute examinations in order to establish their qualifications became unnecessary. Therefore, in view of the expense involved in setting papers, the secretary suggested that nothing be done for the present about giving examinations to those who requested it. The original proposal from the refugees had been that they might write the Institute's examinations to obtain membership, but upon being informed that by a recent ruling of Council membership could not be given to enemy aliens, they had requested that the examinations be given to them in any case as a means of establishing their status in Canada for purposes of finding employment.

On the recommendation of the Montreal Branch executive committee it was unanimously resolved that Mr. Walter G. Hunt be appointed councillor to represent the Montreal Branch until the next annual election, replacing Mr. H. J. Vennes who had resigned. It was also unanimously resolved, on the recommendation of the Montreal Branch, that Mr. Hunt's name be submitted on the forthcoming Officers' Ballot, as councillor for the years 1942 and 1943, completing Mr. Vennes' term of office.

The general secretary reported that the various branches had been written to with a suggestion that they might extend the facilities of the branch to engineers from other countries now in Canada. Letters offering to co-operate had been received from several of the branches, and accordingly the names of the members of the Association of Polish Engineers and of the Institution of Electrical Engineers which had been received at Headquarters had been sent to the branches concerned.

The Toronto branch had made a good start by inviting fifteen Polish engineers as their guests at a dinner held previous to their opening meeting, at which a Polish engineer was the guest speaker. Letters received indicated that such hospitality was very much appreciated.

Vice-President Beaubien, as chairman of the Finance Committee, reported that the finances of the Institute were in a healthy condition. Revenue had increased over last year and over the budget; expenditures had increased slightly over last year, but not over the budget, which placed the Institute at this time of the year in a better position than it has been for a long time. Mr. Beaubien pointed out that this was rather an unusual occasion, in that for the month of November, the Finance Committee had absolutely no resignations or removals from the membership list for other reasons, to consider.

Past-President Challies reported that at a recent meeting in Montreal, at which six past-presidents were present, including three of those who originally established the Past-Presidents' Fund, Council's request for a reconsideration of the purposes of the award was discussed. The past-presidents did not wish to make any fixed decision that would bind Council. They explained that the fund had been collected originally for the purpose of assisting the Institute in establishing prizes and building up its finances. Opinions were expressed by the past-presidents that it was thought desirable to continue an award known as the Past-Presidents' Prize with a value of about $100.00 to be paid out of interest on the fund. The balance of the fund might be used for whatever purposes Council felt would be most useful at the time.

Mr. Challies also reported that there was a discussion as to whether or not contributions to the fund by past-presidents should be continued. In view of the fact that since Dr. Lefebvre's presidency the custom had been established of presidents visiting all the branches it was thought that the fund might be of some financial assistance to those presidents whose personal incomes could not meet this cost without considerable inconvenience.

Past-President Décary thought that the privilege of contributing to the fund should be continued, and Past-President Lefebvre agreed with him, stating at the same time that he thought that the interest should be used every year and that any increase in the total amount should come only from new contributions.

Finally, at Past-President Challies' suggestion, it was agreed that the final decision as to the use of the interest and the future of the fund should be left to the Finance Committee to determine. It was also suggested that in view of the report on prizes and awards being drawn up by Mr. Durley some further consideration be given by him to the Past-Presidents' Prize and included in the report.

In view of the fact that the Julian C. Smith Medal was a new award and final regulations have not yet been agreed upon, Vice-President Cameron recommended that the awards for this year should be determined in the same manner as the original awards of last year. By this means the names of the candidates will be selected by the Provisional Committee of Past-Presidents, and will be submitted to Council for approval. The final regulations for the medal are included in Mr. Durley's report, but it is necessary to make this year's selections before the report can be presented for approval.

The secretary reported that the dates set for the Annual General Professional Meeting in Montreal were Thursday and Friday, February 5th and 6th, 1942. A meeting of the annual meeting committee of the Montreal Branch had been held recently, and the programme for the meeting was now practically complete. The principal papers are on war industries, such as guns and aircraft manufacture, research enterprises and the manufacture of munitions. This had the approval of the Hon. C. D. Howe, Minister of Munitions and Supply, who had consented to speak at the opening luncheon. It was also expected that there would be an exhibit of war materials being made in Canada for the first time.

On Thursday night the Montreal Branch would hold its Annual Smoker, and on Friday, the Annual Dinner of the Institute.

To comply with the by-laws, it was unanimously resolved that the Annual General Meeting be convened at Headquarters on Thursday, January 22nd, 1942, at eight o'clock p.m., the meeting to be adjourned and reconvened at the Windsor Hotel, Montreal, at ten o'clock a.m. on Thursday, February 5th, **1942.**

Past-President Challies, as the Institute's representative on the executive committee of the Engineers' Council for Professional Development, reported briefly on the annual meeting of that body, which had been held recently in New York City. A full delegation of Institute members had been present, including the three representatives on the governing body of the Council, the representatives on each of the standing committees, the president of the Institute, and Past-President Cleveland, of Vancouver. In Mr. Challies' opinion, the Institute was taking a very creditable part in the work of E.C.P.D. A detailed account of the meeting appears in this issue.

The general secretary, as assistant director of the Wartime Bureau of Technical Personnel, made a brief progress report on the activities of the Bureau. He indicated that the work was expanding, both in volume and in importance, and that members of the Bureau realized that they had a very serious problem on their hands. He mentioned that regulations were now being drawn up in Ottawa which would strengthen the hands of the Bureau considerably, but at the same time would place greater responsibilities upon it.

The secretary reported that the ballots for approval of the co-operative agreement in New Brunswick were now in the hands of all councillors and corporate members in the province, and were returnable on December 5th. It was unanimously resolved that Messrs. H. Massue and W. G. Hunt be appointed scrutineers to open the ballot and report to Council.

In view of war conditions it was unanimously agreed that the Institute would not send out Christmas cards this year as has been done in recent years, but would instead send a suitable letter to the presidents and officers of sister societies in Great Britain and the United States.

An invitation to participate in an Inter-American Congress of Engineers and Geologists to be held in Chile in January of next year had been received through the Consul General of that country. Correspondence had indicated that it might be possible to include the subject of hydro-electric power development, in which case the Institute might be able to participate.

Mr. Challies thought that the Institute should be represented at such a conference if at all possible, and suggested that it be left with the president and the general secretary to do whatever was necessary in the best interests of the Institute. It was possible that Mr. Hunter would be in Chile at that time. Mr. Hunter explained that although his plans were rather indefinite at the moment, he would keep in touch with the general secretary, and would be very pleased to represent the Institute if he should be in Chile at the time of the Congress.

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

Admissions	
Members	2
Juniors	2
Students	61

Transfers	
Student to Member	1
Student to Junior	1

It was left with the president and the general secretary to decide on the date for the December meeting of Council.

The president expressed his appreciation of the hospitality of the Quebec Branch, his only regret being that it had been necessary to hurry through the business of the Council meeting in order that he and other out-of-town members might catch the evening train to Montreal.

Dr. Gagnon expressed his appreciation at being invited to the meeting, a privilege which he had greatly enjoyed. Similar acknowledgments were made by other out-of-town guests.

ELECTIONS AND TRANSFERS

At the meeting of Council held on November 15th, 1941, the following elections and transfers were effected:

Members

Fraser, John Hugh, gen. supt., steel divn., Dominion Steel and Coal Corporation, Sydney, N.S.

Parry, Thomas M., B.Sc. (Elec.), (Univ. of Alta.), Technical Vice-Principal, Western Canada High School, Calgary, Alta.

Juniors

Farstad, Charles, B.Eng. (Mech.), (Univ. of Sask.), asst. engr., mech. dept., Laurentide Divn., Consolidated Paper Corporation Ltd., Grand Mere, Que.

Hoseason, Harry J., B.A.Sc. (Univ. of Toronto), sales engr., H. H, Robertson Co. Ltd., Toronto, Ont.

Transferred from the class of Student to that of Member

Lecavalier, Jean-Paul, B.A.Sc., C.E., (Ecole Polytechnique), asst. district engr., Quebec Roads Dept., Quebec, Que.

Transferred from the class of Student to that of Junior

Harding, Charles Malcolm, B.Sc. (Elec.), (Univ. of Alta.), elec. engr. Calgary Power Co. Ltd., Calgary, Alta.

Students Admitted

Bowman, William A., (Univ. of Man.), Hudson, Ont.
Dixon, Frederick, instrument dept., Bepco Canada Limited, Montreal.
Glenn, Clayton H., (Univ. of Man.), 655 Mulvey Ave., Winnipeg, Man.
Harvie, John Duncan, (Univ. of Man.), 1185 Wolseley Ave., Winnipeg, Man.
Johnston, Bruce Fraser, (McGill Univ.), 3520 McTavish St., Montreal, Que.
Lawson, Glenn William, (Univ. of Man.), 760 14th St., Brandon, Man.
Merkley, Murray Roy, (McGill Univ.), 257 Strathearn Ave., Montreal West, Que.
O'Brien, William Smith, 4278 Sherbrooke St. West, Montreal, Que.
Pink, John Frederick, (Univ. of Man.), 371 Inglewood St., St. James; Man.
Smith, Robert Lovelace, (Univ. of Man.), 38 Furby St., Winnipeg Man.
Swerdfeger, John Harvey, (Univ. of B.C.), 1065 S.W. Marine Drive, Vancouver, B.C.
Verdier, Paul André, 1610 Sherbrooke St. West, Montreal, Que.

Students at the Ecole Polytechnique, Montreal, Que.

Auger, Roland, 1131 Laurier Avenue West, Outremont, Que.
Bédard, Jacques, Ecole Polytechnique, 1430 St. Denis St., Montreal.
Berthiaume, Joseph-Alphonse, Contracoeur, Verchères Co., Que.
Bouthillier, Jean, 2564 Desjardins Ave., Maisonneuve, Que.
Brunette, Charles Edouard, 1468 Gilford St., Montreal, Que.
Caron, Lucien, 1690 St. Hubert St., Montreal, Que.
Dumont, Lomer, P.O. Box 513, Amos, Abitibi County, Que.
Dury, Jean, 3621 St. Denis St., Montreal, Que.
Ewart, Philip, 121 Second Ave., Verdun, Que.
Grenier, François, 440 Cherrier St., Montreal, Que.
Joubert, Max Nowlen, 607 Merton Ave., St. Lambert, Que.
Julien, Roger, 684 Radisson St., Three Rivers, Que.
Labrosse, Fernand, 3668 St. Hubert St., Montreal, Que.
Lalande, Jacques Bernard, 6270 St. Denis St., Montreal, Que.
Laroche, Jean-Luc, 4128 St. Hubert St., Montreal, Que.
Lavallée, Jean-Charles, 1451 Sicard St., Viauville, Montreal, Que.
Laverdure, Jean Conrad, 4311 Fabre St., Montreal, Que.
Laviolette, Jean-Guy, 2324 Orléans St., Montreal, Que.
Laviolette, Jean-Paul, 3921 St. Hubert St., Montreal, Que.
LeBrun, Hubert, 3683 Laval Ave., Apt. 6, Montreal, Que.
Lacavalier, Robert, 6280 St. Denis St., Montreal, Que.
Leclerc, André, 6824 St. Denis St., Montreal, Que.
Lemieux, Jacques Raymond, 108 Dufferin St., Sherbrooke, Que.
Livernoche, Roger, 113 rue des Sulpiciens, L'Epiphanie, Que.
Mailhiot, Fernard A., 4174 Oxford Ave., Notre-Dame-de-Graces, Montreal, Que.
Marcotte, Benoit Wilfrid, 4439 Adam St., Maisonneuve, Que.
Marsolais, Irenée Wilfrid, 1612 St. André St., Montreal, Que.

Ménard, Jean, 837 Cherrier St., Montreal, Que.
Ménard, Robert, 5840 Chabot St., Montreal, Que.
Mousseau, J. A. Francois, 3457 Laval Ave., Apt. 1, Montreal, Que.
O'Bomsawin, Gérard, 4785 Ste. Emilie St., St. Henri, Montreal, Que.
Palmer, Joseph Paul Victor, Ecole Polytechnique, 1430 St. Denis St., Montreal, Que.
Pauzé, Jean, 382 St. Joseph Blvd. East, Montreal, Que.
Pépin, Georges Alphonse Maurice, 134-9th Ave., Longueuil, Que.
Proulx, Jean-Noël, 7964 St. Gérard St., Montreal, Que.
Rochon, Georges André, 1029 Lafontaine Park, Montreal, Que.
Rolland, Gilbert Lucien, Mont-Rolland, Que.
Ross, Miville, Ecole Polytechnique, 1430 St. Denis St., Montreal, Que.
St-Laurent, Aurèle, 865 Roy St. East, Montreal, Que.
Sansfaçon, Jacques, 441 Malines St., Montreal, Que.
Séguin, Bernard, 2925 Gouin Blvd. East, Montreal, Que.
Sicotte, Bernard, Ecole Polytechnique, 1430 St. Denis St., Montreal.
Smith, Paul M., Ecole Polytechnique, 1430 St. Denis St., Montreal.
Thauvette, Laurent, 3664 Lafontaine Park, Montrea,l Que.
Thibault, Sylvain, 4080 St. Hubert St., Montreal, Que.
Troalen, Pierre, 4281 Chapleau St., Montreal, Que.
Trudeau, Jean, 7764 DeGaspé St., Montreal, Que.
Turcotte, Leonel, 7656 Boyer St., Montreal, Que.
Turgeon, Joseph Alfred Maurice, 526 Sherbrooke St. East, Montreal, Que.

COVER PICTURE

The picture on the cover of this issue shows members of an East Coast anti-aircraft battery at one of the listening devices which are trained on the sky night and day. So sensitive is this equipment that the sound of a locomotive whistle a mile away creates an almost deafening racket in the ears of the operators.

COMING MEETINGS

Association of Professional Engineers of Ontario—Annual Meeting and Dinner, Royal York Hotel, Toronto, Ont., on January 17th, 1942. Walter McKay, Secretary-Treasurer, 350 Bay Street, Toronto, Ont.

The Engineering Institute of Canada—Fifty-sixth Annual General and General Professional Meeting, Windsor Hotel, Montreal, Que., February 5th-6th, 1942. L. Austin Wright, General Secretary, 2050 Mansfield Street, Montreal, Que.

Personals

News of the Personal Activities of members of the Institute, and visitors to Headquarters

Dr. J. B. Challies, M.E.I.C., vice-president of Shawinigan Water and Power Company, and past-president of the Institute, was inducted recently as chairman of the board of governors of the United Theological College, Montreal. He has been for several years a prominent layman in Dominion-Douglas Church.

Dr. T. H. Hogg, M.E.I.C., chairman and chief engineer of The Hydro-Electric Power Commission of Ontario, and past-president of The Engineering Institute of Canada, was invited to deliver the "Brackett" Lecture at Princeton University on Tuesday, November 18th, 1941—a tribute that has only been paid to one other Canadian engineer, Sir Henry Thornton, who some years ago gave a Brackett Lecture on Transportation.

The subject of Dr. Hogg's lecture was "The Hydro-Electric Power Commission of Ontario—a Study in Public Service." He explained how the Commission was formed, how it operates, how it is meeting the requirements of the present war emergency, and described the social and economic benefits it has achieved during its thirty years of operation.

The Cyrus Fogg Brackett Lectureship was established in 1921 at Princeton University in the School of Engineering, by the Princeton Engineering Association—the official graduate body of Princeton engineering alumni. The lectureship is in memory of Dr. Cyrus Fogg Brackett, the Henry Professor of Physics at Princeton from 1873 to 1908—one of Princeton's greatest and most beloved teachers. The Brackett Foundation has brought to Princeton, as lecturers, many of the leaders of America, including Irving Langmuir, Samuel Insull, the late Sir Henry W. Thornton, and many others. Its objective is to bring before the students and faculty men of prominence in engineering, finance, law and business, and to give to Princeton students a better understanding of the implications of engineering in the affairs of the world.

T. W. Fairhurst, M.E.I.C., is at present in Canada on business. He is a director of Ruston and Hornsby Limited, London, England. Several years ago he was connected with the Vancouver Machinery Depot, Limited, and he also spent several years in the United States before going to England.

Lieut.-Col. K. S. Maclachlan, M.E.I.C., has resigned his post as deputy minister of the Department of National Defence for Naval Services at Ottawa in order to undertake active service with the Royal Canadian Navy. In commenting on Colonel Maclachlan's resignation, the Minister of Naval Services said: "Colonel Maclachlan's work as associate deputy minister of National Defence for the first year of the war and from July, 1940, to date as deputy minister for Naval Services was marked by thoroughness, efficiency and a great zeal. He entered into all the work of the Department with earnestness and vigour and his experience in business of various kinds, together with his military knowledge, were great assets to the Department."

Lieut.-Col. W. S. Wilson, M.E.I.C., secretary of the Faculty of Applied Science and Engineering at the University of Toronto, since 1927, has in addition recently been appointed assistant dean of the Faculty.

Major J. F. Plow, M.E.I.C., is now overseas with the Canadian army. He had been stationed for sometime at Petawawa, Ont. Major Plow was assistant general secretary of the Institute from 1930 until 1938 when he went with Chas. Warnock & Company, Limited, Montreal.

Ernest Smith, M.E.I.C., who was with the provincial Department of Public Works of British Columbia, has recently been transferred from New Westminster to Nelson, where he is district engineer.

E. H. Beck, M.E.I.C., formerly connected with the construction of the new National Research Council Laboratories at Ottawa, has recently joined the staff of E. G. M. Cape and Company at Botwood, Newfoundland.

H. M. Black, M.E.I.C., is manager of the Longueuil Plant of Dominion Engineering Works Limited at Longueuil, Que. He has been with the firm since 1940 when he left English Electric Company of Canada Limited, St. Catharines, Ont., where he was sales manager.

Thomas Lees, M.E.I.C., has recently been transferred from Calgary to Vancouver, where he is district engineer for the Canadian Pacific Railway Company. He has been in the service of this company since 1905 and has occupied the position of district engineer at Calgary since 1923.

Neville Beaton, M.E.I.C.

Neville Beaton, M.E.I.C., has recently been appointed to the consulting branch of Wartime Merchant Shipping Limited, Montreal. He had resigned his position as resident engineer of the Powell River Company Limited, Powell River, B.C., in which capacity he had had for the past eight years, charge of plant properties, projects and engineering developments, including the recently completed $1,000,000 constant angle arch dam at Lois River.

Gérald Molleur, M.E.I.C., has been transferred from Quebec to the Montreal Office of the Public Service Board of the Province of Quebec. He was graduated from the Ecole Polytechnique in 1924 and after a year spent with the National Research Council, he went with Quebec Streams Commission where he remained until 1936, except for a few months in 1927, when he worked with the Quebec Pulp and Paper Mills Limited. He joined the Quebec Electricity Commission in 1936 and became in charge of the Quebec office, a position which he occupied until his recent transfer.

W. L. Kent, M.E.I.C., has accepted the position of assistant to the project engineer for construction with Basic Magnesium Incorporated, Las Vegas, Nevada, U.S.A. He was previously on the staff of the Stuart Cameron Company Limited at Lang Bay, B.C.

Flying-Officer G. S. G. Henson, M.E.I.C., has obtained a leave of absence from the Winnipeg Electric Company and has enlisted with the Royal Canadian Air Force, Aeronautical Engineering Branch. After completing his course at the aeronautical school in Montreal, he was recently posted at Yorkton, Sask.

R. P. Freeman, M.E.I.C., has joined the staff of Wartime Merchant Shipping Limited, Montreal, where he is in charge of the Maritime operations of the Company. Lately he had been connected with Defence Industries Limited at Montreal.

R. L. Morrison, M.E.I.C., who is employed with Messrs. Airspeed (1934) Limited at Portsmouth, England, has been for the past eight months chief technical liaison officer, co-ordinating the work of various sub-contractors, workshops, inspection departments, and drawing office. He also advises on problems of plant efficiency.

J. Lyle McDougall, M.E.I.C., who until recently was on the staff of H. G. Acres and Company at Niagara Falls, Ont., is now located in Montreal with the Canadian Pulp and Paper Association, where he acts as assistant co-ordinator for the Wartime Machine Shop Board.

J. B. Snape, M.E.I.C., has joined the staff of the Works and Buildings Department of the Naval Service and is at present stationed at Halifax, N.S. He was previously connected with the National Parks Branch of the Department of Mines and Resources, as resident engineer, at Jasper Park, Alta.

Flying-Officer D. S. Patterson, M.E.I.C., has been commissioned in the Royal Canadian Air Force, and has been posted to the Vancouver station. He was previously connected with the Department of Highways of Ontario at Kenora, Ont.

W. E. P. Duncan, M.E.I.C., general superintendent of the Toronto Transportation Commission, addressed the sixtieth annual convention of the American Transit Association and affiliated organizations held in Atlantic City, New Jersey, recently, on the subject, "Transit Operations in Wartime."

F. S. Stratton, M.E.I.C., is in the employ of the industrial sales division of Exide Batteries of Canada Limited at Toronto. He was previously connected with the Montreal Light, Heat and Power Consolidated, Montreal.

Lieut. R. F. Shapcotte, Jr.E.I.C., has left his position with Pacific Mills Limited, at Ocean Falls, B.C., to accept a commission with the Royal Canadian Engineers, and is at present stationed at Gordon Head, B.C.

Pilot-Officer M. F. Baird, Jr.E.I.C., who is serving with the Royal Air Force Ferry Command is now overseas.

Pilot-Officer W. M. Diggle, Jr.E.I.C., has left his position with the Canadian Bridge Company at Walkerville, Ont., to join the Royal Canadian Air Force and is at present stationed at the School of Aeronautical Engineering at Montreal.

R. C. Peck, Jr.E.I.C., has accepted a position with Demerara Bauxite Company at Mackenzie, British Guiana, S.A. He was graduated in civil engineering from the University of Alberta in 1940.

Capt. J. T. Hugill, S.E.I.C., has recently returned from England and is at present located at the experimental station at Suffield, Alta.

James O. Dineen, S.E.I.C., has recently accepted a position at the University of New Brunswick in the Royal Canadian Air Force radio technicians' school, as a radio instructor, and is also assistant in the department of electrical engineering at the university.

J. G. Wall, S.E.I.C., is now employed as a junior radio engineer by the Department of Transport. He was graduated in electrical engineering from the University of New Brunswick in 1939.

VISITORS TO HEADQUARTERS

G. R. Duncan, M.E.I.C., Fort William, Ont., on October 30th.

J. G. D'Aoust, M.E.I.C., Consolidated Paper Corporation Limited, Port Alfred, Que., on November 3rd.

D. W. McLachlan, M.E.I.C., Department of Transport, Ottawa, Ont., on November 11th.

O. Quévillon, S.E.I.C., city engineer, St-Hyacinthe, Que., on November 11th.

T. S. Mills, M.E.I.C., chief engineer, Department of Mines and Resources, Ottawa, Ont., on November 12th.

J. A. Vance, M.E.I.C., general contractor, Woodstock, Ont., on November 15th.

Major J. Ormond Riddel, M.Am.Soc.C.E., Port of Spain, Trinidad, B.W.I., on November 19th.

R. B. Young, M.E.I.C., testing engineer, Hydro-Electric Power Commission of Ontario, Toronto, Ont., on November 23rd.

A. C. Northover, Jr.E.I.C., Trinidad, B.W.I., on November 25th.

Obituaries

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

George Phillips, M.E.I.C., died suddenly at his home in Victoria, B.C., on November 4th, 1941. He was born at London, England, on March 21st, 1868. He joined the Admiralty service at the age of eighteen, being for several years with the works department before he came to Canada in 1898 as a representative of the Admiralty. In that capacity, under the Imperial service, he served at Esquimalt as Admiralty agent until 1910, when the Canadian Government took over the dockyard. At their request, he remained a short time in the Canadian service to train the dockyard staff.

At the end of that period he transferred permanently to the Canadian Government service. His family, which had been waiting his return to England, joined him in Victoria, where he was in charge of the dockyard until his transfer to Halifax in 1917. There he remained two years until his appointment to the Naval Defence Department in Ottawa in 1919. In 1922 he was transferred back to the dockyard in Esquimalt, serving as superintendent until his retirement in 1933.

Mr. Phillips helped to negotiate the purchase of the two submarines secured by the Government during the regime of the late Sir Richard McBride, and helped to outfit the hospital ship, *Prince Robert,* which made the port of Victoria its headquarters during the last war.

It was during his time at the dockyard that the Stefansson expedition left for the Arctic, and in that year, 1918, he played an important part in helping to outfit the expedition. Phillips Strait memorializes this connection, it being named after him by Stefansson.

Mr. Phillips' well-known interest in music predated his coming to Canada, as he was a member of the Royal Choral Society in London. Immediately on arriving here, he associated himself with various musical activities. He was a charter member of the Arion Choir of Victoria, of which he was president for some years.

He was one of the founders of the Victoria Choral and Orchestral Union and held the office of secretary-treasurer. Until recent years he was active in dramatic and musical comedy performances, his name figuring in many entertainments during the last war and since, both in Victoria and Halifax.

After his retirement in 1933, he became secretary of the Naval Veterans' Branch of the Canadian Legion, which position he still occupied at the time of his death.

Mr. Phillips joined the Institute as an Associate Member in 1904, and he became a Life Member in 1934.

Malcolm Sinclair, M.E.I.C., died in the hospital at Yorktown, Sask., on October 12th, 1941. He was born at Edinburgh, Scotland, on the 11th of May, 1880, and received his education at the Edinburgh University and Watt College, where he served his apprenticeship from 1900 to 1906 in the office of James D. Gibson, Civil Engineer, Edinburgh. He spent the next five years with various firms of consulting engineers and was engaged in general construction work. He came to Canada in 1911 and for the next four years was connected with the Dominion Land Survey Department at Moose Jaw, Sask. During the first world war he was inspector of munitions at Moose Jaw. Following the war he became city engineer at Moose Jaw and remained in this position for ten years. During that time he did a great amount of construction, developing parks, buildings and water works. In 1930 he became city engineer of Yorktown, Sask. Lately Mr. Sinclair had been connected with construction work on the British Commonwealth Air Training Plan airports in the vicinity of Yorktown.

Mr. Sinclair joined the Institute as an Associate Member in 1917 and he became a Member in 1940.

News of the Branches

Activities of the Twenty-five Branches of the Institute and abstracts of papers presented

CALGARY BRANCH

P. F. Peele, M.E.I.C. - *Secretary-Treasurer*
F. A. Brownie, M.E.I.C. - *Branch News Editor*

The following is a summary of our recent meetings:

A talk on **Oil Exploration** was given by Mr. W. H. Gibson, engineer with the McColl-Frontenac Oil Co., on October 9th. Mr. Gibson described five methods in use for locating possible oil structures. Soil analysis whereby an increase in the hydro-carbon content provides a possible clue to the existence of an oil-bearing structure. Measurement of the electrical resistance of the earth as well as the determination of the strength of the vertical component of the earth's magnetic field provides another means of locating possible oil structures. Both of these methods must be supplemented by more accurate alternatives.

Another and more accurate method consists in measuring the variations in gravity over the piece of ground to be explored. Delicate gravimeters show the difference in mass distribution and hence the presence or absence of rock strata.

The seismic method is the one considered most accurate at the present time. Reflected and refracted waves from explosives can be accurately measured and subsurface structures mapped.

On October 23rd Mr. H. K. Dutcher gave a very interesting account of the **Building of the Terraleah Power Plant** in Tasmania. A comparison was made between working conditions there and in Canada. The Australian workman proved to be very efficient and took a keen interest in the work. The lack of standard railroad track gauges proved a handicap in transporting equipment.

On November 6th Flight-Lieutenant W. Thornber of R.C.A.F. No. 4 Training Command in Calgary gave a very interesting talk on **Modern Military Aircraft**. The importance of striking power and safety to the crew is uppermost in the minds of the designers, and present trends are in the direction of increased speeds and heavier armament.

The speaker outlined the salient features of both allied and enemy aircraft. By means of slides he was able to show the means used in identifying the more common types of planes.

The Calgary Branch recently formed a special committee to assist local military and airforce engineers in selecting suitable recruits for commissioned ranks. This committee is composed of two members from the Alberta Professional Association so that there will be a proper tie-in between the two organizations. It is proposed to invite the chief engineer of our local military district to be present at any meetings of this committee.

HALIFAX BRANCH

S. W. Gray, M.E.I.C. - *Secretary-Treasurer*
G. V. Ross, M.E.I.C. - *Branch News Editor*

The first dinner meeting since May was held Thursday, October 23rd, at the Halifax Hotel. Sixty-seven members and guests were present, an unusually large attendance for this Branch.

The guest speaker was Mr. Guina, Assistant General Manager of Canadian Colloid Company, who spoke on **Boiler Feed-water and its Control**. Mr. Guina outlined the sources of impurities in feed waters, the chemical composition of harmful ones and the condition they produce in a boiler. He then dealt with the reagents used in water treatment and the chemical reactions and results which each one produced in the boiler, and illustrated testing apparatus and control charts for use in boiler plants.

Although Mr. Guina's paper was quite technical it proved to be interesting and informative even to those who have no contact with feed-water problems. The discussion which followed covered everything from small heating plants to battleships until Chairman Fultz called a halt.

Lieutenant Moore, R.C.N., supplied the comedy. His skill in card dealing is such that few of those present would care to sit in with him for even a friendly game.

HAMILTON BRANCH

A. R. Hannaford, M.E.I.C. - *Secretary-Treasurer*
W. E. Brown, Jr.E.I.C. - *Branch News Editor*

On Thursday, November 7th at 8 p.m., the branch visited the plant of the Dominion Foundries and Steel Limited, Hamilton. The occasion was **War Production**, and on this account only Members, Juniors and Students of the Institute were invited.

The members, numbering 65, assembled in the firm's board room where Chairman W. A. T. Gilmour introduced the party to Mr. W. D. Lamont.

Chief Metallurgist Lamont welcomed the party on behalf of his management and then gave a descriptive talk on peace-time and present production of the plant, together with a volume of information of the work we were about to see. He stated that peace-time production of the steel foundry was castings of which a large percentage is alloy steel. The castings are electric steel exclusively. Until very recently they operated the only plate mill in the Dominion of Canada. Five years ago they started the only tin plate mill in the Dominion and are still operating the only cold reduction tin plate mill in Canada. In normal times railway car forged axles accounted for a share of the plant's production.

Dealing with the change of operation due to present needs, Mr. Lamont said that having available a 1,000-ton steam hydraulic press, their position was ideal, in fact unique, for making gun barrels; also the fact that they had plate mills already in operation made possible the immediate start on production of rolled armour plate.

The Canadian Government asked the Dominion Foundries and Steel Limited to attempt to produce homogeneous rolled armour plate; which up to this time had never been produced in the Empire, except in the British Isles. The attempt was made and the first war material produced was bullet-proof plate which is necessary in the construction of the Bren gun carrier. This first attempt stood up against all the British Government ballistic tests and, since that effort, every month production is being improved and vastly increased.

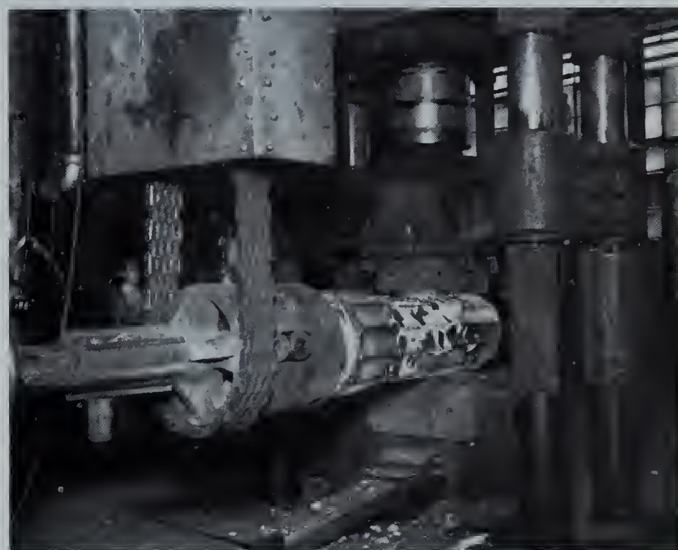
At the same time, as previously referred to, the Alloy Steel Foundry placed the firm in an excellent position to produce armour castings for use in both the British and the American designed tanks which are being fabricated and assembled elsewhere in Canada.

The above explains briefly why the firm was able to enter the war production business and the following will outline what the E.I.C. members saw in the foundries and shops.

The arrangement of guides was very good as each party consisted of five or six members only, so that in some of the noisy shops each person could hear their guide's information.

We first witnessed the forging of a gun barrel blank, from an 8,000 lb. ingot, under the dies of the 1,000-ton hydraulic press. During this operation the forging is balanced in an endless chain manipulator, which handles the hot metal with the skill of a human juggler. When the forging is completed it is heat treated for machinability.

The foundry is busy producing armour castings for tanks and Bren gun carrier castings.



First blow of 1,000-ton press.

Next we went to the Machine Shop and saw a piece being turned on a low swing eight-tool lathe. This operation is completed in four hours following which the piece is bored on a double-ended boring lathe to a size that we are requested to call " blank." The guns are then heated in a 30-ft. deep electric furnace and are treated in pairs, in each furnace, suspended from a jig that passes through the furnace door and then rests hanging on a beam or bracket that crosses over the top of the furnace. The furnace is about 7 ft. in diameter and the top is about 4 ft. above the shop floor; thus the " door " referred to is the top or hatchway of the furnace.

This circular furnace or well is divided into 5 zones, each of which is under close pyrometric control and each of these zones can be controlled to a + or — 5 deg. range. This is very different from the old fuel-fired furnaces.

It is very impressive to see the two 20-ft. long barrels brought up, vertically, from out of this white hot electrically heated well.

The barrels are now carried a short distance to a similar well, except that it is 35 ft. deep and filled with oil. The hot metal is rapidly lowered into the oil and quenched. After 45 minutes in the oil they are again raised and placed in another vertical furnace for temper.

At the end of this shop, six machines stand close by where tests are prepared for observation and acceptance—or rejection—by the British representatives.

Passing into the Armour Plate Department we saw the processing of armour plate and bullet proof plate ranging in gauge from 3 to 60 millimetres. Here we also saw the cast steel tank turrett. This complete casting, in one unit, supersedes the former fabricated turret which was made up of rolled plate and castings which involved considerable cutting and fitting. This new unit enables a saving of 75 per cent. of man-hours machinery time. This development was conceived by this plant during the past few months and had to receive the approval of the British Government after it had been devised.

Next we went to the Melting Department. All the gun

Close up of lathe rough turning gun.

and armour plate steel is melted in electric arc furnaces. There are two 10-ton furnaces and one 25-ton furnace. Nearing completion is a 50-ton electric furnace which will have a transformer capacity of 12,000 kva. and this branch of the Institute was pleased to hear that this unit of the furnace is built by the Canadian Westinghouse Company.

The " open hearth " capacity consists of four 60-ton Isley control furnaces. This kind of furnace is found to be most suitable for melting and refining of the " bottom poured " steel the firm is producing.

Next we went to the Tin Plate Mill. The processing of tin plate starts with the continuous pickling of the hot roll strip, which is then cold reduced in either the 36-inch or the 42-inch four high cold reduction mill. The processing of tin plate strip in this type of mill is revolutionary and marvellous and it was hard to get the party away from this operation. The pressure exerted by the main screws on this mill runs as high as 1,000,000 lb. on each screw.

The processing was carried through the cleaning line where the surface is de-greased and made chemically clean and then on through the annealing department. In the Annealing Department the coils are annealed in radiant tube inert atmosphere furnaces. From there to the Temperature Mill the strip is reduced 1, 2 or 3 per cent. to give it the desired temper. For example, the temper required for a bottle top is quite different to that required for a sardine can.

Next it goes to the shear line in which a " flying shear " cuts the travelling strip faster than one can count. An electro limit gauge segregates heavy or light gauge material automatically. These bright steel sheets then go to the Tin House to be given their coating of tin. This is done automatically, the sheets being fed singly into the tin pot by a system of magnetic rolls. The steel sheet is now completed and becomes known as " tinplate."

After inspection and packing the tin plate is shipped to some of the many packing factories of the Dominion.

After the members had completed the tour of the works, they were taken back to the cafeteria where a most enjoyable light supper was served.

Mr. C. H. Hutton proposed a vote of thanks to Mr. Lamont for his lecture and the able way he had conducted the visit and asked him to thank the management, and particularly Mr. F. A. Sherman and Mr. F. A. Loosley, both Hamilton branch affiliates, for this most instructive evening.

LAKEHEAD BRANCH

W. C. Byers, jr.e.i.c. - *Secretary-Treasurer*

A dinner meeting was held at the Italian Hall in Port Arthur on October 15th at 6.45 p.m. There were 34 members and guests present.

The chairman, B. A. Culpeper, presided at the meeting and five short addresses were given.

G. H. Burbidge spoke on **Lakehead Winds**. He mentioned the various mythical conceptions of winds and with charts he described the causes and actions of the various prevailing and trade winds and showed the differences between cyclones, tornados and thunderstorms. He then described a diagram showing statistics of average velocities and maximum wind recordings of Lakehead winds.

J. Koreen explained briefly the **Building of a Ship.** He referred to the building of the Ark, the length of which was six times its width, the same proportions as are used in modern ship construction. Previous to 1840 all ships were made of wood and seldom exceeded 200 ft. in length. He showed pictures of the first British passenger ship, the *Comet,* which was 43 by 11 by 5 ft. and the latest, the *Queen Mary,* which was 1018 by 118 by 135 ft. He described various phases of shipbuilding and illustrated these with plans and photos.

S. T. McCavour spoke on the **Trials and Tribulations of the Pulp and Paper Industry in Wartime.** During the first two years of the war the industry provided $400,000,000 of foreign currency, and has the largest Canadian industrial payroll being approximately $50,000,000 annually plus woods operation. It consumes about half the industrial electrical energy sold in Canada. The industry met the needs of the United Kingdom when European markets were cut off. The speaker then described problems arising from the war and how the industry was meeting them. Every Canadian mill is practically running at capacity.

R. J. Prettie talked on **Pre-fabricated Hangars.** He described the methods of preframing and the use of ring connectors for joining the timbers. Timber shrinkage presented no problems because the wood was treated with a chemical which attracts moisture and thus keeps the wood from becoming absolutely dry. The speaker illustrated his talk with plans and photos.

H. P. Sisson gave an address on the **Building of a Road.** He reviewed the history of road building in the Thunder Bay district, the earliest account of which was found in a report of 1857 made by the Red River expedition. He described the work of survey parties and the constant struggle to open up the country. Most of the earlier work was done voluntarily. He outlined work done by the provincial government; the establishment of a colonization road branch in the late 19th century; the organization of the Department of Northern Development in 1911, and the change-over in 1937, when the maintenance and construction of local roads was taken over by the Department of Highways. There are now 1595 miles of roads in the district.

W. H. Small tendered a vote of thanks to the various speakers.

LONDON BRANCH

H. G. Stead, jr.e.i.c. - *Secretary-Treasurer*
A. L. Furanna, s.e.i.c. - *Branch News Editor*

The branch held its regular meeting on Wednesday, October 29th in the drill hall of the Talbot Street armouries.

The chairman, R. W. Garrett, introduced Mr. Saunders of the Canadian General Electric Company who showed moving pictures of the present war. These pictures are the property of Mr. H. R. Henderson of Woodstock, who loaned them in aid of the " Milk for Britain " Fund.

The first scenes were of the Russian invasion of Finland. Following these were pictures of the German pocket battleship *Admiral Graf Spee* taken as it limped into the port of Montevideo after its engagement with units of the British fleet. Other pictures showed the ship partially submerged, twisted and burning where it lay scuttled by its own crew. Then was shown the German march into Denmark and Norway. These pictures included several in which the British fleet was seen in action during a raid on the port of Narvik. Following these were pictures of the German advance through the Netherlands and Belgium, then into France and the Maginot Line. Some of the most remarkable pictures were taken during the retreat at Dunkerque. The third reel was of the Italian invasion of Ethiopia, Albania and Greece and ended with scenes of the British campaign against the Italians in Africa. The final reel was a colour film of the Royal visit taken in Ottawa and Toronto.

The large number of members and guests in attendance included several officers from the headquarters of Military District No. 1.

A silver collection was taken in aid of the "Milk for Britain" Fund.

NIAGARA PENINSULA BRANCH

J. H. Ings, M.E.I.C. - *Secretary-Treasurer*
C. G. Cline, M.E.I.C. - *Branch News Editor*

In connection with the opening of the Rainbow Bridge recently constructed over the Niagara River at Niagara Falls, a dinner meeting of the Niagara Peninsula Branch was held at the General Brock Hotel on October 29th. The branch chairman, A. L. McPhail, presided and there was an attendance of 105.

Mr. C. E. Kaumeyer, general manager of the Niagara Bridge Commission, introduced the first speaker, Mr. Shortridge Hardesty, LL.D., of Wardell and Hardesty, who spoke on the design of the bridge, using lantern slides to illustrate his subject. The new bridge was built for the Niagara Falls Bridge Commission to replace a former two-hinged arch span, owned by the International Railway Company, which was destroyed by ice in January 1938. The new bridge is 400 ft. downstream from the old bridge and the deck was raised to cross over roadways on each bank and give better approach conditions. The springing points of the new arch were raised 30 ft. and the span was lengthened 110 ft. to give a total span of 950 ft., which makes this the longest plate-girder arch ever built. The first preliminary designs were for a two-hinged arch, but the hingeless arch design was adopted finally to give greater stiffness. The two box-type ribs are 144 ins. deep and 54 ins. wide and are stiffened by internal plates and by angles. The ribs are spaced 56 ft. on centres and have K-type lateral bracing at the top and bottom flanges, the struts at each panel point being trussed to form a sway frame. The deck framing is supported by square spandrel columns which were left unbraced to improve the appearance. The approach structures at each end of the main span are of reinforced concrete. Further details can be found in an article by Dr. Hardesty published in the September issue of *Civil Engineering*.

The second speaker was Mr. E. L. Durkee, erection engineer of the Bethlehem Steel Company, who described the general erection procedure and commented on the motion pictures taken during erection. The method of erection was described in the Branch News section of the August *Journal* in the report of the June meeting of the branch. Even those who had heard Mr. Durkee before, found much of interest in this second showing of the pictures.

Councillor W. R. Manock moved a vote of thanks to the two speakers.

OTTAWA BRANCH

R. K. Odell, M.E.I.C. - *Secretary-Treasurer*

The initial event of the fall and winter season of the Ottawa Branch was a noon luncheon at the Chateau Laurier on Thursday, October 23rd, at which President C. J. Mackenzie spoke upon the subject of **The Role of the Research Worker in War**. Dr. Mackenzie indicated the place in the war effort now occupied by the National Research Council, of which he is acting president.

Workers who had been engaged on pure research before the war, both in Great Britain and Canada, are now engaged on problems of immediate and vital importance to the war effort, declared the speaker. These trained men had had to turn their talents away from pure research to *ad hoc* problems and were found to be excellently suited to carrying on such work. This is just one more argument in favour of keeping up research work during peace times, for the value of research in wartime, has been established beyond question. "If scientists had not been able to overcome the magnetic mines used by the enemy, and to do that quickly, there is no need for going into details of what might have happened," stated Dr. Mackenzie.

In the present effort, team-play counts for a great deal. Any resemblance to a caste system, maintaining differences between research men, and the mechanics who work with them, can no longer be found. Quite often the most valuable team is the university man, and the workman at the bench, working together and there is always fine harmony between them.

There is one thing that must be remembered, however. Under war conditions, time is a vital element and radical changes involving extensive delays are not feasible. Unless we can put the equipment in the hands of the man in the field, it is of no use. In some cases, therefore, it is better to go ahead with inferior equipment than to try to make the effort to change. This would be the case with large items when major changes involved an extensive time element.

With small items it is possible to effect changes in a reasonable length of time and these can be made. Also in the "middle field" of tanks, planes and other like equipment, changes may have to be made as the battle goes on in order to keep pace with or keep ahead of the enemy. This is a very difficult field in that the development end and the production end of the whole process may have to be "telescoped" as much as possible. Quite often a compromise has to be made and a design "frozen" at some point in order to go ahead with production.

Since the war started, real studies have been made in many fields in Canada. There exists an excellent liaison between scientists in this country and those of Great Britain and United States, through personal contact and interchange of personnel, thereby enabling the work to be correlated. "We are not working in a vacuum in Canada", stated Dr. Mackenzie.

T. A. McElhanney, chairman of the Ottawa Branch presided, and included among the guests at the head table were three past-presidents of the Institute: G. J. Desbarats, Dr. Charles Camsell, and Dr. J. M. R. Fairbairn.

Previous to the president's address, the chairman announced that a mantel clock with chimes had been sent by the Branch, to the officers' mess of the Royal Canadian Engineers' Training Centre at Petawawa. It was sent to them following a visit of the branch to the training centre during the summer, and was acknowledged by the commanding officer and the mess president.

PETERBOROUGH BRANCH

D. J. Emery, M.E.I.C. - *Secretary-Treasurer*
E. Whiteley, S.E.I.C. - *Branch News Editor*

At the technical meeting on October 23rd, Mr. A. E. Byrne of the appliance and merchandise department, Canadian General Electric Company Ltd., Toronto spoke to Peterborough Branch about **Plastics**.

Mr. Byrne described in broad outline the field of plastics as it is to-day and the probable trends. The main classes of plastics were shown, their derivation, outstanding properties and typical uses being mentioned in each case.

This was one of those papers, particularly useful in these days of restricted material supplies, which can

At the Regional Meeting of Council in Quebec City. From left to right, A. B. Normandin, Past-Presidents O. O. Lefebvre and A. R. Decary, Alex. Larivière, Hector Cimon and Bruno Grandmont.

greatly assist the puzzled engineer in an intelligent appreciation of as many available materials as possible and their field of usefulness.

QUEBEC BRANCH

Paul Vincent, m.e.i.c. · *Secretary-Treasurer*

The president of the Institute, Dean C. J. Mackenzie, honoured the Quebec Branch with his visit on November the 15th.

At 1.30 p.m. a reception at the Chateau Frontenac was given to officers of the Institute, who had come to Quebec to attend the regional meeting of the Council. Besides

The president was guest of the Quebec Branch at the luncheon before the Council meeting. From left to right, President C. J. Mackenzie, Chairman L. C. Dupuis, Past President O. O. Lefebvre.

the president, there were among the guests Vice-Presidents de Gaspé Beaubien, Montreal; K. M. Cameron, Ottawa; Councillors W. R. Manock, Fort Erie; J. A. Vance, Woodstock; Huet Massue, Montreal; A. Larivière, Quebec; J. H. Frégeau, Three-Rivers; Treasurer John Stadler, Montreal and General-Secretary L. Austin Wright, Montreal; Past Presidents O. O. Lefebvre, J. B. Challies, A. R. Decary; Past Vice-Presidents J. H. Hunter, W. G. Mitchell, Hector Cimon, and A. B. Normandin; Dr. A. H. Heatley, chairman of the St-Maurice Valley Branch; Dr. Paul Gagnon, of Laval University, Quebec, the officers and several members of the Quebec Branch. This was an excellent occasion for all to meet and chat.

At two o'clock, all sat for the luncheon which was presided over by L. C. Dupuis, chairman of the Quebec Branch. Mr. Dupuis welcomed the Headquarters party, expressed the pleasure of the branch at having them present and introduced the president.

Dean Mackenzie expressed his delight for this opportunity to visit the Quebec Branch and his appreciation of the hearty welcome of the members.

He then spoke in an informal way on the **National Research Council Work in Relation to the Present**

L. D. Swift, Jean Saint-Jacques, René Dupuis, Théo. M. Dechene, Adhémar Laframboise.

War. As acting president of the National Research Council Dean Mackenzie described the work done by this organization. He gave a very interesting outline of the tasks undertaken in every field, and especially in aviation.

He stated that the present war had developed into an engineer's war and the engineers and the technicians were working together as a team by pooling their resources. Through this scientific research Canadian engineers, he mentioned, helped greatly to make the British supreme in the air.

Scientific research to-day meant the full co-operation of all the individuals from the Ph.D. to the mechanic at the bench and the importance of one individual over another could not really be established.

He expressed that we had to be prepared for a long and hard industrial war, which included four steps: research and development; engineering design; industrial production; and fourthly, the operations by and equipment of the men.

In view of this fact, the National Research Council

From left to right, Branch Chairman L. C. Dupuis, Past-Presidents O. O. Lefebvre, J. B. Challies and Past Vice-President J. H. Hunter.

·Bruno Grandmont, Philippe Méthé and Alex. Larivière.

R. B. McDunnough, W. R. Manock, J. A. Vance and Gustave St-Jacques.

was planning to increase its staff of nearly two hundred to some nine hundred and to spend five times more money than their last budget of $800,000, in order to operate on a much larger scale in the four divisions of the Council: mechanical engineering, physics and electrical engineering, chemistry and biology.

Past Vice-President Hector Cimon thanked the speaker in the name of all members.

A short recess followed the lunch, after which Council members invited all Past-Presidents, Past Vice-Presidents, and the officers of the Quebec Branch to the regional meeting. This meeting was adjourned at 5.30 p.m.

At the close of the meeting, Dr. A. H. Heatley and Dr. Paul Gagnon moved a vote of thanks for the kind invitation which had been made to them to attend Council's deliberations.

SASKATCHEWAN BRANCH

Stewart Young, M.E.I.C. - *Acting Secretary-Treasurer*

A special meeting of the Saskatchewan Branch was held in the Saskatchewan Hotel on Thursday, September 25th, to meet the president Dean C. J. Mackenzie. At the noon luncheon, at which the attendance was thirty, Dean Mackenzie spoke of his activities as acting president of the National Research Council of Canada. The meeting adjourned at 2 p.m. to meet at 4.30 when Dean Mackenzie addressed the meeting on the activities of the Institute Both meetings were entirely informal and at the conclusion, Mr. L. A. Thornton moved a hearty vote of thanks to the president, expressing gratitude at his being able to stop over for the day in Regina.

TORONTO BRANCH

J. J. Spence, M.E.I.C. - *Secretary-Treasurer*
D. Forgan, M.E.I.C. - *Branch News Editor*

The Debates Room, Hart House, was filled almost to capacity on November 6th for the second meeting this season of the Toronto Branch of the Institute. Mr. H. E. Brandon, branch chairman, conducted the meeting.

The speaker of the evening, Mr. D. C. Tenant of the Dominion Bridge Company, who is well known in both Toronto and Montreal, was introduced by Dean C. R. Young. His subject was **Air Raid Precautions, Structural Defence,** and the large attendance testified to the widespread interest felt in this timely subject. It is expected that his paper will be printed in an early issue of the *Journal.* Mr. Tenant's most interesting talk was illustrated by lantern slides, and at its conclusion a further vivid description of the actual results of German bombing in London, profusely illustrated by actual photographs, was given by Captain Gordon Kennedy. The latter has spent several months in London and England until returning to Canada recently. At the conclusion of both talks a considerable amount of discussion took place, during which some illuminating information in regard to the behaviour and structural protection afforded by various building materials, was brought out. The thanks of the meeting were expressed by Mr. W. E. P. Duncan.

Owing to its conflicting with other previously scheduled engineering affairs, the third meeting for the year which was to have been held on November 20th, has been cancelled.

VANCOUVER BRANCH

T. V. Berry, M.E.I.C. - *Secretary-Treasurer*
A. Peebles, M.E.I.C. - *Branch News Editor*

The branch opened its season with a dinner-meeting in honour of Dean Mackenzie, president of the Institute, during his recent visit to the western branches. The meeting was well attended, and members were treated to a splendid address by Dean Mackenzie.

He spoke principally of his experiences with engineers who are engaged in war production and training. In his position as head of the National Research Council, Dean Mackenzie comes into intimate contact with all branches of war work, both in industry and in the services. His descriptions of the work done by the engineering profession, and the part taken by members of the Engineering Institute of Canada, were both illuminating and of deep interest to the Vancouver Branch.

Others who spoke briefly were two past-presidents of the Institute, Major G. A. Walkem and Dr. E. A. Cleveland. Dean J. N. Finlayson, branch chairman, presided over the meeting.

The first programme meeting of the season was held in the Medical Dental building on October 16th. The speaker was Mr. Jack Cribb, superintendent of West Coast Shipbuilders Ltd. His subject was **Some Marine Salvage Experiences of the Pacific Coast.**

Mr. Cribb traced the marine salvage history of the Pacific coast, in which he has played a prominent part. He then recounted in detail some of the most interesting and spectacular salvage jobs which have been carried out on this coast. From the narrow channels and rocky shores of northern British Columbia to the sandy beaches of Guatemala and Mexico, each salvage job presents its own problems. Every branch of engineering is involved to some degree, and the salvage superintendent must understand the methods of mining, logging, civil, electrical and mechanical engineers, as he may have to apply any or all of these to some particular salvage operation. One ship will be rescued by hydraulic dredging of sand, another by building a cofferdam around her, or by blasting away the rocks on which she is grounded. Again, the cargo may be salvaged by a logger's skyline, and in every case the salvor must set up and keep in operation many types of equipment and machinery under difficult conditions of weather and remoteness. On occasions he may have to contend with hostile government agents or hijacking beachcombers, and must be able to deal tactfully and successfully with the numerous interested parties who cluster around the wrecked vessel. Some operations are highly remunerative, others are just the opposite, but in every case the risk is high, and those who undertake it must not be lacking in ability or the courage to work in the face of great odds.

In closing, the speaker expressed the opinion that nine out of ten marine mishaps are the direct result of incompetence and carelessness on the part of someone, be it the builder, owner, or captain of the vessel.

A vote of thanks was tendered the speaker for his delightfully informal and non-technical story, by Mr. W. H. Powell. Several among the thirty-two members and visitors present, contributed to an informal discussion.

Tool Steels—Their Use from the Viewpoint of the Shop. This was the subject of a paper presented to the branch on November 6th, by W. O. Scott, vice-chairman of the branch, and assistant superintendent of the Dominion Bridge Company in Vancouver.

Mr. Scott first gave a list of the tools and equipment requiring a special quality of steel which would be found in the average shop not engaged in mass production work. These included punches, dies, chisels, rivet snaps and dies, shear and saw blades, drift pins, taps and dies, hand tools, drills and blacksmith tools. Other special equipment depending upon the nature of the work done includes, in the case of a structural shop, lattice bar punches and dies, square hole punches and dies, spacing tables for multiple punching, boring and milling machine tools, rotary planer tools, threading tools, reamers, as well as various small machine parts which are subjected to severe shock or wear. The items requiring some special type of steel will number many thousand, and these must be made and repaired in the shop itself in most cases, as it is not always possible to secure the necessary item quickly enough from a machine tool manufacturer.

The common requirements of a special steel for such tools and parts are hardness, toughness, high cutting speed, resistance to impact, durability at high temperatures, machinability, and the properties necessary for dies of intricate design. These properties will be desired in varying degrees for each purpose, and the selection and treatment of a material will determine its subsequent behaviour in service.

Most of the ordinary tools may be made from a straight carbon steel. The controlling factor is the carbon content which may range from 0.4 to 1.4 per cent, thereby providing a wide variety of steels for different types of service. The speaker showed a chart of carbon steels, indicating the range of carbon contents for each tool in common use.

In many cases, desirable qualities can be improved by the use of an alloy steel. Alloys will also provide more accurate dies and tools, due to the reduced shrinkage and distortion under heat treatments. A comprehensive chart was displayed, showing the effects produced by the common alloy metals, manganese, chromium, nickel, tungsten, vanadium and cobalt. Some of the desirable qualities of the steel will be increased and some will be decreased by the addition of the above metals. This is according to whether the alloy metal tends to unite with the ferrite portion or the iron carbide portion of the steel. The phenomenon of grain growth, which is a factor in hardness and toughness, is also affected by alloying. Grain growth at high temperatures is retarded, which preserves better these qualities under such circumstances. Another quality acquired in alloy steels is greater uniformity of heat treatment throughout the thickness of the piece. Carbon steels are usually hardened to a very limited depth below the surface, leaving the interior relatively soft.

At the present time there are many tool steels on the market under trade names. These are merely alloy steels of a definite composition, and they will perform the same work as any other steel of the same composition. They should not be treated any differently, regarding the work which they are expected to do, than any tool steel of some specific chemical composition. It is necessary to follow a manufacturer's specifications closely when the composition of his product is not furnished, just as it is necessary to use the correct treatment with any steel of standard composition. Tools are also available, made by casting, pressing and sintering materials other than iron. These are special purpose tools which require different treatment and application than steel tools.

Some discussion took place after Mr. Scott's address, and a vote of thanks was proposed by Mr. P. Buchan. Dean J. N. Finlayson, branch chairman, presided, and thirty-five members and guests were in attendance.

VICTORIA BRANCH

Kenneth Reid, M.E.I.C. · *Secretary-Treasurer*

Spans in Time and Space was the intriguing subject of an address presented before the Victoria Branch of the Institute by Sir Heaton Forbes Robinson, C.G.M., M. Inst. C. E., on the evening of Monday, October 27th. The meeting was preceded by a dinner to which were invited all engineers serving locally in any of His Majesty's Services, whether members of the Institute or not. Twelve engineers in the naval and army services were guests of the branch on this occasion. Altogether thirty-two members and visitors were present.

Sir Heaton Forbes Robinson is an engineer of wide distinction having practiced extensively on the continent of Europe, in South Africa, and in the Argentine in South America. He is now retired and living in Victoria and this Branch is fortunate in securing him as a speaker. Sir Heaton is a graduate of the University of London and a Member of the Institution of Civil Engineers of Great Britain.

In introducing his subject, Sir Heaton Forbes Robinson contrasted the working conditions of half a century ago with those of to-day when an engineer paid for his apprenticeship and worked from 6 to 6. Wonderful advances have been accomplished during the past 50 years. What have the next 50 to offer? Looking back, tremendous developments have taken place particularly with regard to tools, material and fundamental principles connected with bridge building and design. The speaker went on to trace this development from as early as the stone age showing the advance in the use of clean cutting edges, the chisel, axe, saw, file and the turning lathe, a transition from the wheel. The advance in development of materials, wood, stone and metals contributed its effect. Improvements in fundamental principles contributed to the suspension bridge, lintel, corbel, cantilever and arch.

Various types of early bridges in use in widespread parts of the world were then described and the development of modern structures traced from them down to the modern suspension bridge. By means of carefully prepared charts, the speaker showed the fundamental types of spans; the lintel and posts, the truss, which was a tappered lintel with the inside cut out; plate girders, exaggerated lintel; lattice girders, such as used on the Quebec bridge; and the arch.

Sir Heaton concluded by a comparison of music and bridge building; the fundamental principles of each being few but equally interesting. He compared the musical symphony to an automobile; the changing tempo to the changing gears—the automatic gear shift is equivalent to the perfect musical score; the model T Ford to the silly symphony.

A hearty vote of thanks was accorded the speaker for a most interesting address.

Seven reels of motion pictures showing mechanical equipment engaged in actual fire-fighting scenes in the forests of British Columbia and kindly supplied and operated by Mr. J. H. Blake of the Provincial Forestry Department completed the evening.

On the evening of November 10th the members of the Victoria Branch met to witness the showing of the Institute's motion picture film on the **Tacoma Bridge Disaster**. The meeting was preceded by the customary dinner at Spencer's dining room.

Sufficient comment has already been made concerning this marvelous film. As was stated by many present, the Institute is to be congratulated on its enterprise and initiative in acquiring and distributing this film to the various branches across Canada. It has virtually to be seen to be believed, and provides an opportunity for study and comparison of such bridge structures and the possibility of unforseen behaviour under unfavourable conditions.

During, and following the showing of this film, the branch was fortunate in having Mr. A. L. Carruthers, provincial bridge engineer, to augment the descriptive portion of the picture. Mr. Carruthers was very familiar with this bridge and its behaviour subsequent to construction. He explained the unusual behaviour and the building up of periodic vibrations until dangerous proportions could be reached. His remarks were illustrated by the aid of several slides from his own collection. This combination of motion pictures and descriptive comment proved a most interesting subject indeed.

Further moving pictures shown by Mr. J. H. Blake of the provincial forestry department depicting the opening of the Big Bend Highway and other subjects rounded out a very interesting and instructive evening.

WINNIPEG BRANCH

C. P. Haltalin, m.e.i.c - *Secretary-Treasurer*
T. A. Lindsay, m.e.i.c. - *Branch News Editor*

The Winnipeg Branch held its first meeting of the 1941-42 season on October 16th in the Broadway Building of the University of Manitoba.

A motion picture, **The Tacoma Bridge Failure** was presented to an excellent attendance of one hundred and forty-one members and visitors.

Mr. J. C. Trueman, designing engineer, Dominion Bridge Company, Winnipeg, introduced the picture with a short historical paper. He traced the development of suspension bridge design from its early beginnings of about 140 years ago to the present. During the first fifty years of this period there were a number of failures by wind action. The behaviour of some of these failures bore a striking resemblance to the mode of failure of the Tacoma span.

These early bridges were light structures with plank deck built for horse-drawn vehicles. They did not have much in the way of stiffener trusses. About the end of this early period at the middle of the last century, Trautwine, of handbook fame, suggested that the danger arose " from action of strong winds striking below the floor either lifting the whole platform and letting it drop or imparting to it violent wave-like undulation ". He proposed that substantial trusses be used to dampen the undulation.

Coincident with this suggestion, the demands of the heavy live-load concentrations of railway and suburban trains made obvious the necessity of stiffener trusses to distribute these loads along the flexible cable. Following the use of a substantial stiffener truss, trouble from undulation ceased and there were no further failures from this cause until the present.

There seems to be some doubt whether the function of the stiffener truss to dampen undulations, as well as to distribute live-load concentrations, was generally understood at the time of its introduction. Probably it was thought, and understandably so considering the data available, that dead load heavy enough to resist wind uplift was sufficient for this purpose. We do know, however, that subsequently-developed methods of designing the stiffener truss did not directly consider the dampening function.

The modern trend to lighter girders was the direct result of the smaller live-load concentrations of automobile traffic. The Tacoma bridge girder was stiff enough to distribute this live-load but not to dampen the undulations. The low vertical stiffness combined with the narrow width resulted in insufficient torsional rigidity.

The heavy deck of the modern suspension could not be raised by direct wind uplift and when undulations appeared the aerodynamic origin became apparent. Looking back it appears likely that the failures of the early structures of a century ago were due to this same phenomenon. There had been, however, no evidence or analysis which would have lead to this conclusion until the present development. It has apparently taken the failure of a modern, hardly comparable, structure to fully explain the failures of those pioneer structures of one hundred years or more ago.

Mr. Trueman had a table summarizing some of the main characteristics of several long suspension bridges. The table showed how much more flexible vertically, horizontally and in torsion, the Tacoma bridge was, compared to other bridges of like span.

The picture followed and showed very graphically the extraordinary nature of the failure.

Following the showing of the picture there were numerous questions and considerable discussion which brought out some very interesting points as regards design and aerodynamic action. Mr. Trueman was quite confident that safe, adequate, light, long span bridges can be built with the present knowledge. He thought that research would probably make for economies in design.

News of Other Societies

Items of interest regarding activities of other engineering societies or associations

ENGINEERING EXAMINERS SEEK BETTER LAW ADMINISTRATION

Means for improving the handling of applications for professional registration were the chief subjects of interest at the 22nd annual meeting of the National Council of State Boards of Engineering Examiners held in New York Oct. 27-30. Represented at the meeting were 35 of the 44 member boards of the council, the largest registration at any meeting of the council. In addition, members of the Engineers Council for Professional Development meeting concurrently in New York, took part in the discussion.

A recommendation from the secretary that the publication of a registered engineers national directory and handbook be undertaken if a satisfactory proposition for the publication of such a directory can be obtained was approved, provided that it involved no financial commitments on the part of the council.

Qualification

Wide divergence in the practices of the several registration boards with respect to the qualifications of applicants for registration were noted by the committee on qualifications for registration. The committee observed that some states lay principal stress on the knowledge of the fundamentals of engineering while others give much greater weight to practical experience. To aid in obtaining greater uniformity in qualifying applicants, the committee presented for adoption an outline of requirements basic to a determination of competence. It also presented for approval a set of general principles to be applied to interviews of applicants for registration, and a set of general requirements basic to all branches of engineering that should be applied in determining whether the four years of qualifying experience required under most registration acts are up to adequate standards. This latter general statement was supplemented by a detailed statement covering civil engineering. Following approval of the committee's report, it was instructed to prepare similar detailed statements for the other major fields. With respect to civil engineering, the report states " All four years should be of a calibre equivalent to that described under and classified as Grade 1 by the American Society of Civil Engineers' Committee on Salaries," as published in the February, 1939, issue of *Civil Engineering*.

Engineering Examinations

Prof. J. H. Dorroh, chairman of the New Mexico board, stated that the preparation of examinations and the grading of papers presented by applicants for registration had not generally reached a satisfactory status. This matter is less serious with the respect to examinations in fundamentals, he said, than with professional examinations. In the latter, there is a serious lack of information as to how to bring out satisfactorily the evidence of a man's ability to apply his fundamental knowledge. In discussion it was stated that the committee on qualifications for registration is collecting examination papers and making a study of them in the hope of improving practices in this line.

The committee reported that in about one-fourth of the states the qualifications for registration are substantially below those of the model law. This is especially true of the older laws. The committee urged the council to work more aggressively for improvement of these laws.

Professor C. C. Knipmeyer, the new president of the N.C.S.B.-E.E. (right) and the secretary, Mr. Keith Legaré (left).

Registration Laws

Wide divergence of views developed in discussion of the recommendation of the committee on qualifications that the national council ask the Engineers Council for Professional Development to make a study of engineering registration laws and of examining board procedures with the object of bringing out the weak points in the laws and in their administration. Some members of the council maintained that such a study should be a basic function of the council itself, not of an outside agency, while others held that an outside agency would have less hesitancy in pointing out defective laws or in their administration than would the council itself. Chairman Dorroh suggested that E.C.P.D. might accredit state licensing just as it accredits engineering schools, but Dean N. W. Dougherty of Tennessee took strong exception to this view on the basis that practices with respect to registration are matters of state law while the make-up of the curricula of engineering schools is not a matter of law but a matter that can be changed by the faculty of the school at will. Also, he said that he does not believe that divergence between states in the matter of licensing requirements and examination of applicants is as important as some people believe it to be.

Problems raised by efforts to promote reciprocal registration between states for the benefit of engineers who practice in several states were discussed by D. B. Steinman in a report by the committee on interstate registration. The committee stated that insistence on reciprocal registration is a form of coercion toward relaxing responsibility and lowering standards. It urged more general use of "registration by endorsement" under which registration is permissive rather than mandatory, decision in each case being left to the board as to whether it will grant registration to a registered applicant from another state on his record without re-examination.

Effect of Registration

Broader aspects of the registration movement were considered in a general discussion of the report of the committee on the effect of registration, presented by Prof. Charles F. Scott. Professor Scott recommended that the council ask E.C.P.D. to prepare a pamphlet for the use of engineering students and young engineering graduates to help them in rounding out their development in the period before they apply to the registration board for admission to practice. President Harry F. Rogers of Brooklyn Polytechnic Institute endorsed the views expressed by Professor Scott as to the desirability of doing more for the young engineers in their formative period and urged the council to co-operate with the professional groups in such work.

The desirability of requiring applicants for registration to give their endorsement to a code of professional ethics as part of their application for registration, as is now done in some states, was put forward as a desirable step in developing professional consciousness. A major obstacle to such practice is lack of a universally acceptable code of ethics for the engineering profession. Development of such a code by E.C.P.D. was recommended as an objective to be sought in the near future.

The question was raised by P. S. Callahan from California as to the legality of asking applicants to subscribe to a code of ethics, stating that in his opinion enforcement of codes of ethics was a function of the professional societies rather than of the registration board. Exception to that view was taken by F. E. Rightor, secretary of the Texas board, who pointed out that under the model law a license can be revoked for unprofessional conduct, and that lawyers look upon subscription to a code of ethics as the best way to define what is and what is not professional conduct.

A feature of the meeting was the annual dinner, attended by representatives of the major engineering societies both in this country and in Canada, at which Mayor La Guardia took a few minutes from his political campaign to talk to the group, urging them as engineers to take a more active part in the new era into which, in his view, we are entering.

C. C. Knipmeyer, professor of electrical engineering at Rose Polytechnic Institute, Terre Haute, Ind., was elected president to succeed Virgil M. Palmer of Rochester, N.Y., and J. H. Dorroh, dean of engineering at the University of New Mexico, was elected vice-president. New regional directors elected were George M. Shepard of St. Paul and F. W. Anderson of Lexington, Va. The next meeting is to be held in Indianapolis, Ind.

A.S.M.E. ANNUAL DINNER

President Looks Ahead to Post-war Period

Speaking at the annual dinner of the American Society of Mechanical Engineers at the Hotel Astor, New York, on December 3rd, William A. Hanley, president, called for " some realistic thinking and some definite planning " for the post-war period.

While pledging full support of the engineering profession to the task of carrying out our government's pledges and restoring peace to the earth, Mr. Hanley said that it was the job of every individual in the country to help prepare for the situation to be faced when the war ends.

Based on the estimate of the U.S. National Resources Planning Board that, if the war continues, nearly half of the country's 55,000,000 workers in 1944 will be either in defence projects or under arms, Mr. Hanley said that when the war ends the United States will have the colossal job of putting more than 26,000,000 workers back into peace-time employment.

Unless government is to put fifteen to twenty million on WPA work and in CCC camps, Mr. Hanley said, the alternative " is to prepare now to create jobs in private industry, and to plan to reduce government employees to a bare necessary number."

"If all the men and women in America will become interested in this post-war employment," he declared, " and will individually adopt a policy to help in the solution, we can solve the problem, and America can thrive as she did thrive from 1790 to 1930. The solution lies with individuals to a greater degree than it does with corporations, municipalities or other groups.

"As individuals, as corporations, as cities and states and as a nation we should reduce our peace-time expenditures now, so that we can accumulate money to spend, and then spend it, when the war is over. Accumulate needs and money now. Satisfy those needs and spend the money when the war ceases.

" If we could have ten million orders for new automobiles in the first two years after the war, it would be very helpful. If the majority of car owners will drive their cars twenty-four months longer than has been their custom, then we should have the ten million orders for automobiles. As a patriotic duty, to save this nation at home, to save our form of life for ourselves and our children, to avoid fascism, we should not only have this demand for ten million new automobiles but for great quantities of goods and commodities which must be produced by labour. We should accumulate the need for clothing, home furnishings, new equipment for homes and in addition accumulate the need for several million new homes.

" Millions of men can go back to work on these jobs alone, if this back-log is provided. There may be some personal inconvenience in such a programme of waiting, but surely the sacrifices will be greatly repaid in helping create a staple economic condition in America.

" In the same way the commercial organizations should have an accumulation of man-hour projects which have been postponed until the war is over and then should carry forward such projects fearlessly, to assist the job programme.

" The town and city should, where possible, postpone the paving of streets, building of bridges, municipal buildings, extension of utility services, etc. In like manner the respective states might well postpone as far as possible the paving of roads, and repairs and additions to state institutions. The churches, schools, hospitals and non-profit organizations can all contribute to this great effort of accumulation, and if we will all do our part the WPA and CCC can pass into history.

" Let us measure up to our responsibilities in not only winning the war," Mr. Hanley concluded, " but in winning the peace, and in so doing continue our way of life for ourselves and our children, as we received it from our parents and from those whose great sacrifices created it for us. This country has gone through many crises. Surely in this one, when we have the stewardship, we shall not fail."

Library Notes

Book notes, Additions to the Library of the Engineering Institute, Reviews of New Books and Publications

ADDITIONS TO THE LIBRARY

TRANSACTIONS, PROCEEDINGS

American Society of Civil Engineers:
Proceedings, November, 1941, v. 67.

The Royal Society of Canada, 1941:
Minutes of Proceedings, List of Officers and Members.

American Society of Mechanical Engineers:
Transactions, November, 1941, v. 63.

REPORTS

Canada Department of Mines and Resources:
Report of Soldier Settlement of Canada, for the fiscal year ended March 31, 1941, Ottawa. Price 50 cents.

Canada Department of Public Works:
Report of the Minister of Public Works on the works under his control for the fiscal year ended March 31, 1941. Ottawa, Price 50 cents.

Canada Department of Mines and Resources—Mines and Geology Branch:
Geological Survey, Memoir 229, Noranda District, Quebec, by M. E. Wilson. Price 50 cents.

TECHNICAL BOOKS

A.S.M.E. Mechanical Catalogue and Directory, 1942:
Thirty-first Annual Volume issued October, 1941.

Belt Conveyors and Belt Elevators:
By Frederic V. Hetzel and Russell K. Albright, 3d., revised and enlarged, John Wiley & Sons, Inc., 1941. 439 pp. 9¼ x 6 in., $6.00.

Bridge Railings—Their Design and Construction:
Booklet by F. H. Frankland, Director of Engineering, published by the American Institute of Steel Construction, New York. Copies are free to interested persons.

Godfrey's Structural Tables:
By Edward Godfrey, Structural Engineer, Pittsburgh, Pa. Published by the Author, 126 pp., 8¼ x 5¼ in. Price $1.25.
This book is a reprint of Godfrey's Tables first published in 1905 and carries readily available information which, in many cases, is not found in manufacturers' handbooks. Among other things will be found ways of solving skew and batter details as well as lever arms for truss members and other data. Tables are computed for designing girder and truss spans for Cooper's standard loading. The tables of properties of built sections should be useful in designing truss members. The book ends with a list of the author's contributions to various engineering publications.

Highway Curves:
By H. C. Ives, C.E., 3 ed., John Wiley & Sons, Inc., 1941. 380 pp., diagrs., maps, charts, tables, 7 x 4 in., cloth, $4.00.
A presentation of the theory and practice of highway curves as practiced in this country is presented in this manual, together with the mathematical tables required in road building. The new edition has been revised and four new chapters added, dealing with the Selection of a curve and spiral, Curbs, crowns and grades, traffic lanes and divided highways, and construction stakes.

Canadian Engineering Standards Association, Specification:
Standard specification for galvanized (zinc-coated) steel line wire. C3-1941. Ottawa, October, 1941. Price 50 cents.

Canadian Engineering Standards Association Specification:
Standard specification for vitrified clay sewer pipe. A60-1941. Ottawa, September, 1941. Price 50 cents

U.S. Department of the Interior-Bureau of Reclamation—Boulder Canyon Projects Final Reports, Part IV—Design and Construction:
Bulletin 1—General features, presents general descriptive information regarding all of the more important parts of the Boulder Canyon Project and the principal problems involved in their design and construction. Subjects treated separately in the various chapters include preliminary construction; construction plant; river diversion works; Boulder Dam; penstocks, outlets, and spillways; power plant; architectural features; Lake Mead; Imperial Dam and desilting works; and the All-American Canal system. Selected drawings and photographs illustrate the various construction activities as well as the completed structures. Paper-bound $1.50 per copy. Cloth-bound $2.00 per copy.
Bulletin 2—Boulder Dam, present detailed data and information regarding the design and construction of the dam, exclusive of the appurtenant works. Subjects covered by the different chapters include design of dam, excavation of foundation and abutments, foundation and abutment grouting, construction of dam, cooling mass concrete, and contraction joint grouting. Detail drawings and carefully chosen photographs are included to supplement the text and to illustrate the different features of the work. Paper-bound, $1.50 per copy. Cloth-bound, $2.00 per copy.

BOOK NOTES

The following notes on new books appear here through the courtesy of the Engineering Societies Library of New York. As yet the books are not in the Institute Library, but inquiries will be welcomed at headquarters, or may be sent direct to the publishers.

A.S.T.M. STANDARDS ON PETROLEUM PRODUCTS AND LUBRICANTS
Prepared by A.S.T.M. Committee D-2 on Petroleum Products and Lubricants. Methods of Testing, Specifications, Definitions, Charts and Tables. Sept., 1941. 400 pp., American Society for Testing Materials,

Phila., Pa., diagrs., charts, tables, 9 x 6 in., paper, $2.00.

This pamphlet brings together in convenient form the 1941 report of the A.S.T.M. committee on petroleum products and lubrication, over ninety standard and tentative methods of test and specifications pertaining to petroleum, and the regulations and personnel of the committee and subcommittees.

AERODYNAMICS OF THE AIRPLANE (Galcit Aeronautical Series)

By C. B. Millikan. John Wiley & Sons, New York, 1941, 171 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $2.50.

This volume presents a brief but rather intensive summary of those portions of the subject which every well-rounded aeronautical engineer should know. Fundamental fluid mechanical principles are first presented, followed by a discussion of certain of them to specific aerodynamic questions. Airplane performance, stability and control are then treated. The book is based upon lectures to graduate non-aeronautical engineers.

AEROPLANE CARBURETTORS (Part 2)

Edited by E. Molloy and E. W. Knott. Chemical Publishing Co., New York, 1940. 132 pp., illus., diagrs., charts, tables, 9 x 6 in., cloth, $2.00.

This handbook describes in detail the dismantling, adjustment and re-assembling of aircraft carburettors of the Zenith, Rolls-Royce and Stromberg types. Chapters on Boost pressure control and mixture strength and on the Cambridge exhaust-gas analyzer are also included.

AIR PILOTING, Manual of Flight Instruction

By V. Simmons. Revised ed., Ronald Press Co., New York, 1941. 758 pp., illus., diagrs., charts, tables, 8½ x 5 in., cloth, $4.00.

The intention of this book is to illustrate and describe the best known means of developing pilot skill, and in addition to supply technical material, in text and question and answer form, which will definitely aid the applicant in passing the various written examinations. The present revision provides the currently approved techniques for the training and testing of pilots.

AIRCRAFT DESIGN SKETCH BOOK, compiled and published by Lockheed Aircraft Corporation, Burbank, Calif.

Aero Publishers, 120 North Central Ave., Glendale, Calif., 1940. Paged in eleven sections, illus., diagrs., tables, 11 x 8½ in., paper, $3.00.

Some hundreds of sketches of airplane parts and complete aircraft, both military and commercial, compose this book. Brief descriptive information is included in many cases. The purpose of the book is to give the designer a collection of ideas that will stimulate his own creative and inventive mind toward further development.

AIRCRAFT INSTRUMENTS

By G. E. Irvin. McGraw-Hill Book Co., New York and London, 1941. 506 pp., illus., diagrs., charts, maps, tables, 9½ x 6 in., cloth, $5.00.

This book aims to provide, in one volume, a complete course in the subject for all those concerned. The construction and operation of all types are described, and detailed instructions given for installing, using, testing, maintaining and repairing them.

AIRCRAFT LOFTING

By E. P. Grenier; published by Emile P. Grenier, 110 Highland Ave., Buffalo, N.Y., 1941. 202 pp., diagrs., charts, tables, 11 x 9 in., fabrikoid, looseleaf manifold copy, $3.00.

This textbook has been developed as a result of the application of lofting methods to mass production of aircraft. In addition to presenting a practical study of aircraft loft practice, it also includes sufficient information to give an understanding of the necessary mathematical, engineering and aerodynamical concepts. Full use is made of illustrative diagrams.

The AIRCRAFT YEAR BOOK FOR 1941, 23rd Annual Edition

Edited by H. Mingos. Aeronautical Chamber of Commerce of America, New York, 1941. 608 pp., illus., diagrs., maps, tables, 9 x 6 in., cloth, $5.00.

This annual records the developments of American aviation during the past year. Both civil and military activities are reported in considerable detail. Training and education, the growth of air lines and private flying and the increase in airports and airways are described. The expansion of manufacturing is presented. There are tables of aircraft and engine specifications and much statistical matter.

AIRSCREWS, Part 2. (Aeroplane Maintenance and Operation Series, Vol. 20)

Edited by E. Molloy and E. W. Knott. Chemical Publishing Co., New York, 1940. 100 pp., illus., diagrs., 9 x 6 in., cloth, $2.00.

Continuing the airplane maintenance and operation series, this second volume on airscrews deals with the Rotol, Curtiss, Hamilton and Hele-Shaw Beacham variable-pitch airscrews. A section of general notes on the operation, maintenance and inspection of fixed-pitch airscrews is included.

The BELL TELEPHONE SYSTEM

By A. W. Page. Harper & Brothers Publishers, New York and London, 1941. 248 pp., illus., diagrs., charts, maps, tables, 9 x 6 in., cloth, $2.00.

This is a description of the operating policies of the American Telephone and Telegraph Company and its constituent companies, written by the Vice-President in charge of public relations. Problems of research, technology, wages, rates and service, relations with the government, and finance are considered, and the methods and achievements of the organization set forth. Much hitherto scattered information is brought together in convenient form.

CHEMICAL ENGINEERS' HANDBOOK (Chemical Engineering Series)

Edited by J. H. Perry. 2 ed. McGraw-Hill Book Co., New York and London, 1941. 3,029 pp., illus., diagrs., charts, tables, 7 x 5 in., lea., $10.00.

The new edition of this valuable reference work has been thoroughly revised and largely rewritten to bring it abreast of current practice. New sections have been added on solvent extraction; on shotting, granulating and flaking, and sprays and spraying; on bulk packaging and on sublimation. Many new chapters have been added. The section on patents and patent law has been omitted, but the new edition nevertheless contains nearly four hundred pages more than the previous one. The work covers chemical engineering comprehensively.

The CHEMICAL FORMULARY, Vol. 5

Edited by H. Bennett. Chemical Publishing Co., Brooklyn, New York, 1941. 676 pp., diagrs., tables, charts, 9 x 5½ in., cloth, $6.00.

This latest volume of this series follows the form of preceding ones, but contains entirely new formulas. Receipts are given for preparing large numbers of adhesives, beverages, cosmetics, foods, inks, metal products, paints, etc. The formulas have been collected from many sources.

DESIGN OF PIPING SYSTEMS, EXPANSION STRESSES AND REACTIONS IN PIPING SYSTEMS

Published by M. W. Kellogg Company, Jersey City, N.J., 225 Broadway, New York, 1941. 97 pp., illus., diagrs., charts, tables, 11½ x 8½ in., cloth, $10.00.

The general method of analyzing pipe lines for flexibility presented in this manual is applicable to piping systems of almost any shape or configuration such as are needed in the power, oil refinery and chemical industries. The derivation and application of formulas for expansion stresses and reactions are presented in a detailed manner, design data are furnished, and there is a bibliography.

ELECTRICITY APPLIED TO MARINE ENGINEERING

By W. Laws. Institute of Marine Engineers, London; Engineers Book Shop, New York, 1940. 276 pp., diagrs., charts, tables, 7½ x 5 in., cloth, $2.00.

A clear, simple presentation of the fundamental principles of electricity, with special emphasis upon their application in ships. The text is intended for young engineers without much mathematical or technical background, who are preparing for British Board of Trade Certificate examinations, and is based upon articles published in the Transactions of the Institute of Marine Engineers.

ELECTRONICS

By J. Millman and S. Seely. McGraw-Hill Book Co., New York and London, 1941. 721 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $5.00.

The primary purpose of this textbook is to provide a development of basic electronic principles with applications to many problems in electrical engineering and physics. It co-ordinates the physical theory of electronics and the theory of operation of electronic devices, gives attention to material of present-day commercial importance, and includes both detailed illustrative problems and groups of problems to be worked.

FIRE SERVICE HYDRAULICS

By F. Sheppard. Case-Shepperd-Mann Publishing Corporation, New York, 1941. 254 pp., illus., diagrs., charts, tables, 8½ x 5½ in., lea., $3.00.

A presentation of the principles of hydraulics as applied to fire department work. Detailed instructions are given for calculating nozzle velocities and pressures, friction losses in hose and mains, engine pressures, fire streams, sprinkler systems and pump discharges, and are illustrated by many worked examples.

FUNDAMENTALS OF VACUUM TUBES

By A. V. Eastman. 2 ed. McGraw-Hill Book Co., New York and London, 1941. 583 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $4.50.

The aim in this work has been to combine in a single text the basic theory underlying the operation of all types of modern vacuum tubes with descriptions of their more common applications in communications and industry. Mathematical analyses are preceded by verbal descriptions of the phenomena under consideration. The new edition has been completely revised and entirely rearranged.

GLASS: THE MIRACLE MAKER Its History, Technology and Applications

By C. J. Phillips. Pitman Publishing Corp., New York and Chicago, 1941. 424 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $4.50.

This is a welcome addition to books on glass, for it provides an up-to-date, comprehensive and authoritative account of this important, widely used material. The manufacture, physical and chemical properties and uses of glass are all presented in sufficient detail for all ordinary purposes, and illustrated by a wealth of drawings and photographs. References accompany each chapter.

Great Britain, Board of Education and Ministry of Labour and National Service.
HANDBOOK OF WORKSHOP CALCULATIONS

His Majesty's Stationery Office, London; British Library of Information, New York, 1941. 40 pp., diagrs., tables, 7 x 5 in., paper, 3d (obtainable from British Library of Information, 30 Rockefeller Plaza, New York, 10c.).

This pamphlet is issued as a guide to students and workers in the engineering industry. The introductory exercises and the practical examples are nearly all solvable by simple arithmetic.

Great Britain, Dept. of Scientific and Industrial Research
BUILDING RESEARCH. WARTIME BUILDING BULLETIN No. 15A, Supplement to Bulletin No. 15.

His Majesty's Stationery Office, London, 1941. 14 pp., diagrs., charts, tables, 11 x 8½ in., paper, (obtainable from British Library of Information, 30 Rockefeller Plaza, New York, 15c.).

This bulletin supplements a previous one upon the design of one-storey war-industry factories, by describing modifications in the interest of camouflage treatment. It also presents a new reinforced concrete design, introduced for steel economy.

HANDBOOK OF AIRPLANE INSTRUMENTS

Kollsman Instrument Division of Square D Company, 80-08 45th Ave., Elmhurst, New York, 1940. Paged in sections, illus., diagrs., charts, maps, tables, 11½ x 9½ in., fabrikoid, $2.00.

This is a guide to the testing, repairing and adjustment of airplane instruments, with special attention to those made by the company which issues the book. The directions are full and explicit, and illustrated by many drawings.

HOW TO TRAIN SHOP WORKERS

By C. A. Prosser and P. S. Van Wyck. American Technical Society, Chicago, 1941. 126 pp., diagrs., charts, tables, 11 x 8 in., stiff paper, $1.25 manifold copy.

This shop training manual is for the use of foremen and instructors in training workers in production and service jobs. It is intended for both manufacturing plants and vocational schools, and covers the duties, responsibilities and characteristics of the efficient foreman, as well as practical training methods and suggestions.

MACHINE TOOL OPERATION. Pt. 1, The Lathe

By H. D. Burghardt. McGraw-Hill Book Co., New York, 1941. 420 pp., illus., diagrs., charts, tables, 7½ x 5 in., cloth, $2.25.

This text for apprentices and young machinists presents the fundamental principles of the construction and operation of all types of lathes, describes bench work done by hand, and discusses methods of soldering, hardening and tempering, and hand forging. The material added in this revised edition is chiefly on hand forging.

MATERIALS TESTING, Theory, Practice and Significance of Physical Tests on Engineering Materials

By H. J. Gilkey, G. Murphy and E. O. Bergman. McGraw-Hill Book Co., New York and London, 1941. 185 pp., illus., diagrs., charts, tables, 11½ x 8½ in., cloth, $2.75.

The field of materials testing work in colleges is covered comprehensively in this laboratory manual, from general observations on test procedures to suggestions upon the conduct of a course of instruction, and on typical final examinations. More material is included than is likely to be used in any one laboratory, in order to provide for wider use. Answers are given for the many supplementary questions, and there is an unusually complete subject index.

THE MICROSCOPE

By S. H. Gage. 17th ed. revised, Comstock Publishing Company, Ithaca, N.Y., 1941, 617 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $4.00.

In the new edition of this well-known and popular textbook, additions and modifications have been made to clarify the text and add new developments of the last five years. The book remains, as before, an admirable guide for beginning microscopists. The construction of the instrument, its limitations, and its possibilities for aiding one to arrive at truth are presented clearly and thoroughly.

MODERN MARINE ELECTRICITY

By P. de W. Smith. Cornell Maritime Press, New York, 1941. 279 pp., illus., diagrs., charts, tables, 7½ x 5 in., cloth, $2.50.

This handbook is intended to provide the operating marine electrician with a practical guide to the electrical equipment of the modern ship and to its maintenance.

MOLDING TECHNIC FOR BAKELITE AND VINYLITE PLASTICS

Bakelite Corporation, New York, 1941. 224 pp., illus., diagrs., charts, tables, 11½ x 8½ in., fabrikoid, $3.50.

The important phases of the molding processes and molding equipment employed generally in the commercial production of plastic parts are discussed. Materials, mold design, finishing processes, inspection and plant layout are among the topics covered. There is a glossary, including a list of terms not recommended.

MOTION STUDY

By H. C. Sampter. Pitman Publishing Co., New York and Chicago, 1941. 152 pp., illus., diagrs., charts, tables, 8½ x 5 in., cloth, $1.75.

The principles of motion study, as distinct from time study, are presented in a clear and simple manner. Motion symbols are explained, the basic laws and principles for motion economy are discussed, and flow process charts are emphasized to eliminate the study of superfluous operations in a series or complete process.

NUCLEAR PHYSICS. (University of Pennsylvania Bicentennial Conference)

By E. Fermi and others. University of Pennsylvania Press, Phila., 1941. 68 pp., diagrs., charts, tables, 9 x 6 in., paper, 75c.

This pamphlet contains six papers presented at a conference on nuclear physics held in connection with the bicentenary of the University of Pennsylvania.

PERFORMANCE OF PRESSURE-TYPE OIL BURNERS (Iowa Engineering Experiment Station Bulletin 151)

Iowa State College, Ames, Iowa, 1941. 32 pp., illus., diagrs., charts, tables, 9 x 6 in., paper, gratis.

An investigation of four high-pressure oil burners operated with various nozzles and cycling rates in both conversion and oil-designed boilers is reported in this bulletin. The apparatus and testing procedure are described and detailed results are given, including the effect of various characteristics upon efficiency.

PERSONNEL MANAGEMENT, Principles, Practices and Point of View

By W. D. Scott, R. C. Clothier, S. B. Mathewson and W. R. Spriegel. 3 ed., McGraw-Hill Book Co., New York, 1941. 589 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $4.00.

Completely revised and rearranged, the new edition of this text presents a comprehensive outline of up-to-date principles, practices and instruments in the important relationships of management, work and workers. The revision includes a discussion of modern personnel practices and procedures supported by a detailed survey of 231 companies employing more than 1,750,000 workers.

PRACTICAL SHIP PRODUCTION

By A. W. Carmichael. 2 ed. McGraw-Hill Book Co., New York and London, 1941. 283 pp., illus., diagrs., charts, maps, tables, 9½ x 6½ in., cloth, $3.00.

The present increased interest in shipbuilding is responsible for the revision of this text, which appeared originally in 1919. The book is intended particularly for engineers and technical men who are transferring their activities from other fields to those of the marine engineer and naval architect. The treatment is practical, rather than theoretical, and concerned with construction, rather than design. The new edition has been partly rewritten, especially the section on electric welding.

PROTECTIVE and DECORATIVE COATINGS, Paints, Varnishes, Lacquers and Inks: Vol. 1, Raw Materials for Varnishes and Vehicles

By J. J. Mattiello. John Wiley & Sons, New York; Chapman & Hall, London, 1941. 819 pp., illus., diagrs., charts, tables, 9½ x 6 in., cloth, $6.00.

This volume is the first of three which are intended to form a comprehensive treatise on the paint and varnish industry. The present instalment is devoted to the raw materials for varnishes and vehicles. Drying oils, resins, driers, thinners and solvents, natural minerals and ethers are discussed, each chapter being prepared by one or more specialists. An enormous amount of information upon the sources, properties and uses of these materials is summarized in this work, and numerous lists of references to original papers are included.

The RUNNING AND MAINTENANCE OF MARINE MACHINERY

Institute of Marine Engineers, London. 2 ed. Engineers Book Shop, New York, 1941. 164 pp., illus., diagrs., charts, tables, 10 x 7 in., cloth, $2.50.

A practical work, prepared for junior members of the Institute of Marine Engineers, intended as a guide for those entering upon a sea-going career. Steam reciprocating engines and turbines, boilers, diesel engines, electrical and refrigerating machinery, pumping arrangements and steering gears are discussed. A list of books is appended.

SANITARY ENGINEERING

By H. G. Payrow. International Textbook Co., Scranton, Pa., 1941. 483 pp., illus., diagrs., charts, tables, 8½ x 5 in., fabrikoid, $4.00.

In preparing this work the author has endeavoured to supply a concise textbook covering the general field of sanitary engineering for civil and chemical engineers. The fundamentals of water supply and purification and of sewerage and sewage treatment are comprehensively covered with the help of many tables and practical examples. Hydrology and other related topics, new types of equipment, and the application of recent developments such as air conditioning are included.

SHIP AND AIRCRAFT FAIRING AND DEVELOPMENT for Draftsmen and Loftsmen and Sheet Metal Workers

By S. S. Rabl. Cornell Maritime Press, New York, 1941. 90 pp., illus., diagrs., charts, tables, 12 x 8½ in., paper, $2.50.

This practical manual for draftsmen, loftsmen and sheet-metal workers presents the essentials of both ship and aircraft fairing and of the development of surfaces as necessary in sheet metal work. Descriptive plates are alternated with pages of explanatory text to facilitate the understanding and application of the principles described.

PRELIMINARY NOTICE

of Applications for Admission and for Transfer

November 25th, 1941.

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 at the January meeting.

L. Austin Wright, General Secretary.

*The professional requirements are as follows:—

A 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 or 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 tbe 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 tbis age limit.

An Affiliate shall be one who is not an engineer by profession but whose pursuits, scientific attainment 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

AUGER—GERARD J. B., of 65 Broadway, Shawinigan Falls, Que. Born at Ste-Croix-de-Lotbinière, Que., Aug. 29th, 1906; Educ.: 1930-33, School of Engrg., Milwaukee, Wis., Industrial Elec. Engr.; 1930-33, substation experience in a rotary station; 1933-37, elec. mtce. work for the Provincial Govt.; 1937-41, power plant supervision, North Shore Paper Co.; 1941, rectifier stn., Aluminum Company of Canada, Arvida, and at present, witb same company at Shawinigan Falls, i/c of new rectifier stn. being constructed and two D.C. power plants.

References: J. A. Babin, A. O. Dufresne, G. Molleur, D. Anderson, R. V. H. Keating.

BARRATT—ERNEST F., of Hamilton, Ont. Born at Toronto, Jan. 2nd, 1908; Educ: B.A.Sc., Univ. of Toronto, 1932; R.P.E. of Ont.; 1925-27, gen. surveying, sewer layout, waterworks design, Township of Etobicoke; 1928, highway surveying, 1929-31 (summers), i/c higbway surveying & bridge layout, 1932-34, i/c bighway engrg., and 1937 (summer) i/c highway engrg. & bridge installn., Toronto and York Roads Commn.; 1938 (summer), i/c sewer design layout & installn., also gen. surveying & office supervn., Township of Etobicoke; 1939 to date, county engr. & road supt., County of Wentworth, also engr. & road supt., Hamilton Suburban Roads Commn.

References: J. J. Mackay, E. G. Mackay, W. L. McFaul, J. R. Dunbar, N. MacNicol, C. R. Young.

BEAUDOIN—HECTOR OSWALD, of Riverbend, Que. Born at South Durbam, Que., Dec. 5th, 1890; Educ.: Elec. Engr., I.C.S., 1932; 1920-25, asst. elec. engr., Brompton Pulp & Paper Co., East Angus, Que.; 1926 to date, chief electrician, Price Bros. & Co. Ltd., Riverbend, Que. (Applying for admission as an Affiliate).

References: G. F. Layne, N. F. McCaghey, K. A. Brebner, G. H. Kirby, D. S. Estabrooks.

BENTLEY—WILLIAM ALEXANDER, of 17 Claxton Blvd., Toronto, Ont. Born at Toronto, July 27th, 1903; Educ.: 1923-26, civil engrg. dept., Univ.of Toronto; R.P.E. of Ont.; Summer vacations—surveying with H.E.P.C. of Ontario; 1926-27, dftsman., Solvay Process Company, Syracuse, N.Y.; 1927-30, structl. dftsman , McGregor & McIntyre Ltd.; 1930-31, structl. designer, Dominion Bridge Company; 1931-32, structl. designer, Harkness & Hertzberg, Toronto; 1934 to date, structl. designer, Dominion Bridge Co. Ltd., Toronto, Ont.

References: A. R. Robertson, D. C. Tennant, W. H. M. Laughlin, A. H. Harkness, G. L. Wallace, C. F. Morrison, C. D. Carrutbers.

BROWN—RAYMOND WARRINGTON, of Winnipeg, Man. Born at Butte, Montana, U.S.A., Jan. 25th, 1911; Educ.: B.Sc. (Mech.), Univ. of Sask., 1934; 1934-35, Ford assembly plant, Long Beach, Calif.; 1935-36, United States Naval Force, Pensacola; 1936-41, witb the Winnipeg Free Press, from 1938 to date, asst mecb. supt.

References: E. S. Braddell, I. M. Fraser, W. E. Lovell, A. R. Greig, W. A. Trott, J. D. Peart.

GAGNON—PAUL EDOUARD, of Quebec, Que. Born at Kingsey, Co. Drummond, Que., Feb. 26th, 1901; Educ.: Chem. Engr., Laval Univ. (Quebec), 1926; D.Sc., Univ. of Paris, 1929; D.I.C., Univ. of London, 1930; Ph.D., Laval Univ. (Quebec), 1934; Major, R.C.A.; 1926-31, advanced courses and research; 1931-32, lecturer, 1932-35, associate professor, 1935 to date, professor, 1938 to date, Director, Dept. of Chemistry, and 1940 to date, President, Graduate School, Laval University, Quebec, Que.

References: A. R. Decary, A. Surveyer, O. O. Lefebvre, J. B. Challies, A. B. Normandin, L. A. Wrigbt.

GUNN—GEORGE JOHN TAIT, of Port of Spain, Trinidad. Born at Gorebridge, Scotland, Dec. 15th, 1902; Educ.: B.Sc. (Engrg.), Heriot-Watt College, Edinburgh, 1924; Assoc. Member, Inst. E.E., Graduate, Inst. Mech. Engrs.; 1921-23 (9 mos. coll. vacations), elec. engrg. ap'ticeship; 1924-27, elec. engrg. ap'tice & erection trainee (elec. & mech.), Metropolitan-Vickers Electrical Co. Ltd., Manchester, England; 1927-29, elec. erection engr., for same company in Argentina, England & Ireland; 1929 (2 mos.), engr., contracts dept., General Electric Co., Witton, England; 1930-32, asst. distribution engr., F. M. S. Govt. Elec. Dept., Kuala Lumpur; 1932-33, asst. dist. engr., County of Dumfries Elec. Dept., Scotland; 1934-35, power station (steam) shift charge engr., North-Eastern Electric Supply Co., Spennymoor, England; 1935-37, elec. engr., Indo-Burma Petroleum Co., Rangoon; 1937-39, refinery elec. engr., Trinidad Leaseholds Limited, Pointe-a-Pierre; 1939-40, refinery engr. for same company; 1940 (2 mos.), elec. engr., Saguenay Power Company, Arvida, Que.; 1940-41, elec. engr. on war constrn. work, Demerara Bauxite Co., Mackenzie, Britisb Guiana; Mar. to Sept. 1941, aet. distribution engr., and at present, chief asst. engr., Trinidad Electricity Board, Port of Spain, Trinidad, B.W.I.

References: M. DuBose, F. L. Lawton, A. W. Whitaker, J. H. Reid, R. W. Emery, P. H. Morgan.

HAVEN—FRANK GOLDIE, of Winnipeg, Man. Born at Minneapolis, Minn., April 30th, 1886; Educ.: 1904-08, Univ. of Minn.; 1908-10, various engrg. positions up to res. engr., Great Northern Rly.; 1911-13, locating engr., Can. Nor. Rly.; 1913-16, asst. to chief engr., Greater Winnipeg Water District; 1916-19, overseas., Major, Can. Rly. Troops; 1919-34, locating, division & supervising engr., C.N.R.; (Not connected with engrg. for several years). At present. res. engr., civil aviation branch, Dept. of Transport, Winnipeg, Man. (A.M.E.I.C. 1915—M.E.I.C., 1920-31).

References: W. Burns, A. J. Taunton, M. V. Sauer, A. P. Linton.

HELWIG—CARL EVERETT, of 100 Lyndhurst Ave., Toronto, Ont. Born a Alexandria, Jamaica, B.W.I., Jan. 25th, 1903; Educ.: B.A.Sc., 1930, M.A.Sc., 1937, Univ. of Toronto; 1930 to date, instructor in strength of materials Laboratory, Univ. of Toronto, since Dec. 1940, lecturer and i/c of lab.; Summer work as follows: 1937, design & detailing reinforced concrete, Ontario Paper Co. Ltd., Thorold, Ont.; 1938, detailing & checking struct'l. steel, Dominion Bridge Co. Ltd.; 1939, design in reinforced concrete & steel, Dufferin Paving Co.; 1940, design & checking jigs, Massey Harris Company, Weston; 1941, design in steel & concrete, H.E.P.C. of Ont.

References: C. R. Young, W. H. M. Laughlin, C. F. Morrison, R. C. McMordie, A. R. Robertson.

HOLGATE—DAVID CROSSLEY, of 19 Forman Ave., Toronto, Ont. Born at Montreal, March 27th, 1915; Educ.: B.Eng. (Civil), McGill Univ., 1938; 1938-39, dftsman., MacKinnon Steel Corpn. Ltd., Sherbrooke, Que.; 1939 to date, dftsman., Dominion Bridge Co. Ltd., Toronto, Ont.

References: W. H. M. Laughlin, D. C. Tennant, E. Brown, G. J. Dodd, C. F. Morrison.

HOLSTEN—ALFRED, of Flin Flon, Man. Born at Johannesburg, South Africa, March 9th, 1902; Educ.: 1922-25, Trondhjem Tekniske Skole, Norway, 1925-27, studied for B.A. at Trondhjem Private Gymnasium. One year advanced study in theory of alternating current, Norges Tekniske Hoiskole, Trondhjem; 1927-29, practical elec. work in Norway and Winnipeg; with the Hudson Bay Mining & Smelting Company at Flin Flon, as follows: 1929-31, practical work, partially i/c of constrn., and from 1931 to date, electrical chief operator, in complete charge of substation. Responsibility includes installn., operation & mtce., also gen. plant installn., operation & testing & repair of protective relays, electric metering of power & water, etc.

References: F. S. Small, F. A. Becker, L. M. Hovey, E. C. King, M. K. T. Reikie.

IRWIN—HAROLD STEPHEN, of 329 Lytton Blvd., Toronto, Ont. Born at Delhi, Ont., Feb. 13th, 1905; Educ.: B.A.Sc., Univ of Toronto, 1927. R.P.E. of Ont.; 1927 (summer), Horton Steel Works, Fort Erie, Ont.; 1927-37, with Toronto Iron Works Ltd., from 1929, designed & estimated storage tanks, elevated tanks & towers, pressure vessels, etc.; 1937 to date, with the Dominion Bridge Co. Ltd.,

(*Continued on page 627*)

Employment Service Bureau

SITUATIONS VACANT

MECHANICAL DESIGNING DRAUGHTSMAN. Graduate preferred, urgently needed for work in Arvida for specification drawings for plate work, elevators, conveyors, etc., equipment layouts, pipe layouts and details. Apply to Box No. 2375-V.

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MECHANICAL DRAUGHTSMAN preferably with pulp and paper experience. Good salary and permanent position. Apply giving details of experience to Box No. 2480-V.

The Service is operated for the benefit of members of The Engineering Institute of Canada, and for industrial and other organizations employing technically trained men—without charge to either party. Notices appearing in the Situations Wanted column will be discontinued after three insertions, and will be re-inserted upon request after a lapse of one month. All correspondence should be addressed to THE EMPLOYMENT SERVICE BUREAU, THE ENGINEERING INSTITUTE OF CANADA, 2050 Mansfield Street, Montreal.

GRADUATE MECHANICAL ENGINEER required for Mackenzie, B.G., immediately on work of plant and mining equipment maintenance. We are prepared to do necessary training which will give exceptional opportunity for experience. Apply to Box No. 2481-V.

MECHANICAL ENGINEER preferred with experience on diesels and tractors, for work in Mackenzie, B.G. Apply to Box No. 2482-V.

MECHANICAL DRAUGHTSMEN and engineers for pulp and paper mill work. Experienced men preferred. Good salary to qualified candidates. Apply to Box No. 2483-V.

SITUATIONS WANTED

CIVIL ENGINEER, B.A.SC., JR.E.I.C., age 29, married. Two years city engineer, five years experience in highway work, including surveying, location, construction, estimating and inspection. Apply Box No. 2409-W.

ELECTRICAL ENGINEER, B.E., in electrical engineering, McGill University, Age 24, married, available on two weeks notice. Undergraduate experience, cable testing and cathode ray oscillography. Since graduation, five months on construction of large and small electrical equipment in plant and sub-station. One year operating electrical engineer in medium size central steam station paralleled with large Hydro system. At present employed, but is interested in research or teaching. Associate member of the American Institute of Electrical Engineers. Apply to Box No. 2419-W.

CIVIL AND STRUCTURAL ENGINEER, M.E.I.C., R.P.E. (Ont.), M.I.Struct.E. Age 49. Married. Home in Toronto. Experience in Britain, Africa, Canada, Turkey. Chief engineer reinforced concrete design offices, steelworks construction. Resident engineer design and construction munitions plants, and general civil engineering work. Extensive surveys, draughting, harbour and municipal work. Location immaterial. Available now. Apply Box No. 2425-W.

ELECTRICAL, MECHANICAL ENGINEER, age 35. Dip. and Assoc. R.T.C., Glasgow, A.M.I.E.E., (Students Premium) G.I. Mech.E., M.E.I.C., Assoc. Am.I.E.E Married. Available after December 22nd. Seventeen years experience covering machine shop apprenticeship, A.C. and D.C. motors, transformers, steel and glass bulb arc rectifiers, design, testing and erection sectional electric news and fineprints paper machine drives, experience tap changers H.V., L.V. and marine switchgear. Apply to Box No. 2426-W.

MECHANICAL ENGINEER age 55 years. Married. Available at once. Thirty years experience in draughting and general machine shop and foundry work. Fifteen years as works manager. Considerable experience in pump work, including estimating and inspection. Apply to Box 2427-W.

PRELIMINARY NOTICE (*Continued from page 626*)

design & estimating high pressure water mains, stacks, coal bunkers, ore bins, etc., and at present, squad boss, dfting room.

References: W. H. M. Laughlin, D. C. Tennant, M. W. Huggins, C. R. Young, A. R. Robertson.

LeBEL—HARRY WALTER SCOTT, of Fort Erie North, Ont. Born at Pointe a la Garde, Que., April 25th, 1914; Educ.: B.Eng. McGill Univ., 1937; 1937 to date, detailing & design, Horton Steel Works Ltd., Fort Erie, Ont. (St. 1937).

References: W. R. Manock, L. C. McMurtry, C. S. Boyd, R. DeL. French, E. Brown.

LEWIS—WILLIAM MILTON, of Napanee, Ont. Born at Napanee, March 16th, 1892; Educ.: B.Sc., (Mech.), Queen's Univ., 1925; 1916-19, Can. Engrs. and C.A.M.C.; 1919-22, oiler, Third Engineer, electrician, on Great Lakes boats; 1925-30, instr'man. & precise leveller, and 1930-34, office engr. i/c of records and final calculations, Welland Canal, Dept. of Rlys. and Canals; 1936 to date, road supt. & township engr., i/c all mtce. & constrn. of roads, Township of Ernestown.

References: L. T. Rutledge, D. M. Jemmett, D. S. Ellis, L. M. Arkley, M. N. Hay, H. L. Schermerhorn, J. C. Street.

McRITCHIE—CHARLES BELL, of 3622 Lorne Crescent, Montreal, Que. Born at London, England, July 5th, 1876; Educ.: Diploma in Civil Engrg., Glasgow & West of Scotland Technical College; Assoc. Member, Inst. Civil Engrs. (London); 4 years shop ap'ticeship, (mech.) on the Clyde, and 2 years (civil), Glasgow & South-western Rly.; 1899-1901, asst. res. engr., Dalroy & N. Johnstone Rly.; 1901-06, 1st asst. engr., Central South African Rly.; 1907-11, engr. and asst. mgr., constrn. of Kallang Reservoir, Singapore; 1913-14, general contractor, Murray & McRitchie, Canada; 1914-20, War Service with Royal Engrs.; 1921-37, McRitchie & Black, general contracting, housing developments, developing drying systems for lumber, vegetables & grain, etc.; 1938 to date, partner in firm R. A. Rankin & Coy., consltg. industrial engrs., Montreal, Que.

References: G. G. Ommanney, E. Cormier, W. Griesbach, J. B. Stirling, R. A. Rankin, T. W. W. Parker.

OXLEY—LOREN ARTHUR, of Toronto, Ont. Born at Ottawa, Ont., Sept. 18th, 1917; Educ.: 1935-38, School of Arch'ture, Univ. of Toronto; 1935-38 (summers), and 1938-39, with Chapman & Oxley, Architects & Engrs.; 1940 (Aug.-Dec.), on design work, Canadian Acme Screw & Gear; 1941 (Jan.-May), dfting. & designing, Gordon S. Adamson, Architect; 1941 (May-Nov.), architect's representative at bldg. for Fleet Aircraft Overhaul Depot; has been accepted, with a Commission, in the R.C.E. Now waiting appointment for active service.

References: H. A. Lumsden, H. H. Angus, R. A. Crysler, E. A. Cross, J. M. Oxley.

PRICE—GORDON JAMES, of 30 Haddon St., Toronto, Ont. Born at Montreal, April 6th, 1889; Educ.: I.C.S. course (not completed owing to war); 1905-08, apprentice, Phoenix Bridge Co., Montreal; 1908-10, struct'l. detailer, Manitoba Bridge Company, Winnipeg; 1910-12, struct'l. detailer, Structural Steel Works, Montreal; 1912-14, struct'l. checker, McGregor & McIntyre, Toronto; 1914-19, overseas; 1919-28, chief dftsman., McGregor & McIntyre, Toronto; 1928-35, asst. chief dftsman. (Ont. Divn.), and 1935 to date, chief dftsman., Dominion Bridge Company Ltd., Toronto, Ont.

References: A. R. Robertson, A. H. Harkness, E. A. Cross, D. C. Tennant, F. J. McHugh, G. L. Wallace.

PRICE—MALCOLM MACKAY, of 156 College St., Port Arthur, Ont. Born at Boston, Mass., Aug. 3rd, 1896; Educ.: Private tuition and home study. I.C.S. Civil Engrg., Chemistry & Water Softening; R.P.E. of Ont.; With the C.N.R. as follows: 1919-27, chainman & rodman, rld. constrn.; 1927-32, res. engr. i/c water supply investigations, prelim. studies & constrn., etc.; 1932-34, inspr.; 1934-39, instr'man., 1939 to date, asst. bridge & bldg. master, supervising constrn. of bridges, bldgs., culverts, tunnels, etc.

References: J. W. Porter, W. Walkden, T. C. Main, G. W. Rayner.

SHORT—HAROLD WILLIAM, of Toronto, Ont. Born at Toronto, Oct. 31st, 1890; R.P.E. of Ontario; 1906-12, dftsman. & checker, Canada Foundry Co. Ltd.; 1912-15, part interest in Hunter Structural Steel, office, shop & field; 1915-20, dftsman. & checker, 1920-35, asst. chief dftsman., and 1935 to date, engrg. design, representative Northern Ontario, Northwest Quebec, Dominion Bridge Co. Ltd.

References: A. H. Harkness, A. Ross Robertson, W. H. M. Laughlin, D. C. Tennant, G. P. Wilbur.

SMITH—DUNCAN NORMAN, of Toronto, Ont. Born at Toronto, Feb. 27th, 1909; Educ.: B.Sc. in C.E., Tri-State College of Engrg., 1932; R.P.E. of Ontario; 1927-30 & 1933-36, dftsman., 1936, designer & estimator, short order dept., and 1937 to date, designer & estimator, design dept., Dominion Bridge Co. Ltd., Toronto, Ont.

References: W. H. M. Laughlin, D. C. Tennant, A. R. Robertson, G. P. Wilbur C. F. Morrison, M. W. Huggins.

THORNE—EDWARD CHARLES, of Knowlton, Que. Born at London, England, June 27th, 1903; Educ.: 1921, Polytechnic Engineering Institute London; 1927, qualified as Capt., Royal Engrs., School of Military Engrg., Chatham, England; 1927, qualified as Capt., R.C.E., Petawawa Training Centre; 1922-25, ap'tice with Crompton & Co. Ltd., Chelmsford, England, mfrs. of elec. apparatus; 1926-27, junior engr. in head office of same company; 1927-28, engrg. investigator staff, Hughes Bros. Ltd., company promoters, London; 1928-29, manager, London office, Robert Bright Ltd., Cons. Engrs., Coventry, England; 1930-38, mtce. engr., operating dept., Southern Canada Power Co. Ltd.; 1937-39, raised and trained 19th Field Coy., R.C.E. (N.P.A.M.); 1939-40, Capt. R.C.E. Appointed 2nd i/c 4th Field Coy., R.C.E. (C.A.S.F.), Montreal, Overseas, 1939; 1940-41, Major, R.C.E. Appointed Officer Commanding 2nd Field Coy., R.C.E. (C.A.S.F.), Overseas.

References: A. G. L. McNaughton, C.S.L. Hertzberg, J. P. Mackenzie, H. Kennedy, J. B. Woodyatt, P. T. Davies.

WOOD—ERNEST WILLIAM, of Esquimalt, B.C. Born at Southsea, Hants, England, Nov. 13th, 1905; Educ.: 1921-25, Mechanical Training Establishment (Admiralty), Portsmouth, England. Graduated Dec. 1925; Passed Admiralty Higher Educational Tests March, 1926. Credits in six subjects, Colorado State College—summer 1937; 1921-25, ap'tice (fitter & turner), Mechl. Training Establishment; 1926-30, engine room artificer, Royal Navy; 1930-40, with Provincial Institute of Technology and Art, Calgary, Alta., 1930-36, teaching mech. dfting., maths., physics, app. mechs., workshop practice, and 1936-40, head of machine shop dept.; 1940 (July-Sept.), loaned to take position as supervisor of Dominion Provincial Youth Training Centre at Lethbridge (under War Emergency Training Programme); Feb. 1941, granted leave of absence for duration. Joined the R.C.N. as lecturer in marine engrg. to Sub. Lieuts (E), and at present, Lieutenant (E), R.C.N. (T), Engineer Officer in Charge, Mechanical Training Establishment, Esquimalt, B.C.

References: B. R. Spencer, A. Higgins, F. N. Rhodes, J. B. deHart, J. H. Ross.

FOR TRANSFER FROM JUNIOR

EMERSON—ROBERT ALTON, of Brandon, Man. Born at Plum Coulee, Man., April 12th, 1911; Educ.: B.Sc. (C.E.), Univ. of Man., 1930; Strathcona Memorial Fellowship in Rly. Transportation, Yale Univ., 1933-34; 1931-32, locating engr., 1934-35, transitman, Ontario Dept. of Nor. Development; With the C.P.R. as follows: 1928-30, rodman & inspr. of rock ballast; 1930 and 1935-39, transitman, 1939-41, roadmaster, and at present, divn. engr. at Brandon, Man. (St. 1929, Jr. 1932).

References: T. E. Price, S. C. Wilcox, K. A. Dunphy, S. T. Lewis, W. D. Hurst, P. E. Savage.

FOR TRANSFER FROM STUDENT

BALDERSON—KENNETH KINCADE, of Pointe-a-Pierre, Trinidad. Born at Magrath, Alta., Aug. 9th, 1917; Educ.: B.Sc. (Elec.), Univ. of Alta., 1939; Feb. 1940 to date, asst. elec. engr., Trinidad Leaseholds Ltd., Pointe-a-Pierre, Trinidad, B.W.I. (St. 1939).

References: R. W. Emery, W. E. Weatherbie, A. R. Bonnell, I. F. Morrison, W. E. Cornish.

BRYDGES—ROBERT JAMES, of 478 Langside St., Winnipeg, Man. Born at Souris, Man., Jan. 4th, 1917; Educ.: B.Sc. (Elec.), Univ. of Man., 1938; 1936-37 (summers), signal mtce. work, C.P.R.; 1938-40, student apprentice course, A. Reyrolle & Co. Ltd., Hebburn-on-Tyne, England; 1940-41, Northern Electric Co. Ltd., Montreal, power apparatus sales, supply sales, wire & cable manufacture; At present, wire & cable sales engr. for same company in Winnipeg, Man. (St. 1938).

References: E. P. Fetherstonhaugh, J. W. Dorsey, G. H. Herriot, W. R. Bunting, E. S. Braddell, N. L. Morgan.

NOWLAN—BRETE CASSIUS, Jr., of 5510 Queen Mary Road, Montreal, Que. Born at Montreal, May 20th, 1914; Educ.: B.Eng. (Elec.), McGill Univ., 1937; R.P.E. of Que.; 1937-38, student engrs. course, and 1938 to 1940, student engr. and asst. engr., Montreal divn. plant engrg. office, Bell Telephone Company of Canada; 1940-41, Lieut., R.C.C.S. (A.F.), at present, E Section Commander, 4th Cdn. Divn. Signals. (St. 1937).

References: A. B. Hunt, E. Baty, C. V. Christie, R. DeL. French, G. A. Wallace, H. J. Vennes...

SMILEY—DONALD CHARLES, of 357 Victoria St., Kingston, Ont. Born at Ottawa, July 29th, 1917; Educ.: B.Sc., Queen's Univ., 1940; 1940-41, demonstrator, mech. engrg. dept., Queen's Univ.; May 1941 to date, instructor, R.C.A.F. Radio Detachment, Queen's University, Kingston, Ont. (St. 1938).

References: D. M. Jemmett, L. M. Arkley, L. T. Rutledge, D. S. Ellis, J. B. Baty.

Industrial News

Industrial development — new products — changes in personnel — special events — trade literature

AIR RAID SYRENS

A 4-page bulletin No. 4110, recently issued by Burlec Limited, Toronto, Ont., features the "Burlec-Carter" syrens, designed by Carters of Nelson, Lancashire, England and now built by "Burlec" in Canada. The salient features of these syrens are given.

C-G-E APPOINTMENT AT PETERBORO PLANT

H. A. Gadd, for the past seven years manager of Carboloy and Metals Products for Canadian General Electric Co., Limited, has been appointed assistant general superintendent of the company's gun carriage plant at Peterborough. Mr. Gadd's promotion to this responsible position comes after almost twenty years of experience with Canadian General Electric.

CENTRALIZED SYSTEM OF LUBRICATION

The Farval Corporation, Cleveland, Ohio, has issued an 8-page bulletin, Form No. 167 which, under the title "Why Farval," describes "Farval" centralized system of lubrication. After a brief comment on the importance of correct lubrication in maintaining high production schedules, the booklet deals with the simplicity of the "Farval" system, illustrates its component parts, and charts 12 distinct savings effected.

DRILLING MACHINES

Canadian Blower & Forge Co. Ltd., Kitchener, Ont., feature in their 8-page bulletin No. 2726-C, the "Buffalo" No. 14, high speed sensitive drilling machines, which are available in either bench or pedestal type models, in single or multiple spindle units. Illustrations, dimensional drawings and specifications are given.

CENTRAL OFFICE NOW IN TORONTO

Canadian Johns-Manville Co., Limited has moved its Canadian headquarters to 199 Bay Street, in downtown Toronto. This office was formerly located at Leaside where the Toronto district warehouse remains. The telephone number of the new offices is Adelaide 9431.

ELECTRICAL EQUIPMENT

In a 62-page looseleaf catalogue, E. W. Playford Limited, Montreal, Que., has incorporated information covering a wide range of electrical equipment produced by manufacturers for whom the company is sales representatives. Illustrations, specifications and other data are included.

ELECTRICAL INSULATION

Bulletin No. CG9.D, 20 pp., issued by Fiberglas Canada Limited, Oshawa, Ont., describes the method of production of "Fiberglas" and its application for electrical insulation. A section deals with the electrical properties of "Fiberglas" and is followed by sections on insulating tapes, cordage, braided sleeving, and varnished or impregnated materials with "Fiberglas" base. Illustrations, curves and specification tables are included.

HOISTING EQUIPMENT

The Yale & Towne Mfg. Co. Canadian Div., St. Catharines, Ont., are distributing a 44-page Catalogue dealing with hoisting equipment. Introduced by a comparison of the three types of chain hoists, and an outline on how to select the proper type of hoisting equipment, this catalogue is really a "text book" on the subject. It contains a large number of illustrations, tables and specifications with details of design and characteristics covering the four types of hoists—differential, spur-geared and screw-geared and various modified types, notably—clevis, trolley, rail hugger, twin hook and extended wheel.

REPRESENTATIVE FOR WINDSOR DISTRICT

Railway & Power Engineering Corporation Limited announce the appointment of E. S. Mitchell, President and General Manager of Windsor Brass Works Limited, as Representative in Windsor, Ont., district of Canadian Controllers Limited.

HEAVY DUTY PRODUCTION DRILL

"Buffalo" No. 15 heavy duty production drill; No. T-15 tapping machine; and accessories, are dealt with in the recently issued 8-page bulletin No. 2963-D of Canadian Blower & Forge Co. Ltd., Kitchener, Ont. Detailed descriptions, drawings and illustrations are given for each. The accessories include a slow speed attachment, straight shank adaptor and mortising attachment.

PRESIDENT OF B. F. GOODRICH

G. W. Sawin has been elected President of the B. F. Goodrich Rubber Company of Canada, Limited, which position was previously held by John L. Collyer who now becomes Chairman of the Canadian Company's Board of Directors in addition to being President of the B. F. Goodrich Company, Akron, U.S.A. Mr. Sawin has been with the company for over twenty-nine years and was Vice-President and General Manager for the past five years.

SWITCHGEAR

Catalogue No. 42, 250 pp., published by Canadian Line Materials Ltd., Scarboro Junction, Ont., presents well-illustrated details of Canadian Line Materials and Delta-Star products. This catalogue includes data on outdoor bus supports and fittings, switches and fuse mountings, high tension switching equipment, bus bar clamps, pipe structure fittings, spool insulator cable fittings, indoor bus supports and fittings, indoor switch and fuse mountings, and switchgear control accessories.

MANAGER CARBOLOY DIVISION OF C-G-E

Mr. Charles Neal has been appointed as manager of Carboloy and Metals Products Division of Canadian General Electric Co., Limited, succeeding Mr. H. A. Gadd. Mr. Neal was formerly in charge of sales of this product.

FREQUENCY CHANGER

As described in a folder issued by Milton-Thompson Electric, Toronto, Ont., the "M.T.E." induction frequency changer is designed to furnish 3-phase, 60-cycle current for fluorescent lighting, motor testing, X-ray, etc., where the primary source is 3-phase, 25-cycle. These frequency changers have been supplied in capacities from 1 to 150 Kv.a.

DOUBLING PLANT CAPACITY

Canada Illinois Tools Ltd., 177 Front St. East, Toronto, manufacturers of metal-cutting tools, hacksaws and gauges, are doubling their plant capacity to take better care of present business expansion. It is expected that the increased facilities will be in operation early in November.

TEMPERATURE AND PRESSURE CONTROLLERS

The 8-page catalogue No. 77-2 issued by Minneapolis-Honeywell Regulator Co. Ltd., Toronto, Ont., emphasizes the fact that "Automatic control stops wasteful hand regulations." This bulletin describes the company's line of "Brown" non-indicating air operated controllers for temperature and pressure. Illustrations, sectional and dimensional drawings, specifications and tables supply complete data regarding these instruments.

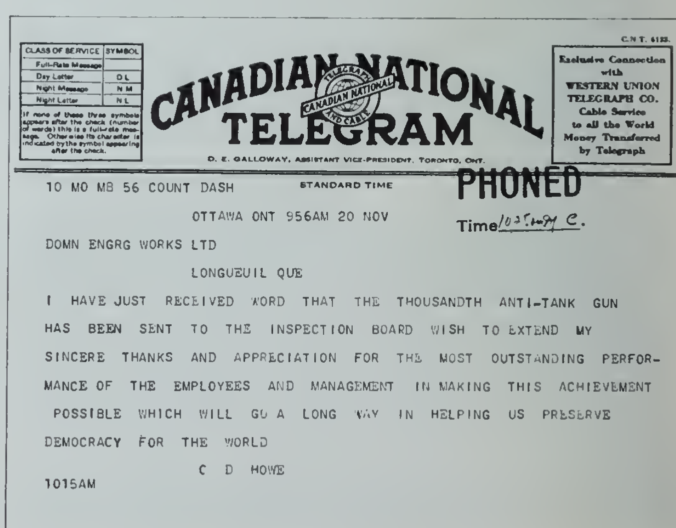
TUBE CLEANERS AND EXPANDERS

Affiliated Engineering Corps. Ltd., Montreal, Que., have issued a 16-page catalogue devoted to the products of the Airetool Mfg. Co. of Springfield, Ohio. This publication describes the "Airetool" tube cleaners, tube expanders and refinery specialties. Each type is thoroughly described and illustrated and is accompanied by a table of specifications.

WORM GEAR SPEED REDUCERS

Cleveland Worm & Gear Co., Cleveland, Ohio, has issued an 8-page bulletin designated as Form No. 150. Entitled "Background," this booklet reproduces quotations from a series of letters from manufacturers who began purchasing these drives 15 to 20 years ago. The conditions under which the worm gear driven machinery must operate in each industry are described.

Commenting on the telegram reproduced herewith, the President of the Company, Mr. W. F. Angus, said: "The credit goes to our employees. I am sure the Minister's telegram will spur us all on to even greater efforts. Right now the Plant is far ahead of original production schedules."



CANADIAN NATIONAL TELEGRAM

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